STOCK BUBBLES:
THE THEORY AND ESTIMATION

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by

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For my husband, Ping. You suffered the most. Apart from being my support system, you were also denied the love, care and company of a wife and a family for four years in a row. You are one in a billion.

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Abstract

This work attempts to make a breakthrough in the empirical research of market inefficiency by introducing a new approach, the value frontier method, to estimate the magnitude of stock bubbles, which has been an interesting topic that has attracted a lot of research attention in the past. The theoretical framework stems from the basic argument of Blanchard & Watson's (1982) rational expectation of asset value that should be equal to the fundamental value of the stock, and the argument of Scheinkman & Xiong (2003) and Hong, Scheinkman & Xiong (2006) that bubbles are formed by heterogeneous beliefs which can be refined as the optimism effect and the resale option effect. The applications of the value frontier methodology are demonstrated in this work at the market level and the firm level respectively. The estimated bubbles at the market level enable us to analyse bubble changes over time among 37 countries across the world, which helps further examine the relationship between economic factors (e.g. inflation) and bubbles. Firm-level bubbles are estimated in two developed markets, the US and the UK, as well as one emerging market, China. We found that the market-average bubble is less volatile than industry-level bubbles. This finding provides a compelling explanation to the failure of many existing studies in testing the existence of bubbles at the whole market level. In addition, the significant decreasing trend of Chinese bubbles and their co-moving tendency with the UK and the US markets offer us evidence in support of our argument that even in an immature market, investors can improve their investment perceptions towards rationality by learning not only from previous experience but also from other opened markets.

Furthermore, following the arguments of "sustainable bubbles" from Binswanger (1999) and Scheinkman & Xiong (2003), we reinforce their claims at the end that a market with bubbles can also be labelled efficient; in particular, it has three forms of efficiency. First, a market without bubbles is completely efficient from the perspective of investors' responsiveness to given information; secondly, a market

with "sustainable bubbles" (bubbles that co-move with the economy), which results from rational responses to economic conditions, is in the strong form of information-responsive efficiency; thirdly, a market with "non-sustainable bubbles", i.e. the bubble changes are not linked closely with economic foundations, is in the weak form of information-responsive efficiency.

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Chapter 1 Introduction

1.1 Research Background and Aims

The Efficient Markets Hypothesis (EMH) had been a central proposition of the academic finance before the 1980s. Shleifer (2000) emphasised that the field of finance in general and security analysis in particular was created on the basis of EMH. Jensen (1978), one of the pioneering researchers of the EMH, declared that "there is no other proposition in economics which has more solid empirical evidence supporting it than the Efficient Markets Hypothesis". However, after more than thirty years' pondering, the initial perception of EMH is significantly diminished by the perplexing look of the real-world stock market. The challenge to the EMH is initially raised by more and more frequent bubble events of the real-world and the testing failure of EMH. To cope with the weakness of EMH in explaining the real-world events, the idea of rational bubbles was advanced as a compromised replacement in the early 1980s. However, the school of rational bubbles merely concentrates its research on verifying stock bubbles, which leaves the argument of market inefficiency at a primary stage of discussion. Thus, in the past decade, as an opposite school of EMH, a new discipline of the stock market theory, behavioural finance, which challenges the theory of efficient markets and is delicated to explaining the inefficiency of a stock market, stands out.

Although the school of rational bubbles and behavioural researchers have been trying to formulate a framework containing stock bubbles to explain the real-world phenomena in recent years, all these attempts hardly give a coherently convincing answer due to the limit of methodology. Furthermore, the ongoing studies in stock markets have a fatal problem. Summers (1985) stated that traditional finance is not interested in the determination of stock values, but in the price movement itself. In other words, traditional finance is more interested in testing if there is price difference between two 8 oz bottles of ketchup and one 16 oz bottle of ketchup, than in understanding what determines the actual price of ketchup. Despite considerable progress in behavioural finance, however, as addressed by Shleifer (2000), the knowledge of determination of security prices still remains limited. Being aware of the academic discrepancy in studying stock market inefficiency, we aim to ease this discrepancy by changing the course of the bubble research from testing the market inefficiency and modelling investors' behaviours to measuring the level of market inefficiency (i.e. measuring the magnitude of bubbles). In the case of Summers (1985), our work aims to calculate the mispricing level of two 8 oz bottles of ketchup if the price of one 16 oz bottle of ketchup is right and treated as a benchmark. Certainly, the measurement of the mispricing level will in turn facilitate the study in understanding the determination of the actual price of ketchup. Shleifer (2000), one of the creators of behavioural finance, believes that "what we know now is quite a bit different from what we thought we knew in 1978". It is believed that the success of bubble measurement will help us substantially to further update what we think we know already.

The line of thought above about the research background and aims will be portrayed in details below.

1.1.1 The Development of Academic Views on Stock Bubbles

The efficient market hypothesis (EMH), which is the central part of efficient market theory, is known generally as a foundation of modern financial economics. Under EMH, the stock prices incorporate and reflect all the relevant information, i.e. no investors can beat the market by buying securities at bargain prices. However, this hypothesis seems over-idealistic in front of the real world where we witness winners and losers everyday. With the development of capital markets, EMH has been gradually losing its unique power, since its theoretical foundation is heavily challenged by the controversial reality. As summarised by Shleifer (2000), there are three weaker assumptions in EMH: first, investors are assumed to value securities rationally; second, even though some investors are irrational, their random trading will cancel each other out without affecting prices; third, the rational arbitrageurs will eliminate the irrational influence on prices, even if the irrational behaviours fail to offset each other. Many real-world stock market crashes and empirical results have appeared to show the existence of irrationality. Furthermore, some experts, such as Blanchard and Watson (1982), Flood and Garber (1980) and Diba and Grossman (1987) pointed out that the rational market may also contain the expectation distortion which is defined as rational bubbles. From then on, the enormous topic of EMH has been standing in a hot position strongly challenged by the bubble school.

The idea that bubbles in stock markets might exist is often traced to John Maynard Keynes's (1936) description of an equity market as an environment in which speculators anticipate "what average opinion expects average opinion to be," rather than focusing on things fundamental to the market. He describes the forecasting of stock prices as conjectures about the winner of a beauty contest. The candidate's beauty is not the basis of prediction. What is crucial is how one thinks the other judges' perceptions of beauty will be reflected in their voting patterns. Keynes's analogy seems striking and interesting; however his picturesque account appears embarrassing for the absence of proof.

With the development of the real world economy, the intuition that bubbles may exist is progressively stronger. More and more economists stand on the hypothesis of the existence of rational bubbles. Rational bubbles arose with the development of an explanation for the movement of stock prices. The simple present-value model based on constant discount rates and rational expectation bears a low power to explain the capricious behaviours in stock markets and was rejected by some pioneering financial economists in the 1980s.[1] Shiller (1981) proposed and verified that stock prices are too volatile to be justified by changes of dividends. While some researchers attributed the failure of explanation to the irrational behaviours, rational bubbles were viewed as a more theoretically reasonable and parsimonious alternative. From then on, economists have paid widespread professional attentions to bubble issues. However, this research is stuck in the hypothesis test which suffers from many unreasonable assumptions and statistical biases. Therefore, with the aid of psychology, the effort goes further to model individual behaviours, which are the major source forming prices.

After nearly two decades' investigation, the knowledge of investors' behaviours and capital markets constitutes a new area of research - behavioural finance, which was eventually created as the opposite of the efficient market hypothesis (EMH). In broad terms, behavioural finance argues that models containing irrationality can explain some financial phenomena better (Thaler, 2005). In order to show the irrationality, this new school of research draws the attention from the normative economic model to the psychological findings which precisely demonstrates that investors do not deviate from rationality randomly, but rather most deviate in the same way. Undoubtedly, this theoretical breakthrough eventually pulls down the foundation of EMH. Thaler (2005) attributes the success of behavioural finance to its two building blocks: theories of "limits to arbitrage" and psychology. However, the theoretical success is overshadowed by the lack of evidence for the assumption of the behavioural model in explaining the reality (i.e. lack of evidence that agents actually behave the way that a model claims they do.). Thaler (2005) raised two empirical weaknesses on the behavioural model. First, he mentioned that the massive psychological descriptions about people's cognitive biases offer behavioural

[1] Stephen LeRoy and Richard Porter(1981); Robert Shiller (1981); Marjorie Flavin (1983); Robert Pindyck (1984); James Poterba and Lawrence Summers (1986); N. Gregory Mankiw et al. (1985); Allan Kleidon (1986); Terry Marsh and Robert Merton (1986); Robert Flood et al. (1986); John Campbell and Shiller (1987); Kenneth West (1987,1988a), Froot (1987); John Cochrane (1989).

modelers so many degrees of freedom that anything can be explained. Second, the empirical evidence in behavioural finance is not ample enough to verify the assumption of the behavioural model. In other words, it is argued that behavioural modelers can always model a specific form of irrationality to explain the reality but lack the evidence to prove their behavioural assumptions. To emphasise this weakness in behavioural finance, he concluded: “we should be skeptical of theories based on behavior that is undocumented empirically. Since behavioral theories claim to be grounded in realistic assumptions about behavior, we hope behavioral finance researchers will continue to give their assumptions empirical scrutiny.”(Thaler, 2005)

It is worth mentioning a recent article which tries to describe the principles of bubbles. Kevin Hasset (2002) published a new science of stock market, so called bubbleology. Based on the analysis of the existing efficient market and the bubble theories, he supports the idea of existence of irrationality and bubbles in the stock market and proclaims that if investors believe they can sell the stocks with higher prices, the present stock prices could contain bubbles.

Obviously, the academic studies are full of arguments but lack concrete evidence, which waits for a breakthrough idea to lead to new development of empirical studies. No doubt, this impregnable opinion should also fully reflect the real-world image.

1.1.2 The Real-World Image: Historical Events

In the financial area, the early bubble events normally cited by stock market experts are the “Tulip Bulb Mania” in the 1630s, the “South Sea Bubble” and the “Mississippi Bubble” in the 1710s.

The “Tulip Bulb Mania” in Holland was stimulated by a non-harmful plant virus called mosaic which gives tulip petals beautiful “flames” of colour. The effect of this mosaic highly increased the value of tulip bulbs, which were already rare and exclusive status symbols and novelties for the rich and famous. The rapidly rising price quickly attracted speculators who traded in their land, livestock, farms and life savings to acquire one single tulip bulb. In 1636, tulips were trading on the Amsterdam stock exchange as well as on exchanges in Rotterdam, Harlem, Levytown, and other exchanges in other nearby European countries. Moreover, option contracts were offered to speculators which further activated the speculation and increased risk. With the regulation developed by the Dutch government to help control the tulip mania, people started realising that tulips were not worth the prices they were paying. In less than six weeks, tulip prices crashed by over 90%. The price of tulips at the height of the mania was $76,000 and was less than $1 after the crash. The financial devastation that followed this crash lasted for decades.

Another terrible historical bubble was the “South Sea Bubble” that started in 1711 in Britain. In order to finance the debt caused by a war, the British government gave exclusive trading rights in the South Sea to a financial institution, the South Sea Company, which planned on developing a monopoly in the slave trade. Share prices were quickly boosted by the perception of investors who perceived the value of the South Sea Company in the monopoly of the South Sea. However, the South Sea Company didn’t operate well due to the widespread corruption that occurred among directors, company officials and their political friends. Eventually, after 1718 when Britain and Spain went to war again, company directors realised that this company wasn’t generating any profit from its operations and sold out completely. A panic started when investors became aware that the company was profitless. To recover from this crash, the issuing of shares was outlawed for nearly one century.

At the same time as the “South Sea Bubble”, the “Mississippi Bubble” occurred in France. In order to stabilise the economy, the “Banque Generate” was established, which took deposits of gold and silver and issued paper money in return. The

“Banque Generate” was merged in the Mississippi Company. The shares of this company could be bought and paid for with bank notes or with government debt. When this company expanded to monopolise all French trade outside Europe, its share price rapidly increased to around 190% in a year. However, hyperinflation caused by the massively increased amount of bank notes devaluated the bank notes which were no longer backed by previous metals. Shares collapsed 90% in half a year. The collapse of the “Mississippi Bubble” gave France and Europe a severe economic depression.

The three crashes detailed above rang the red alert to the people who never carried the conception of bubbles before. Although these events ended up with terrible losses for investors, the miserable memories were not imprinted in their minds, as those bubbles were merely considered as contingencies not likely to be repeated often. Until the extensive crash of 1929 in the American stock market, people had started to believe that stock markets not only carry fortune but also contain the dangerous element of bubbles. In the 1920s, the American economy benefited from the increased industrialisation and new technologies. Influenced by the exuberant economy, the stock market also soared and bubbles were inflated. From 1921 to 1929, the Dow Jones went up more than 600% from 60 to 400. However, in 1929, the Fed raised the interest rate to cool the overheated stock market, which caused a panic of selling among investors who realised the stock boom had been an over-inflated bubble. In three days, the New York Stock Exchange erased over 5 billion dollars. The depression was gone over 26 years.

After more than half a century’s tranquility, when the stock market was generally believed to be efficient, three bursts happened in succession. The disclosure of illegal insider trading exploded the inflated bubbles of the 1980s in the American stock market. Unlike the bubble events of 1929, the crash of 1987 recovered quickly due to the relatively strong foundation of the economy and the stimulation of the bull in the

Japanese stock market. However, soon after, at the beginning of the 1990s, the Japanese stock market finally crashed after a thirty-five-year-long amazing boom. The crash was stimulated by the raised interest rate and was worsened by realising the stocks were over-valued. Meanwhile, new bubbles blew up again stealthily in Nasdaq due to an economic recovery and greatly increased output caused by computer usage and internet technology, which once again raised the mania in the American stock market during the late nineties. However, the over-output reduced the profit margin of companies, and finally gave rise to the burst in Nasdaq at the beginning of the new era of the twenty-first century.

If the historical bubbles before the 1980s were considered as the abnormal phenomena of stock markets, the recent evidences of bursts are ample enough to reveal the persistent existence of bubbles. In essence, the market value generally deviates from and is most likely above the fundamental value. Bubbles are not remarkably perceived by the market simply because they are always imperceptible until the sudden burst (the above historical events are summarised in Appendix 1.1).

1.1.3 Research Motivation and Aims

With more and more frequent crashes in stock markets, research attention on the topic of bubbles has been gradually increasing. However, what have we learnt from the studies of bubbles since the first bubble of the "Tulipmania" in the 1630s? The answer is not clear-cut, since the results of bubble investigations are not satisfactorily convincing in offering a good explanation of the phenomena; for example, the rational bubble tests are weakened by excessive assumptions as well as statistical biases, and the behavioural models are hardly verified empirically.

Furthermore, the confusion of the stock market theory raises questions in other financial economic research, since most of the conventional contributions stand on the ground of EMH which is commonly doubted at present, and they are hardly updated without a fresh practical stock market theory taking the place of EMH.

In order to solve the above problems plaguing the academia, an idea to study the magnitude of the stock market inefficiency is procured. The initial inspiration comes from a comparison between the stock market and the goods market. If stocks are deemed as the "products" in stock markets, the study of inefficiency on the goods market may give the reference to the examination on the inefficiency of the stock market. Turning to the economic theories, the efficiency is discussed as the technical efficiency and the allocative efficiency respectively. The allocative efficiency exists when the economy is doing the best job possible of satisfying unlimited wants and needs with limited resources - that is, of addressing the problem of scarcity, and the technical efficiency is achieved when producers minimise the wastage of resources for a given output in the production process. Our ideas come from looking for the inefficiency generated in the stock price forming process, i.e. the inefficiency of a stock market is eased by minimising the stock price for a given fundamental value, which is concerned to be similar with the argument of technical efficiency in economics.

The success of this fresh idea will undoubtedly bring the new approach to the research of financial economics, in that it will not only bridges a link between the normative models and the behaviour study, but also provides a new practical foundation for the common financial economic research on the topic of the inefficient market. The major contributions in this work are illustrated in the sections below.

1.2 Theoretical Contributions: The Value Frontier Framework

The foundation of the new framework is a belief that stock bubbles persist in markets. This belief is adherent with Binswanger (1999) and supported by the recent real events in stock markets.

Returning to the pioneering bubble research, the attempt to detect bubbles started from the comparison between the actual performance of companies, fundamental values, and stock prices. Shiller (1981) examined the stock market inefficiency by jointly considering the stock price volatility and the changes in the actual cash flow. Also, Diba and Grossman (1987) verified that stock prices tie up with the dividend income. Meanwhile, the rational bubble school went further trying to verify the existence of bubbles. After that, behavioural studies such as Hong, Scheikman and Xiong (2006) argued that heterogeneous beliefs and psychological properties of humans are causes of bubbles. Stemming from these antecedent viewpoints and inspired by the development of research on production inefficiency, a new approach to measure the stock market inefficiency/bubbles is introduced by this study. It is concerned with the fact that the stock market may be efficient in revealing the information but not in responding to the information. If the opinion that bubbles commonly exist is accepted, the stock market inefficiency/bubbles can be measured by setting up a value frontier which empirically is the least-inflated price for given fundamental values. If it is assumed that at least one stock fully reflects fundamental values and undervaluation is not possible in the long run due to the short-sales constraint, this frontier in theory equals the fundamental value of a stock which is defined as the fundamental valuation of investors with a neutral expectation. Thus, the belief of market responding inefficiency, the determination of fundamental value under a condition of heterogenerity among investors, and the descriptive explanation on the causes of bubbles jointly form the theoretical foundation of the value frontier framework to support our empirical measurement.

It is worth noting that the value frontier framework does not completely conflict with the efficient market theory. The efficient market is considered as an ideal situation or equilibrium under which stock prices equal fundamental values. However, this equilibrium is just a theoretical expectation which can be very difficult to observe from the real-world stock market. As Hasset (2002) mentioned, the efficiency can be achieved only if the financial market strictly follows all the preconditions of the efficient market, which almost never happens in reality. Shleifer (2000) also puts forward the same argument that market efficiency only emerges as a special case, and is unlikely to hold under plausible circumstances. In addition, the value frontier framework combines the normative and behavioural studies together to accomplish the measurement of bubbles. In theory, it integrates some behavioural theories on the fundamental valuation and bubbles so as to set up the theoretical basis; in practice, it borrows some mathematical techniques from normative studies to formulate the fundamental value and estimate bubbles. In brief, the full content of the value frontier framework is to provide us with both theoretical and empirical foundation to measure the stock market inefficiency/bubbles, which will change the course of bubble researches.

Crucially for the above argument, the value frontier represents the fundamental value in theory, though empirically it is not exactly equivalent to the theoretically expected fundamental value, since the frontier of sample data may be higher than, or standing on, the equilibrium point. So the frontier is the best proxy of the fundamental value in an empirical context, since it represents the least-inflated price of a stock for its given fundamentals.

1.3 Empirical Contributions: The Estimated Bubble (or Bubble Index)

Obviously, the stock market inefficiency is affiliated with bubbles. If the fundamental value is uncertain, the magnitude of bubbles seems never to be obtained. However, the relative levels of bubbles can be detected based on the "value frontier" concept, which is our major contribution to empirical studies.

The measurement is based on the vast amount of historical data. After choosing the fundamental variables based on the pervious studies of rational bubbles (Shiller, 1981; Blanchard and Watson, 1982; Diba and Grossman, 1987 etc.) and fundamental valuation (Feltham and Ohlson, 1995 etc.), the estimated bubble can be measured by applying the cost frontier estimation technique. Among the sample observations, given a certain fundamental performance, the least-inflated price obtained is picked up as the value frontier, which is then used as a benchmark to measure the deviation of stock prices relative to the value frontier, i.e. a bubble index (or the estimated bubble), by comparing the value frontier with the prices of other stocks.

The empirical modelling of value-frontier is very flexible, in that the structure of fundamental variables can be adjusted in accordance with any particularities. Therefore, this methodology of bubble measurement can be applied in both macro and micro horizons.

1.3.1 Estimation of Bubbles in Macro Research

Normally, investigation starts with the most general case. Thus, the market level estimation without involving risks is firstly conducted using aggregate data in a panel. The market-level model starts from the basic model of fundamental valuation (for example, the model by West [1987]) with only one variable, dividends, as its fundamental variable. The magnitudes of the bubbles of 37 markets in our sample are clearly shown for the first time. This group of numbers are further proved different from variables, such as price-earning ratio and price-dividend ratio, which implies that our estimated bubbles embed different information from the price-earning ratio and price-dividend ratio. Furthermore, our study goes further to primarily examine the relationship between bubbles and the expectation of real economic activities by reviewing two bubble events in the 1990s: the “dot-com fad” and the “Southeast Asian financial crisis”.

Moreover, the relationship between stock markets and the real economy is further discussed by regressing the stock prices, the estimated bubbles and the proxy of fundamental values with some real economic factors respectively. In this study, an “economic enigma”- the “share price-inflation puzzle” - is re-examined by taking bubbles into account. The findings are remarkable in that, in theory, instead of EMH by default, an account of bubbles is embedded into stock prices to derive the relationship between stock prices and some economic factors, particularly inflation. Empirically, the market-level bubbles make the empirical work feasible and interplay with the theoretical deduction. The “economic enigma” is eventually clarified theoretically and empirically on the basis of a bubble framework.

1.3.2 Estimation of Bubbles in Micro Research

Further effort is made in the micro firm-level estimation for three markets: the U.S., U.K. and China. Based on some antecedent ideas in the research area of the capital market in accounting, especially the residual income model of Feltham-Ohlson (1995) (F-O Model), a more delicate pattern is devised in the firm-level value frontier model. The accounting numbers, such as earnings and the book value of equity, are employed to pick up the fundamental value. In addition, the risk is also considered in the model. The bubble comparisons at firm and industrial levels reveal a tendency for bubble converging among the U.S., the U.K. and the Chinese stock markets. Meanwhile, for the Chinese stock market, the figures of the estimated bubbles also imply that, as an emerging market that is still struggling to pave a shortcut to catch up with the developed markets, investors in this market have become more rational, i.e. bubbles formulated by investors’ thoughts in the Chinese stock market are not more absurd than the ones in mature markets.

Moreover, it is argued that the estimated firm-level bubbles bear more information than the market-level bubbles. The market average level of bubbles appears to be more stable over time than the bubble movement of each individual stock, which implies that the risk-adjusted investment strategy plays a significant role.

1.4 Research Outline

After several decades' investigation, the theories and reality both explicitly reveal that the intuition about the inefficient stock market is not just a fanciful thought. However, it is not easy to prove EMH inappropriate and to accept the idea of persistent bubbles. The investigation is therefore needed for the evidence collection. Our idea in this work is triggered by the pioneering thoughts which are fully reviewed in Chapter 2, where three areas of research are surveyed.

The first area is the general bubble research. The attention in this part is drawn on the efforts to verify bubbles, and the behavioural finance. Although standing alongside the rational bubble school and the behavioural finance to provoke the market inefficiency, to some extent, the goal of our investigation is not identical to them since the theories of behavioural finance care more about the behaviours causing bubbles than the level of bubbles, and the school of rational bubbles is only interested in the statistical test on the existence of bubbles. The second area touched on in this work is "stock price-inflation relation" which is regarded as an "economic enigma" unsolved until now. Some of the contributions of the ongoing work are still accepted in our new research pattern, which will also be surveyed in this chapter. The third area of the capital market research in accounting gives rise to the inspiration for the firm-level value frontier modelling. The residual income valuation model is given particular attention.

After reviewing the antecedent work, in Chapter 3 we go further to study the current bubble theories and research methodology. With understanding of the limitations in the current research, the value frontier framework and its assumptions are then discussed in details. Some concepts in the current stock market research, such as mistaken beliefs, optimism effect, resale option effect, speculation, noise trading, rationality (and irrationality) and market friction are reconsidered and jointly analyzed in this chapter.

The endeavor does not stop at the theoretical side. An empirical study integrated with the theory is also attempted. Chapter 4 is devoted to the empirical estimation of bubbles at the market level. The understanding is enhanced, since the bubble path graphed by the estimated bubbles illustrates the persistence level of stock prices deviated from their fundamental values. Moreover, the chapter also tests whether the estimated bubbles are different from price-earning and price-dividend ratios in terms of the information embedded.

A further effort in a macro horizon is also made in Chapter 5. The aim of this chapter is to apply bubble theory to explain the "share price-inflation puzzle" by taking account of an inefficient stock market. The "share price-inflation relation" is tested using a method whereby a share price is decomposed into two parts, the fundamental value and bubbles, to be explained by inflation respectively in regression. It is found in our empirical work that the effect of inflation on share prices is made through the changes of interest, not bubbles or fundamental values.

Thereafter, the firm-level value-frontier estimation is conducted in both chapters 6 and 7. Chapter 6 is devoted to constructing a sound firm level value frontier model by employing a commonly acknowledged residual income valuation model devised by Feltham and Ohlson (1995). The model is put into empirical estimation for the data of U.S. and U.K. stock markets. The bubble patterns at the industrial level are drawn by the estimated firm-level bubble. In fact, although applause should be raised for the success in the estimation of the firm-level bubbles, the bubble pictures in these two developed markets are not entirely intriguing, since the researchers of the bubble school have been studying both markets for a long time. Thus, the examination for an emerging market, the Chinese stock market, is more attractive, which is obtained in Chapter 7. The firm-level value frontier model is adjusted for the Chinese stock market according to a particularity that more than half of the shares are not tradable in the public market. The investigation on this market is carried out by jointly plotting the bubble figures of the U.S. and U.K. markets. The comparative study highlights a Chinese stock market that is moderate at present with more experienced investors in it.

The value frontier methodology paves a new way for the inefficient market research. The predominance of this idea and the findings of our work are succinctly highlighted in Chapter 8. Also, in this final chapter, the description ends with the prospect of extensive future work.

Appendix 1.1 Historical Events of Bubbles

Bubble	Place	Time	Initial Displacement	Stimulator of Crash
Tulip Bubble Mania	Holland	1630s	Mosaic virus produced beautiful looking tulips; Prosperity of Holland	Government regulation to control the tulip craze
South Sea Bubble	Britain	1711-1718	Supposed monopoly on trade with Spanish ruled parts of America	Failure of management and leaders' selling
Mississippi Bubble	France	1717-1720	Rapidly growing trade with the New World	Hyperinflation
Stock Market Crash of 1929	America	1921-1929	Economic boom after the World War I	Increase of the interest rate
Stock Market Crash of 1987	America	1986-1987	Takeovers, leveraged buyouts and merger mania	Discovery of inside-trading
Nikkei Bubble	Japan	1950-1991	Economic boom after the World War II	Increase of the interest rate
Dot-Com Bubble	America	1990s	Economic Growth caused by the techniques of computer and internet	Reduced profits caused by the over output

Sources: Shleifer (2000); http://www.stock-market-crash.net

Chapter 2 Literature Review of Current Studies in Stock Bubbles

This chapter reviews literature in relation to bubble researches starting from the 1980s when the financial theory of the efficient market hypothesis (EMH) was challenged by studies of the excess volatility of stock prices. The review is also extended to study the relationship between share prices and inflation so as to understand how the relationship between them is viewed in the past, which can help us make a new approach to look at this relationship through the application of our bubble research. This extension of the review is further followed by reviewing the accounting research on the company fundamental valuation, which is our theoretical basis for the firm-level bubble estimation in this thesis.

2.1 The General Review of Research on Stock Market Bubbles

Bubble research is needed to understand the cause of the volatility of stock prices. In order to find out the reason for excessive price volatility, two schools of research are utilised. One is used to look for an explanation for stock price volatility from the movement of dividend and discount rate respectively. The other is to view stock price fluctuation as a result of bubbles. The latter defines a stock price as consisting of two basic components: market fundamentals and bubbles.

The bubble corresponding to noise trading and irrationality has been mentioned in many literatures regarding superior asset price movements. However, bubbles shouldn't be confined within an irrational approach. Since the 1980s, rational bubbles have been viewed as a reason for capricious behaviours in stock markets, while financial economists are vexed about explanations for all the financial market behaviours under the EMH. For example, Blanchard & Watson (1982) portrayed rational bubbles as the deviation of the price from its fundamental value. The market fundamental value of an asset as an intractable issue on bubble research is defined as the present expected discounted value of dividends (Flood & Garber, 1980). Diba & Grossman (1988b) illuminated a more theoretical definition which stated that "a rational bubble reflects a self-confirming belief that an asset's price depends on a variable (or a combination of variables) that is intrinsically irrelevant, i.e. not part of market fundamentals or on truly relevant variables in a way that involves parameters that are not part of market fundamentals."

2.1.1 Defining Rational Bubbles From A Theoretical Perspective

The theoretical efforts to understand stock bubbles can be traced back to John Maynard Keynes's (1936) description of an equity market as an environment in which speculators anticipate "what average opinion expects average opinion to be," rather than focusing on things fundamental to the market. He describes the forecasting of stock prices as conjectures about the winner of a beauty contest. The candidate's beauty is not the basis of prediction. What is crucial is how one thinks the other judges' perceptions of beauty will be reflected in their voting patterns. Even the supporter of EMH doesn't refuse the existence of irrationality. They believe that irrationality can not substantially affect the stock market efficiency since the noise traders merely cancel each other out and are squeezed out of markets due to bad profits. Moreover, the irrationality is commonly treated as the cause of many historical bubbles.

Blanchard & Watson (1982) believed that fundamentals are only part of what determines the prices of assets, and there can be rational deviations of the price from its value, which are rational bubbles. They defined two bubble paths: one is deterministic bubbles and another is explosive (stochastic) bubbles. In the first case, bubbles grow exponentially which means that negative bubbles are not possible, because a negative bubble today implies a positive probability of a future negative price. The second path pictures bubbles with a probability π to remain or to crash with the probability of 1- π. They also describe allegorically rational bubbles as Ponzi games: if a market is composed of successive generations of participants, then bubbles can emerge. Their intuition is that "bubbles are more likely in markets where fundamentals are difficult to assess". After exploring the pricing model with a rational bubble component carefully, Diba and Grossman (1987) believe that a rational bubble in the stock market must "start at date zero (the first date of trading) and this stock must have been continuously overvalued relative to market fundamentals". This implies that once a positive rational bubble has burst, it cannot restart. Tirole (1985) asserts that bubbles are present "with an infinite succession of overlapping generations of asset holders with finite planning horizons as long as the growth rate of the economy is greater than or equal to the required rate of return".

An intrinsic bubble is considered as a simplified alternative to the rational bubble. Froot and Obstfeld (1991) developed a nonlinear market price model that is a function of dividends only. [2] Since the model captures the idea that stock prices overreact to news about dividends, and intrinsic bubbles are not obviously inconsistent with the apparent time-series properties of stock prices, their tests seem more parsimonious and capable. Sutherland (1996) pointed out that due to the mean reverting property of an intrinsic bubble, it owns similar characters with autoregressive fad which should be distinguished from the intrinsic bubble. Driffill and Sola (1998) combined the opinion of an intrinsic bubble with the regime-switching in their model and verified that the Markov switching model is more reasonable than a dividend assumption of constant random walk with drift. Similar to the focus of Froot and Obstfeld (1991), Ackert and Hunter (1999) analysed the nonlinear relationship between prices and dividends with a consideration of how managers choose the dividend payout. Their dividend-controlled model implies that

[2] One striking property of an intrinsic bubble is that, for a given level of exogenous fundamentals, the bubble will remain constant over time: intrinsic bubbles are deterministic functions of fundamentals alone (Froot & Obstfeld 1991).

the non-linear relationship between prices and dividends may not depend on intrinsic bubbles. Empirically, in support of the intrinsic bubble model, Ma and Kanas (2004) revisited the intrinsic bubble model, of which the forecasting power is emphasised, against other bubble models.

Many assumptions with respect to bubble movements were documented in the above literatures. Unfortunately, the efforts do not dramatically improve the authenticity of the theory; in fact they make the bubble research ambiguous due to the unrealistic assumptions of bubble paths. In particular, in the conventional theory of Blanchard's bubbles[3], the bubbles are assumed to crash completely and never restart thereafter; in other words the bubbles crash only once, which is apparently an unrealistic assumption. In order to overcome shortcomings in former researches, a sound improvement in the bubble modelling was made by Fukuta (1998). They clearly categorised previous bubble models into two classes: the class of simple rational bubbles and the class of complicated rational bubbles, under which a new three-state bubble model, namely incompletely bursting bubbles, was designed. In their new model, bubble paths are classified into three states: a large bubble state, a small bubble state and an incomplete burst state, which integrates and enhances the previous bubble models by exhibiting a more reasonable picture of rational bubbles, in which bubbles are allowed to rise again after incomplete crashes.

Beside the endeavour on the design of bubble paths, the attention is also thrown on the economic background of the bubble modelling. Santos and Woodford (1997) systemically modelled an infinite-horizon economy in an intertemporal competitive equilibrium model, under which rational asset pricing bubbles may still be excluded. They proceed to an extensive result that the "Fundamental Theorem of Asset Pricing" designed in a finite-horizon economy can still be valid under an infinite-horizon assumption, i.e. rational asset pricing bubbles do not exist.

[3] Blanchard (1979) and Blanchard Watson (1982).

The above studies are interpreted within the compass of an infinite-dimensional economy. Alternatively, breaking the conventional belief of non-existence of rational pricing bubbles in a finite horizon, Loewenstein and Willard (2000) innovatively discuss the presence of bubbles in a finite-horizon continuous trading economy in which agents face wealth constraints. They conclude that bubbles are absent in a situation of positive asset supply, and when there is a zero asset supply, bubbles can generally exist.

2.1.2 Empirical Studies in Rational Bubbles

Along the direction of the bubble concept discussed above, empirical studies have been trying to develop new econometric techniques to find evidence for verifying the bubble hypothesis, while others lay particular stress on a well-specified model for fundamental values. However, the development of techniques is still very limited in helping to sufficiently prove bubble theories.

In order to test the excessive price volitility, Shiller (1981) first employed the Standard and Poor's series data that were used by most of the subsequent researchers. He defined separately "perfect foresight rational price" p*, which is the present discounted value of actual dividends, and its optimal forecast value - actual price p. He proposed that if markets are efficient, the actual price p, which is the expected discounted value of future dividends, should have less variance than p*, since the expected value of a set of numbers must be more stable than the numbers themselves, from which the variance bound inequality $V(p) \leq V(p^*)$ is deduced. The results of his statistical tests and the plot analysis give a positive answer to the question of whether stock prices move too much to be justified by changes in dividends. Meanwhile, LeRoy and Porter (1981) raised a similar test by employing the earning variable into the model. They reach the same conclusion as Shiller (1981) which is that stock prices are too volatile to be explained by the efficient capital market model. Although some critical issues are documented to the variance bound test, such as Flavin's (1983) argument about the small sample bias and the negative comments from Marsh and Merton (1986) regarding the unrealistic stationary dividend assumption, plausible results of this new test are deemed to be the initial evidence alerting the EMH supporters.

This idea was followed by West (1984)[4] who undertook a three-step test on stock bubbles by using Shiller's modified Dow-Jones and the Standard and Poor's data. His empirical work comprised of the Euler equation specification test, the estimation on a prediction function for real dividends and the test on the consistency of the two asset price models. [5] Among the three steps, the consistency of the two models in the third step implies the strong evidence of stock price bubbles, while the specification of the models in the first two steps is the necessary condition for the final test. Flood et al (1986) reviewed the work of West (1984) and concluded that the bubble test model employed by West (1984) was misspecified due to the problems of the assumptions of a constant rate of return, and stationary dividends and prices in West's work. After that, West (1987) developed and applied a new test for rational bubbles that "(a) allows for a wider class of bubbles; (b) is specifically designed to test against the alternative that bubbles are present, in contrast to the volatility tests of Shiller (1981) and LeRoy and Porter (1981) and (c) is able to be applied even when prices and dividends are non-stationary, again in contrast to the volatility tests". Estimations shown from these improved tests are that the annual data on the Standard and Poor's 500 Index (1871-1980) and the Dow Jones index (1928-1978) rejected the null hypothesis of no bubbles. In order to clarify the small sample power of West's test, Dezhbakhsh and Demirguc-Kunt (1990) modified the

[4] The original paper "Speculative Bubbles and Stock Price Volatility" is shown in financial research center memorandum No.54 in Princeton University.

[5] The first asset price model involves parameters estimated in the first two steps; the second asset price model involves estimating an unconstrained regression of the asset price on the information used to form the dividend forecasts.

third step of West's procedure while keeping the first two steps of the misspecification tests. Contrary to West's results, their two small samples cannot reject the non-existence of speculative bubbles.

Campbell and Shiller (1987) argue that if the first differences of the unobservable variables (e.g. the future tax treatment of dividend income) and the first differences of dividends are stationary (in the mean), and if rational bubbles do not exist, then the model implies that the first differences of stock prices are stationary, and stock prices and dividends are cointegrated of order one. The converse inference is cited by Dibba and Grossman (1988b). That is, if the first differences of stock prices have a stationary mean and/or the stock prices are cointegrated with dividends, rational bubbles do not exist. However, if the empirical test shows the opposite result, it doesn't imply the existence of rational bubbles since it may result from the nonstationarity of unobservable variables in market fundamentals. They proposed an empirical strategy based on stationary tests and rejected the existence of rational bubbles. However, the power of unit root tests is suspended by Evans (1991), in that the cointegration tests are misleading in the case of periodically collapsing bubbles. It over-rejects the null hypothesis of nonstationarity in favour of the non-existence of bubbles. The negative opinion on the cointegration test was also raised by Charemza and Deadman (1995). As they admitted, although their newly assumed bubble rout of the stochastic explosive roots (STER) are more parsimonious than the periodically collapsing bubble processes, it still holds a misleading nature when the unit root test is applied. This casts further doubts over the unit root tests for detecting bubbles.

Flood and Hodrick (1990) summarised misspecifications and drawbacks on bubble tests in past empirical literatures. They were concerned that the existing empirical tests of bubbles are more likely specification tests than pure bubble tests. At the same time, they threw a laudatory light on the stock price volatility tests that were implemented by West (1988) and Campbell and Shiller (1988 a, b) who specially consider the variance of discount rate in the volatility test, and stressed that bubble tests required a well-specified model of equilibrium.

Evans (1991) emphasises that bubbles appear to be empirically implausible unless there is a significant chance that they will collapse after reaching high levels. He reviews the previous unit root tests of detecting rational bubbles and concludes that these tests are unable to detect periodically collapsing bubbles, which as he admitted, are not affirmably present in stock markets, and the presence of rational bubbles remains an open question. Another empirical work for the explosive bubbles was implemented by Norden and Schaller (1993). Based on a model describing two bubble paths which are initially documented by Blanchard and Watson (1982), they found the evidence of regime switches in stock returns in Toronto Stock Exchange using switching regression techniques.

After demonstrating the problems in the data for the present-value model, Barsky and DeLong (1993) couched the stock price fluctuation in a rational expectation framework in which dividends follow a permanent growth rate. However, they didn't deny the existence of positive feedback trading and bubbles in stock markets, and comprehensively summarised three alternative categories of stock price models: present-value model; "irrational" present-value model; and "fads" and "irrational bubble" models.

McQueen & Thorley (1994) adapted the traditional duration dependence test and derived a new testable implication from the rational bubble model. In their test, the real monthly data of returns for both equally and value-weighted portfolios of all New York Stock Exchange stocks were employed instead of stock price data, and the rejection of the no-bubble hypothesis was particularly robust. Afterwards, Chan et al. (1998) extended this test method for six Asian stock markets (Hong Kong, Japan, Korea, Malaysia, Thailand and Taiwan) and found that none of these markets were likely to be consistent with the presence of rational bubbles when the duration dependence was applied. Fung (1999) reviewed Blanchard & Watson's (1982) two bubble types. After testing the value-weighted NYSE stocks that consist of 720 monthly arithmetic nominal returns, he found a significant duration dependence effect in a given return series and concluded that the duration dependence effect is uniquely associated with periodically collapsed bubbles.

Donaldson & Kamstra (1996) constructed a nonlinear ARMA-ARCH-ANN model to forecast the time-variant discounted dividend growth rate, which is a multiplier of the dividend in order to obtain the fundamental price. They found that under the new approximation procedure of fundamental values, the simulated fundamental values fitted the data of actual prices very well, and the unit root test failed to reject the hypothesis of no bubbles.

With the development of econometric techniques, the discussion of bubble tests is resuscitated in recent work. Taylor and Peel (1998) raised a new non-cointegration test for periodically collapsing bubbles to weaken the size distortion of foregoing tests. Shiller's (1989) data are duplicated in their work to reject the presence of bubbles. Psaradakis et al (2001) detected a periodically collapsing rational bubble based on random coefficient autoregressive models. Bohl (2003) applied the Enders-Siklos momentum threshold autoregressive (MTAR) technique to the examination of periodically collapsing rational bubbles. He ascribed his inconsistent results between the sub sample and the whole sample to the distinct performances between the short run and long run. Koustas and Serletis (2005) employed an autoregressive fractionally integrated moving average (ARFIMA) process to test the bubbles. Both the traditional unit root test procedure and the fractional integration test presented in their work reject the hypothesis of no bubbles. Cunado et al (2005) also applied the fractional integration test to the bubble examination. Instead of using the data of S&P 500 which are repeatedly used by most others, they focused attention on the NASDAQ performance. They concluded that the fractional integration test is sensitive to the sampling frequency.

In addition, empirical investigators are no longer satisfied with the unique sample of the U.S. market. They try to push forward the bubble research by applying a broader horizon of data. Ahmed, Li and Jr. (2000) examined the behaviour of the Shanghai stock index (China) during the 1990s since this stock market was established. Two alternative VAR models were estimated, one with global variables and another with domestic variables in the first differenced logarithmic form. Their empirical results are consistent with rejecting all nulls of no trends or persistence of bubbles and also with rejecting the null of no nonlinearity of the VAR residual series beyond ARCH effects. Although they recognised that their results must be viewed as provisional at best, the result of the existence of bubbles with possible nonlinear components in Chinese stock markets was fully obtained by their empirical work. Wu (2002) proposed a new testing procedure for rational bubbles in stock markets that improved the conventional unit root tests in the presence of collapsible bubbles. The tests were applied to weekly price and dividend yield data for the Standard and Poor's 500 Index and the Hang Seng Index (Hong Kong) from 1974 to 1998. The results suggested that, after taking into account the time-varying growth and risk-premium, the evidence of a bubble in the U.S. market is weak but in Hong Kong it is strong.

The investigation of rational bubbles aims to reveal how the market prices of stocks may deviate substantially from their fundamental values even when market agents are homogeneous, rational and the market is informationally efficient. Adam and Szafarz (1992) reviewed and analysed the traditional bubbles and rational bubbles in order to probe an intersection of foregoing variously defined bubbles. They consider that the answer for why and how the price deviates from fundamental values is still ambiguous due to the confused fundamental value criteria, and the study of economic behaviours which give rise to the rational bubbles might improve the understanding of the real world phenomena. A similar opinion is mentioned by Cuthbertson (1996, p157) who claimed that the "origin" of bubbles still couldn't be explained.

2.1.3 Behavioural Finance and Bubbles

Since the economic model cannot reach a consensus during two decades' investigation, the research on investors' behaviours becomes a fresh inspiration. Behavioural financial theories, which are mostly based upon the human psychology, are developed to describe and model the behaviours of investors in making their investment decisions, which offers an alternative to explain stock bubbles.

In fact, the effect of psychology on prices was demonstrated in the early part of the 20th century by some reputable economists, such as Adam Smith ("overweening conceit of mankind"), Irving Fisher ("money illusion"), John Maynard Keynes ("animal spirits in stock markets"), Harry Markowitz ("people focus on gains and losses relative to reference points") and Herbert Simon ("bounded rationality"). Besides, many financial economists and socialists have provided alternative theories to the CAPM when the assumption of rational and homogeneous investors is relaxed. Hirshleifer (2001) surveyed some psychological effects that are potentially relevant to securities markets and summarised the diversified examinations on the dynamic psychology-based asset-pricing theory. All these researches stem from one common belief that bubbles exist in stock markets to restructure the asset pricing model with the participation of psychological elements. To highlight the contribution of behavioural researches in terms of modelling bubbles, in this section we will only review some studies that demonstrate the effects of human psychological patterns and/or investors' behaviours on stock bubbles.

Allen and Gorton (1991) modelled two groups of portfolio managers who are described theoretically as one of the reasons bubbles form in an infinite horizon model with infinitely lived agents. White (1995) built a model of the brokers' loan market. He found that the addition of bubbles improves the fit of the model. In Kraus and Smith's (1998) sunspot model, a "pseudo-bubble", which is unlike a true bubble and rational bubble because "it has no probability of ever bursting" and is not necessarily positive, is described as being produced by the "endogenous sunspots" which are raised by some investors' uncertainty about others' beliefs. Shleifer (2000) connects the model of positive feedback investment strategies with the existing price bubble theories, and recapitulates the historical famous bubble events. According to the studies on ten historical bubbles, they pointed out that important new elements of noise trading and "smart money"[6] play a crucial role in the course of most bubbles. In the survey of bubbles in the area of behavioural finance, Shiller (2002) centralised the less-than-rational aspect of investors' behaviours by which bubbles are amplified. Particularly, he emphasised that some factors, such as the concrete translation about the Prudent Person Standard mentioned in a relative law, the news media, the beliefs of EMH and the professionals' "groupthink" etc., lead professionals to "ultimately end up generally assuming that what their colleagues believe is true". With the view of bubble growth and burst, Abreu and Brunnermeier (2003) studied the dispersion of arbitrageurs' opinions as well as their coordination and competition in the existing strategies. They concluded that bubbles can be long-lasting even though rational arbitrageurs are aware of the overvalued price. Scheinkman and Xiong (2003), as well as Hong, Scheinkman and Xiong (2006) highlighted that a bubble arises as investors' beliefs are heterogeneous and the optimism effect as well as the resale option effect jointly produce stock bubbles. Based on this theoretical argument, they found that the bubble's size dramatically decreases with float as investors anticipate an increase in float with lockup expirations and speculate over the degree of insider selling.

As a new layer of research regarding stock market bubbles, behavioural finance

[6] 'The smart people who bought it early selling to dumb people who bought it late.' Shleifer (2000)

paves a new way to closely examine the real occurrences. Different from classic economic research, behavioural studies began with the real world phenomena and the corresponding models are born to explain these happenings. However, as Shleifer mentioned in his book, “there is no single unifying model in behavioral finance…the field of behavioral finance is still in its infancy.” (Shleifer, 2000)

2.1.4 Summary

There are vast amounts of literature in this area. However, most of the bubble tests stand on a single market ground and strong assumptions on bubble movement paths make bubble research too far behind in terms of catching up with the real world. Furthermore, the majority of current empirical attention has largely focused on the hypothesis tests of existence of bubbles which are the first step towards bubble research. Demand for the appearance of more empirical evidence of bubbles calls for the study to move further to identify the magnitude of bubbles. Although the behavioural studies shine a light on the debilitated traditional bubble researches in terms of explaining the reality, it has its weakness in finding empirical support to its key assumptions about investors' behaviours. If the bubble of a stock can be measured or estimated, it will be significantly helpful for us to lift the limit in examining the bubble impact of various investment behaviours expected by the current theory of behavioural finance.

In addition, Shiller (2002) clearly indicates that “human patterns of less-than-perfectly rational behaviour are central to financial market behaviour, even among investment professionals”. However, most historical bubbles containing elements of irrationality cannot be interpreted by the rational bubble framework. Blanchard and Watson (1982) reveal why researchers lose sight of irrational bubbles: “It is hard to analyse rational bubbles. It would also be much harder to deal with irrational bubbles.” In spite of Blanchard's explanation, going along with Shiller, we confidently believe that, in most stock markets, irrationality generally exists. Therefore, this research is dedicated to developing a new technique to estimate bubbles caused by the interaction of rationality and irrationality without imposing the necessity of drawing any bubble paths.

2.2 Share Price-Inflation Puzzle

Challenging the EMH by verifying the market inefficiency, the school of bubbles has extensively documented stock bubbles, which paves a new way to explain the real-world occurrences plaguing the supporters of the EMH. However, the argument of "efficient or inefficient market" brings the confusion to the financial economic research, in which massive historical contributions were conducted on the basis of the EMH and were convincible in the era of the EMH. Therefore, the attention in this work is not only paid on the bubble picture itself, but also on a prospect to update the theories about the relationship between the economy and the stock market. A longstanding topic of the "share price-inflation puzzle" is targeted as an example in this work. Instead of the EMH, a bubble frame will be employed to derive the relationship between stock prices and inflation in Chapter 5. Thus, the former literatures in the area of share price-inflation relation are reviewed below.

2.2.1 Early Evidence of the Positive Relationship

Earlier opinions about the relationship between stock returns and inflation is based on the "Fisher Effect" (Fisher, 1930), in which a positive correlation between inflation and stock return is defined as the expected rates of return on common stocks which consist of a real return plus the expected rate of inflation. Dulan (1948) concurs with the positive correlation theory when he examines the performance of U.S. markets from 1939 to 1946, and concludes that the stock market functions as a hedge against inflation as the decline of purchasing power caused by inflation can be compensated for by the inflated dividends. However, this positivism is soon challenged by the puzzling empirical results which instead show a negative correlation between inflation and stock prices.

2.2.2 Micro Explanations to the Negative Relationship

The early question to the "Fisher Effect" was answered by Nichols (1968), based on an analysis of three distinct sets of claims on the return to capital outlined as follows: "Inflation will always diminish the real value of fixed income claims, increase the real value of the tax authority claims, and have an effect on the value of the equity claim". He implies that the inflation hedge is not true for all stocks. Firms with large monetary liabilities but low levels of depreciable assets will perform best. Motley (1969) extends Nichols' results from the standpoint of the tax law and concludes that a continuing high inflation tends to reduce the real value of capital-intensive firms.

Feldstein (1980) develops a model conveying how the inflation raises the effective tax rate on corporate-source income so as to reduce the price that investors are willing to pay for stocks. The constant rate of inflation and the expected future rate of inflation were shown to affect stocks differently. When a steady-state rate of inflation is higher, the share prices rise faster, but the expected future inflation causes a concurrent fall in the price-earning ratio.

Unlike Motley and Feldstein's accounting practice, Keran (1976) viewed the topic from a regulation standpoint and concluded that prices of utility stocks would be bid down by inflation relative to non-regulated industrial stocks in the same way that investors have bid down the prices of bonds relative to stocks due to the fact that the regulatory authority always attempts to maintain a constant nominal rate of return to utility firms in a period of accelerating inflation, leading to a decline in the real rate of return. He describes three interrelated factors by which an investor can value his equity: first, the dividends and/or capital gains; second, the discount rate he uses to determine the present value of his future earning; and third, the degree of confidence with which he holds his expectations, i.e. risk.

Modigliani and Cohn (M-C) (1979) claim that the inverse movement is a result of two investors' errors in valuing shares. First, investors do not recognise that the inflation will reduce the burden of debts so as to profit the shareholders. Second, investors fail to realise that inflation may raise the future nominal earnings. Following the Modigliani-Cohn (1979) hypothesis of two valuation errors, Cohn and Lessard (1981) observed eight countries' behaviours and concluded on a strong negative stock return-inflation relation for the sample countries. The value of their work not only adds on the innovative multi-countries touch, but also their theoretical foundation of the absence of an EMH is a welcome step forward. However, to our surprise, their model lacks specification, as interest rate and inflation existing together in the model causes it to suffer from a colinearity problem.

Feldstein and M-C's work theoretically explained the "economic enigma" from the different viewpoints. However, the limitation of dismissing other elements, such as foreign competition and declined productivity has been acknowledged. In particular, the unrealistic assumption in Feldstein's model that corporations have no debt and pay out all earnings in dividends makes his work less convincible. Gordon (1983) summarised the Feldstein and M-C theories, and set out a valuation equation for Tobin's q in which the two pioneer achievements were assimilated and improved. His findings confirmed Feldstein's explanation that inflation and the capital gain tax combined to reduce the after-tax return on shares. In addition, he concluded that Tobin's q fell between 1960 and 1980 in the U.S. market because of the decline of corporate profitability and the rise of the share yield required by the investors, and it will fall even further if nothing else changes but the inflation rate.

Carmichael (1985) presented a model showing that inflation levies a tax on corporate earnings through the cost of holding money and consequently depresses the stock price. Two effects on the stock price caused by inflation are contained in his theory: the decrease of firms' profits (dividends) and the dividends cut by the inflation-enhanced tax burden.

Deviating from other existing research, Sharpe (2002) tried to examine the negative relationship from the standpoint of stock valuation. After controlling for earning factors, the Price to Earnings ratio, which represents equity valuation, is still negatively affected by the inflation. The results confirm that two effects play the role in the negative relationship: real earnings growth and required real returns.

2.2.3 Macro Explanations to the Negative Relationship

The researches listed above imply a common idea that inflation depresses the stock prices through investors' expectation on the firms' real values measured by the discounted future dividend stream. While the researchers concentrated on the accounting explanations, Branch (1974) studied this topic from a macro standpoint. He indicates that instead of a one-to-one relationship, stocks may be only a partial hedge against inflation since inflationary expectations do depress stock prices. Three possible explanations are given for this strange occurrence: first, a high level of inflation may cause the government to adopt price control policies which are unfavourable to firms; second, countries with rapid inflation are likely to have overvalued currencies which put their export at a disadvantage due to the lagged exchange rate adjustments; third, business uncertainty is greater than before due to worse inflation expectations, which increases business difficulties. In addition, the impact of a tax increase may also worsen the situation. The empirical results are consistent with his consideration that stocks appear to be a partial rather than complete long-run inflation hedge. However, the compromise is not strong enough to explain the whole scenario.

Fama (1981) breathed fresh air into the investigation. He employed U.S. data and also reached a contrary to the norm conclusion that stocks move inversely with inflation. Although some supporters of the Fisher theory tried to maintain the traditional viewpoint, such as Firth (1979) who found evidence in British data in support of the "Fisher Effect", Fama offered a plausible explanation for the "economic enigma". He tried to release the "puzzle" from the view of traditional expectation combined with a macro opinion by explaining the negative correlation by a "proxy effect", i.e. the negative stock return-inflation relation is the proxy for positive relations between stock returns and real activity which negatively relates to inflation. His fresh idea and fully explained empirical work represent a milestone in this area. However, his work has been challenged by some of other experts due to the unanswered macro questions. Also, his American study obviously is not enough to generalise the theory. Running on the same track as Fama, Day (1984) theoretically derived the negative relations between stock returns and inflation that are respectively explained by the exogenous economic shocks. Although his model fails to embrace all economic situations, it proves that a negative returns-inflation correlation model can be achieved from the existing theoretical framework under certain conditions, and the derivations have no way of offending the market efficiency theory. Cozier and Rahman (1988) found that the inverse relationship between stock returns and inflation is spurious in Canada due to the result of causality tests that inflation does not cause real stock returns, and they explained the specious relation by the "proxy effect" defined in Fama (1981).

In Fama's theory, the changes of real activity affect inflation through the alteration of money demand. In contrast, Geske and Roll (1983) introduced a model from the standpoint of money supply. They presented an inverse causality between stock returns and inflation: the stock market signals the inflation, i.e. a depressed stock market will raise the government deficit, and then in such a situation the government would be more willing to monetise its debts, and the enhancive money supply will boost the inflation.

Hess and Lee (1999) innovatively put the supply and demand shocks into consideration at the same time. After testing the U.S., U.K., Germany and Japan, they conclude that the stock return-inflation relations can be either negative or positive depending on the relative importance of the two types of shocks. Their work seems to be just an update of previous research. However the full-scale examination reached a sound solution for the long existing puzzle.

Chang and Pinegar (1987) add the risk element into the Fama (1981) and Geske-Roll (1983) models. Under the belief of negative movement between stock returns and inflation, they conclude that the relationship becomes more negative as security risk increases.

The concern for the risk is also embraced in the research of Pindyck (1984), which attributes the decline of the New York Stock Exchange Index between 1965 and 1981 to the substantially increased riskiness of capital investment instead of inflation that is proved only to function as a negligible part in the whole effect. This riskiness was related to unanticipated regulatory changes, exchange rate fluctuations and competition. This paper seems to alleviate the confusion of anomalous movement between inflation and stock returns by explaining the depressed share prices as a result of increased riskiness. Hasbrouck (1984) also finds that the relationship between real activity and inflation appears to be a less important explanation of the inverse relationship between stock return and inflation; however, he finds that the increased uncertainty of the economy is a major contributing factor, while also confirming that the impact of inflation declines economic profits which in turn depresses share prices.

Theoretical support also comes from the research by Jovanovic and Ueda (1998), in which the modern monetary theory is improved to explain the inflation-stock return dilemma. They believe that both firms and workers confuse the absolute and relative price changes. Therefore, an expected inflation will shift real income from firms to workers, so that stock returns are lowered.

It is worth noting that a study on the stock market reaction to unemployment news by Boyd, Hu and Jagannanthan (2005) also sheds light on the puzzle of the “stock price-inflation relation”, since unemployment generally correlates with inflation. They raised an argument that the stock market’s response to unemployment news depends on whether the economy is expanding or contracting. The implication of their work on the “stock price-inflation relation” is that since stock prices can be influenced by three factors - the interest rate, the growth expectation and the risk premium which respond to the unemployment/inflation differently - stock prices do not need to go up when inflation falls.

The finding of the relationship brings to the minds of researchers an ambitious idea that stock markets may function as a predictor of inflation. Titman and Warga (1989) regressed the inflation change rate on the lagged stock returns using American data from 1979 to 1982, and reported a positive relationship between stock returns and future inflation rate changes. Consequently, they made a point that stock returns forecast the future inflation. However, no convincible theoretical descriptions can be found in their maverick work.

Single countries’ studies in previous work appear to have a limitation in the exploration of general rules. Gultekin (1983) filled the gap of the empirical work by employing the concept of expected and unexpected inflation from Fama to the investigation of 26 countries’ data in the time series and the cross-section format respectively. The results, however, provide us with no insights into the existing confusion. A recent international investigation was made by Rapach (2002) who measured the long-run response of real stock prices to a permanent inflation shock in 16 individual industrialised countries from 1957 to 2000. Inconsistent with most of the other researches, his results indicate a neutrality or positive relationship between stock price and inflation.

2.2.4 Summary

The "share price-inflation puzzle" has been well studied but not concluded yet. On first appearances, it does not seem hard to reveal the answer. However, after looking through the previous studies, it suggests that the difficulties are due to the scanty knowledge about stock markets. Some of researchers confine their theories within a framework relating with the EMH, others concentrate on the economic side but overlook the study of the stock market side. These fatal discrepancies in the former researches cause this topic to become an "economic enigma" plaguing the academia. To overcome these discrepancies, the attention should be focused on the investigation of the stock price forming process which can provide the answer by taking into account the bubble, since stock prices are constituted not only by fundamental values but also by bubbles as a result of the over-optimistic expectation and the speculation in stock markets. Withstanding this, one will recognise that the puzzle of share price-inflation relation, in fact, is the puzzle of respective inflationary effects on fundamental values and on stock bubbles. Thus, considering this topic within a framework of bubbles undoubtedly will make a breakthrough eventually disclosing this "economic enigma".

2.3 Share Valuation - Determination of Companies' Fundamental Values

While the bubble research in financial economics expands its view on the accumulated market behaviours, accounting researchers stand on the company-specific accounting information assessing the relation between companies' fundamental values and their prices in the stock market. They aim to obtain a valuation model which is able to best explain stock prices by regressing stock prices or returns with fundamental variables. The specification of the model is conducted by checking the stability of parameters and the explanatory power of fundamental variables with respect to stock prices or returns, i.e. R^2. Since we intend to combine fundamental values and bubbles in the firm-level modelling of stock prices so as to achieve the measurement of bubbles for individual stocks, models of fundamental valuation in the past should be examined and then carefully quoted to the part of fundamental values in our model.

The investigation in the area of fundamental valuation has experienced two stages: primary attempts in the early days of EMH and the recent extensive work with an acceptance of the stock market inefficiency. Researches of these two stages will be reviewed below.

2.3.1 Research on the Fundamental Valuation in the Early Time

The research linking accounting numbers to stock prices can be traced to the 1960s, when the modern capital market theories were developed. In the early days, this topic was known as the market-based accounting research (MBAR). Lev and Ohlson (1982) defined this research area as "the search into the relationship between publicly disclosed accounting information and the consequences of the use of the information by the major group of users: equity investors, as such consequences are reflected in characteristics of common stocks traded in major exchanges." Its rudiments are some frameworks integrating the accounting information, prices and other market variables, and expected utilities of contingent consumption patterns.

However, the investigation of fundamental values was initially only a very small part of MBAR and stood along with the efficient capital market theory. The model started from the association between asset returns and accounting information. However, as Lev and Ohlson (1982) pointed out, the explanatory power of the examined variables with respect to the distribution of stock returns is rather low. Thus, an alternative method relating to stock prices was considered thereafter. The effort can be traced to the 1930s. Meader (1935) formulated a model to explain stock prices by five independent variables: stock turnover, book value per share, net working capital per share, earnings per share, and dividends per share. Since then, the empirical efforts had halted due to the unsatisfactory results from Meader's work until the 1960s. Many researchers, such as Whitbeck and Kisor (1963), Malkiel and Cragg (1970), and Litzenberger and Rao (1971), attempted to construct a powerful and stable model to assess the fundamental values of stocks, but their results were not optimal. The slim progress is exhibited by incorporating the macroeconomic variables, such as interest rates, into models.

Due to the limit of econometric methods, the analysis of cross-sectional or time series data is hardly trustworthy to estimate the stable parameters. In addition, the acceptance of the efficient market theory in MBAR gives rise to the difficulty in acquiring stable parameters with the high explanatory power by regressing stock prices with respect to fundamental variables. Lev and Ohlson (1982) pointed out this discrepancy by stating that "early studies appearing to indicate investor rationality have given way to discomfiting findings. It is now clear that the existence of some investor irrationality cannot be precluded. This is very disturbing because there are no satisfactory behavioural alternatives to investor rationality." However, since methodological refinement was one of the major difficulties waiting to break through in that age and the ignorance of the market inefficiency causes the valuation model heavy in hand, the MBAR research was more in the spirit of "the beginning of the end" than "the end of the beginning", as Lev and Ohlson (1982) also noted.

2.3.2 Recent Studies on the Fundamental Valuation

Until the late 1980s, as the opposite of the efficient market advocators, the school of stock bubbles had been gaining more influence in expecting the burst of bubbles and so the collapse of stock markets. Thus, with the development of stock markets and its corresponding theories against EMH, the research of capital asset valuation by fundamental variables expanded rapidly, and was named "valuation and fundamental analysis research". All of these researches were aimed not only at establishing a channel between the financial market and accounting numbers, but also at seeking to determine firms' intrinsic values under a demand for practically identifying mispriced securities for investment purposes. Kothari (2001) concluded that "the principal motivation for fundamental analysis research and its use in practice is to identify mispriced securities for investment purposes…" With sound motivation, however, the attention is mainly focused on estimating stable parameters and there are still no any elements representing the inefficiency in the valuation modelling. Their inference is that in an inefficient capital market, a good model of fundamental value should predictably generate positive or negative abnormal returns. Therefore, it is worthwhile establishing a valuation model which best explains share prices and/or has the most predictive power with respect to future returns (Kothari, 2001).

Over several decades' exploration, researchers and professional financial analysts have constructed a succession of valuation models which can be mainly divided into two streams: statistical valuation models and deduced valuation models (Skogsvik, 2002). The first kind of model tries to explain the market prices or returns directly by financial ratios conceived relative to the fundamental values, while the other kind is deduced precisely upon the financial theories. Furthermore, in the deduced valuation models, two divisions respectively called the "residual income" and "value added" valuation model have been growing separately over the years.

Some researchers, such as Francis, Olsson and Oswald (2000) and Skogsvik (2002) reviewed and summarised the valuation models at a standpoint of practice, on the basis of which the strengths and weaknesses of these models were numerated.

The models of the first kind yield the merit of simplicity. They are extremely easy to use as long as there are enough empirical data to hand. However, the difficulties are located in the modelling logic, which calls for complicated work on the statistical specification. Moreover, the efficient market hypothesis is the precondition of the model, due to the principles of this method which intend to find reasonable and stable parameters reflecting the relation of stock prices and a series of fundamental variables.

The residual income valuation model developed from a dividend-discounting model was originated by Williams (1938). Generally, the dividend-discounting model defines share price as the present value of expected future dividends discounted at their risk-adjusted expected rate of return (Kothari, 2001). The discounted dividend model is abstracted from the financial theories which premise no arbitrage in markets and the investors evaluate the reasonable prices (fundamental values) by the total acquirable dividends from this investment. However, for the purpose of value estimation, the prediction of dividends is a barrier hardly conquered. Since the unrealistic assumptions are imposed in the estimation, the empirical work based on this model is bare of credit. Such a problem is sorted out by its transformation-residual income model. Although prediction is still the focal point of the research, the residual income model simplifies this process.

Holding the idea that future dividends can be explained by the forecasted values of earnings and investments, Fama and Miller (1972, Chapter 2) transformed the dividend-discounting model to an earnings capitalisation model. This model yields a basic point that value depends on the forecasted profitability of current and future investment which offers some new and understandable viewpoints to explain the fundamental value. However, this valuation model is regardless of the capital expansion either through the reinvestment or issuance of new equity.

In line with the conclusion reached by pioneer accounting researchers, a path-breaking achievement was made by Ohlson and Feltham (F-O) whose contribution is deemed as the milestone of this area. Kothari (2001) concluded: "Ohlson (1995) and Feltham and Ohlson (1995) deserve credit for successfully reviving the residual income valuation idea, for developing this idea more rigorously and for impacting the empirical literature". In their model, the fundamental value is defined as the sum of the current book value and the discounted present value of expected abnormal earnings which is the profit above a capital charge.

Regardless of the algebraic derivation, Penman (1997) analysed the equity valuation in the sight of accounting. Following the idea that any differences between the benchmark price and market price are treated as mispricing in the market, he investigated approximate benchmark valuations by combining two elements, book value and earnings, which are traditionally considered separately. His research focuses on the weights of the two components, but differs from the F-O model in that weights change over time rather than being fixed.

Finally, the value-added valuation model comes from the consideration of company free cash flow. This model has become increasingly popular in recent years in virtue of caring about the accounting details. Nevertheless, some arguments revolve around the calculation of free cash flow: the more comprehensive variables are considered, the more biases are produced from the unavoidable accounting record mistakes. Furthermore, the complicated process of calculation makes the model heavy-handed.

In summary, in the recent literatures, there are two basic approaches to convey the linkage between accounting numbers and stock prices. One is statistical valuation models which excel due to their simplicity. Another is deduced valuation models which bear the virtue of containing more delicate calculations and theories.

2.3.3 Summary

The research of fundamental valuation has been enhanced with the development of capital market theories. The early attempts in the light of the efficient market theory and the recent efforts with an acceptance of market inefficiency have conveyed extensive valuation models which are designed under the criteria of best explaining stock prices. However, although all of these approaches employ stock prices as the dependent variable in their empirical estimation and some of them accept the opinion of an inefficient market, the linkage established between stock prices and fundamental variables doesn't embrace bubbles, which are the part of stock prices in excess of fundamental values, since the aim of their studies is to find the best combination of fundamental variables to reveal companies' values, not to model stock prices. In our study of stock price modelling, stock prices are composed by two parts: fundamental values and bubbles. The most popular residual income valuation model will be adopted in the model to obtain the part of fundamental values. Having formulated the firm-level model of stock prices, the measurement of bubbles for all individual stocks in the sample can be made in the empirical work.

Chapter 3 Bubbles: Theories and Development of the New Estimation Methodology

The objective of this chapter is to conduct a critical review of the theoretical foundation of the research, which aims to extend the theory of bubbles to facilitate us in developing a new technical approach to estimate bubbles. The new estimation methodology will lead us to change the course of research on bubbles from verifying their existence over a time period to identifying the determinants of them, since the new methodology makes a breakthrough by allowing us to estimate the magnitude of bubbles at a particular point in time. The structure of this chapter is as follows: Section 3.1 is devoted to review current bubble theories; Section 3.2 will discuss the value frontier theory in order to build up a theoretical framework in support of the new statistical approach to estimate bubbles, and the new approach will be discussed in Section 3.3.

3.1 Bubble Behaves: Current Theories

"Bubble" is not a word specific to the stock market. The initial opinions about so-called price bubbles refer to various kinds of assets, such as foreign exchange, gold, real estate, and stock. Bubbles have been concerned with driving up all these asset prices to grow rapidly. Following Blanchard and Watson (1982) who stated that bubbles are more likely to exist in the price of an asset with obscure fundamental values, it is expected that bubbles hardly exist if the fundamental value of an asset is easily identified. With this idea in mind, it is expected that the research of bubbles is best conducted in stock markets where the fundamental values of stocks are blurry. Thus, we review some of the previous theories with the focus on stock bubbles, although most of them theorize about bubbles in a general manner, not about stock bubbles in particular.

The research on stock market bubbles is, in fact, a study of the stock market inefficiency, and the investigation about the stock market inefficiency should embrace three layers of topics. First, how to verify the market/share price inefficiency; Second, how to measure the market/share price inefficiency; Third, what cause the market/share price inefficiency? The first and third questions are the major issues to direct the researchers' attention from the efficient market hypothesis to the rational bubble studies as well as the recent behavioural theories. Accordingly, various types of bubbles have been modelled in these two layers of research.

3.1.1 Bubbles in Normative Models

The challenges to the EMH begin in the 1980s when some empirical evidence failed to cope with the efficient market theory. The primary explanations focus on a rational bubble hypothesis which cannot be rejected by various econometric tests. The theoretical model is based on an expectation formula and is illustrated clearly by (West, 1987):

$$P_t = \kappa E(P_{t+1} + D_{t+1}) \big| I_t \qquad \text{with } \kappa \leq 1 \tag{3.1}$$

where P_t is the observed price at time t, $E(P_{t+1} + D_{t+1})$ is the expected sum of price and dividends of the next period with the present information I_t, and $\kappa = \dfrac{1}{1+i}$. With the assumption of constant discount rate i, the equation (3.1) can be resolved recursively forward to get:

$$P_t = \sum_{i=1}^{n} \kappa^i \mathrm{E} D_{t+i} \big| I_t + \kappa^n \mathrm{E} P_{t+n} \mid I_t \tag{3.2}$$

If the transversality condition $\lim_{n\to\infty} \kappa^n \mathrm{E}P_{t+n} \mid I_t = 0$ is achieved, the observed price equals the fundamental value P^f :

$$P_t^f = \sum_{i=1}^{\infty} \kappa^i \mathrm{E}D_{t+i} \big| I_t \tag{3.3}$$

Similar to solutions documented in literatures before West (1987), such as Blanchard and Watson (1982) and Shiller (1978), the failure of transversality condition means the observed stock price fails to be equal to the fundamental value P_t^f. Thus the price P_t can be thought of as the sum of the fundamental value P_t^f and a bubble B_t :

$$P_t = P_t^f + B_t \qquad \text{with } B_t \geq 0 \tag{3.4}$$

$$B_t = \kappa^{-1} E_t B_{t-1} \tag{3.5}$$

Equation (3.5) implies that an investor who pays for an asset today is expected to be rewarded by an even higher value than the fundamental-expected value of the next period. Therefore, although investors rationally know that the current market price exceeds the present value of future dividend payments, they still invest in the market (Donaldson and Kamstra, 1996). This bubble is deemed as the result of a self-fulfilling behaviour which is called rational bubbles or speculative bubbles.

Regarding the assumption of a non-negative bubble path in the theoretical deduction above, there are two points raised by researchers' contentions. First, negative bubbles are impossible because if B_t is a negative value today then (3.5) implies that there is a positive probability that at some point *t+i*, B_{t+i} will be largely negative enough to make the price negative. Second, if bubbles exist, they must start on the first day, and will not restart after bursts (Diba and Grossman, 1988b). However, these implications from (3.5) are obviously inconsistent with the real world.

Moreover, the evidence of bubbles is based on the rejection of the transversality condition. The representative investor model pictures an equilibrium price at which the transversality condition is achieved, i.e. a competitive agent will always buy undervalued stocks and sell overvalued ones which adjusts the demand so as to draw the stock price back to the equilibrium point (fundamental value). However, this theory is little more than an oversimplified conception which pays no attention to a special property of stock markets that fundamental values are uncertain. The fundamental value depends on the future dividends which don't appear in the present and cannot be forecasted ascertainably by any statistic modelling techniques.

As many researchers realised, the above theory is fragile due to the naturally weak assumption of equation (3.5). In order to overcome the fatal problem in the initial theory of rational bubbles, some new bubble paths are specified.

Blanchard and Watson (1982) as well as West (1987) illustrated two bubble paths. The first one is called a deterministic bubble:

$$B_t = B_0 \times \kappa^{-t} \tag{3.6}$$

Another one with an explosive property is accordingly called a stochastic bubble:

$$B_t = \begin{cases} (B_{t-1} - \overline{B})/(\pi_t \kappa) & \textit{with probability} \quad \pi_t \\ \overline{B}/[(1-\pi_t)\kappa] & \textit{with probability} \quad 1-\pi_t \end{cases} \tag{3.7}$$

with $0 < \pi < 1$, $\overline{B} > 0$

In equation (3.7), B represents speculative bubbles and $\overline{B}$ is the starting-point bubble. The probability that a bubble grows is π_t, and the probability that it collapses is $1-\pi_t$.

Norden and Schaller (1993) generalised Blanchard and Watson's (1982) bubble paths in two ways: first, the probability of collapse is enlarged with the bubble growth; second, the model allows the collapsed bubbles to be above zero (partially collapsed).

Afterwards, Diba and Grossman (1988a) mentioned that bubbles periodically shrink. This periodically collapsed bubble is illustrated by Evan (1991):

$$B_{t+1} = \begin{cases} (1+i)B_t\varepsilon_{t+1} & \text{if } B_t \le \alpha \\ [\delta + \pi^{-1}(1+i)\theta_{t+1} \times (B_t - (1+i)^{-1}\delta)]\varepsilon_{t+1} & \text{if } B_t > \alpha \end{cases}$$

$$0 < \delta < (1+i)\alpha \quad 0 < \pi < 1 \qquad \textbf{(3.8)}$$

δ and α are positive parameters, and changes in them can alter the frequency with which bubbles erupt and the average length of time before collapse; ε is an exogenous independently and identically distributed positive random variable with a mean of 1, and θ is an exogenous independently and identically distributed Bernoulli process which takes the value 1 with a probability of π and 0 with a probability of $1-\pi$. The characteristics of bubbles can be adjusted by varying the parameters δ,α, and π. In (3.8), only if $B \le \alpha$, bubbles grow at a rate of $(1+i)$. As long as $B > \alpha$, bubbles move into an eruption pattern until collapse. When bubbles collapse, they fall to a mean value of δ, i.e. bubbles can restart after collapse.

In order to integrate the foregoing descriptions about bubbles, Fukuta (1998) devised a three-state bubble model:

State 1: the state of large bubbles

$$B_{t+1} = (1+i)(\frac{\varpi_1}{\pi_1})B_t \qquad \text{with probability } \pi_1$$

State 2: the state of small bubbles

$$B_{t+1} = (1+i)(\frac{\varpi_2}{\pi_2})B_t \qquad \text{with probability } \pi_2$$

State 3: the state of incomplete bursts

$$B_{t+1} = (1+i)(\frac{1-\varpi_1-\varpi_2}{1-\pi_1-\pi_2})B_t \qquad \text{with probability } 1-\pi_1-\pi_2$$

(3.9)

where ϖ_1 and ϖ_2 are arbitrary with assumptions of $0<\varpi_1<1$, $0<\varpi_2<1$ and $0<1-\varpi_1-\varpi_2<1$. π_1, π_2 and $1-\pi_1-\pi_2$ are the probability of each state and they are strictly positive. The condition of $(1-\varpi_1-\varpi_2)/(1-\pi_1-\pi_2)<\varpi_2/\pi_2<\varpi_1/\pi_1$ is also assumed. With various assumptions of ϖ and π, (3.9) can be transformed into the same specification of other bubble models described before.

As a parsimonious alternative of rational bubbles, Froot and Obstfeld (1991) defined an intrinsic bubble which is the function of only dividends. The idea stems from an intuition that bubbles are generated from an overreaction regarding dividend news, and the model appears to fit the data in the U.S. stock market during both the 1960s and 1970s. However, at the same time, this model with the newly defined bubble is inconsistent with the conventional description of fundamental values which is defined as irrelevant with the bubble term. However, the overreaction-driven bubbles should in fact be generally free from dividends, though it is the result of the news about dividends. For example, investors push up the price by buying stocks because they believe the fundamental values of stocks will increase due to the good news about dividends. Since investors are heterogeneous, and no two can ever react identically. The different levels of overreaction are not due to dividends but to the heterogeneity of investors' decisions. Therefore, the intrinsic bubble seems to lack a sound theoretical foundation.

With the improvement of the bubble assumption, the rational bubble theory seems to be further developed. However, one problem remains; it is still quite difficult to mimic a bubble path, since they are moving with uncertain decisions from heterogeneous investors.

3.1.2 Bubbles in Behavioural Studies

While the rational bubble researchers struggle to extend the efficient market theory into a more realistic model of rational bubbles, with the accumulation of theoretical challenges and empirical deviations, the substance of EMH has been evaded. Instead, with a new body of theory, a new set of explanations of empirical regularities, as well as a new set of predictions, behavioural finance has been generated as a study of human fallibility in competitive markets. The behavioural economists consider that "financial markets are not expected to be efficient and the market efficiency only emerges as an extreme special case unlikely to hold under plausible circumstances" (Shleifer, 2000). Shiller (2002) similarly indicated that the efficient market theory is only "a half-truth". While irrational traders are often known as "noise traders" and rational traders are referred to as "arbitrageurs" who raise the riskless and costless profit in their investment, the school of behavioural finance argues that the strategies adopted by rational investors are not necessarily arbitrages since they are often risky and costly. As a result, the mispricing can remain unchallenged (Thaler, 2005).

Shleifer (2000) summarises three areas in which people deviate from the standard decision making model: attitudes toward risk, non-Bayesian expectation formation, and sensitivity of decision. In addition, Black (1986) indicates that many investors trade on noise rather than information, namely “noise traders” or “unsophisticated traders”. The investors’ belief, which conforms to the psychological evidence rather than the economic model, is named “investor sentiment”.

The two major foundations of behavioural finance are “limited arbitrage” and “investor sentiment”, which are the direct disapproval to the principal assumptions of EMH - the irrelevance of irrationality. Under EMH, markets are fully rational, since irrational trading strategies are uncorrelated and offset to each other. Rational arbitrageurs, who “simultaneous purchase and sale the same or essentially similar security in two different markets at advantageously different price”, bring the security prices in line with their fundamental values and squeeze the irrational traders out of the market. As the alternative approach to the study of the financial market, behavioural finance is aimed to theoretically and empirically model the real world, in which “arbitrage is risky and therefore limited” and investors form their beliefs by sentiment. Although the initial aim of those models is to display a price forming process with a consideration of investors’ psychological factors, there are some strong resemblances to bubbles implied in the models. Four models, namely the noise trader risk model, the model of relative returns of noise traders and arbitrageurs, a model of investor sentiment and the positive feedback model, are reviewed below with the intention of picking up some pioneering ideas about bubbles in the behavioural finance.

At the arbitrage side of research, DeLong et al (1990) defined two kinds of risks that arbitrageurs may face. The first one is the risk caused by imperfect substitutes of securities, and the second one is called "noise trader risk"[7]. In other words, the latter is the possibility that mispricing becomes worse due to noise trading. Furthermore, Shleifer (2000) introduces two models which are against the assumption of rational markets. One is a pricing function which describes how noise traders affect the price. Its final equation is written:

$$p_t = 1 + \frac{\mu(\rho_t - \rho^*)}{1+r} + \frac{\mu\rho^*}{r} - 2\gamma\frac{\mu^2\sigma_\rho^2}{r(1+r)^2} \qquad \rho_t \sim N(\rho^*, \sigma_\rho^2) \tag{3.10}$$

where μ presents the noise traders, and $1-\mu$ presents the arbitrageurs. ρ_t represents noise traders' misperceptions of the expected price. γ is a behavioural parameter capturing the risk aversion and r is the riskless rate. The implication of each term in (3.10) is explained by Shleifer (2000). The second term of equation (3.10) means that the more noise traders' misperceptions depart from the average, the more prices fluctuate. Since the average misperception ρ^* is not zero, the third term captures the deviation of price from its fundamental value. The final term of equation (3.10) can be interpreted as meaning that a noise trader's negative outlook on risks drives the price down.

The central point of the noise trader risk model above is to mark out the impact of noise traders on the stock price, which implies a self-evident extrapolation that the price deviation can be traced to the irrational behaviours of noise traders. In other words, from the standpoint of the bubble research, the noise trading behaviours contribute to the bubble by keeping arbitrageurs from driving prices all the way back to fundamental values. That calls for another model which is concerned with the misperception of EMH about the noise trader, i.e. it's not always the case that noise

[7] The risk that noise traders' beliefs become even more extreme before they revert to the mean. "An arbitrageur selling an asset short when bullish noise traders have driven its price up must remember that noise traders might become even more bullish tomorrow, and so must take a position that accounts for the risk of a further price rise when he has to buy back the asset." Shleifer (2000, page 29)

traders are weeded out of markets since they can earn a higher return than the arbitrageurs.

The idea is illustrated by analysing the expected difference between noise traders' and arbitrageurs' total return $E(\Delta R)$.

$$E(\Delta R) = \rho^* - \frac{(1+r)^2(\rho^*)^2 + (1+r)^2\sigma_\rho^2}{2\gamma\mu\sigma_\rho^2} \qquad \textbf{(3.11)}$$

The first term of the equation implies the "hold more" effect, i.e. when noise traders on average hold more of the risky assets, their expected returns are higher than those of arbitrageurs. The numerator of the second term of equation (3.11) combines the "price pressure" effect and the "buy high-sell low" effect. The denominator contains the "create space" effect. The "price pressure" effect means that the returns are diminishing with the growing price provoked by noise traders' misperceptions. The "buy high-sell low" effect refers to how the large variation of noise traders' beliefs damages their expected returns. Also, the various beliefs of noise traders push up the price risk so as to "create more spaces" for noise traders by expelling some risk-averse arbitrageurs. Therefore, the "create space" effect captured by the denominator can reduce the damages of noise traders' expected returns resulting from the "price pressure" and "buy high-sell low" effects. In addition, Shleifer (2000) considers that the noise traders may keep coming back even when they suffer capital losses, since "they keep earning investable labor income, besides, there is a noise trader born every minute".

The implication of the behavioural models discussed above to the study of bubbles is clear. First, financial markets are not efficient due to the persistent irrationality. Second, the deviation of prices from fundamental values, the so-called bubbles, is the outcome of noise trading.

The model of investor sentiment is devoted to the simulation of the belief formation using psychological theories. There are two important psychological phenomena involved: representativeness and conservatism. As a result of representativeness, “people see patterns in truly random sequences” (Shleifer, 2000). The slow updating of models in the face of new evidence is formed by the conservatism (Edwards 1968). Accordingly, the two psychological phenomena are suggestive of the investors' overreaction and underreaction of prices. A model of the investor sentiment introduced by Shleifer (2000) starts from an assumption that investors believe the earning shocks y following one of the two models which represent two “states” or “regimes” of the economy:

Model 1	$y_{t+1} = y$	$y_{t+1} = -y$	**Model 2**	$y_{t+1} = y$	$y_{t+1} = -y$
$y_t = y$	π_L	$1-\pi_L$	$y_t = y$	π_H	$1-\pi_H$
$y_t = -y$	$1-\pi_L$	π_L	$y_t = -y$	$1-\pi_H$	π_H

(3.12)

where π_L and π_H are probabilities of changing the sign of the earning shock with $\pi_L < \pi_H$, i.e. under model 1, the positive shock is likely to be reversed and under model 2, a positive shock is likely to be followed by another positive shock. Furthermore, the probabilities of switching from one model to another are also defined as λ_1 and λ_2 with $\lambda_1 + \lambda_2 < 1$.

With the acceptance of the valuation model that prices are the expectations of the discounted future earnings, the final equation is derived:

$$P_t = \frac{N_t}{\delta} + y_t(p_1 - p_2 q_t) \qquad N_t = N_{t-1} + y_t \qquad \textbf{(3.13)}$$

where N_t is the earnings and y_t is shock to earnings at time t, δ is the discount rate, and p_1 and p_2 are constants that depend on π_L, π_H, λ_1 and λ_2. q_t represents the probability that y_t is generated by model 1 and is calculated according to the Bayes Rule.

Shleifer (2000) illustrates the deviation of the price from its "correct value" as a result of investors' ignorance of the randomly walking earnings. Instead, the price is modelled as an expectation formula, not as a set of random true numbers. Therefore, the first term of equation (3.13) is interpreted as "the price that would obtain if the investor used the true random walk process to forecast earnings". Thus, the second term stands for the deviation of prices from fundamental values. Shleifer (2000) also pointed out sufficient conditions on p_1 and p_2 which allow both behaviours of overreaction and underreaction in the model (3.13). This implies a possible negative sign to the second term[8], which is obviously different from the assumption of positive bubbles in the rational bubble model.

The diction of "bubble" appearing in behavioural research is used for the positive feedback trading theory in which bubbles are considered to occur in a situation of price soaring without news. Three kinds of investors, namely noise traders, passive investors and arbitrageurs, are involved in the model. Since noise traders are positive feedback traders who buy securities after prices rise and sell after prices fall, they play the role of trend chasing. In contrast, passive investors, who do not play an active role in the business, will purchase investments with the intention of long-term appreciation and limited maintenance. Meanwhile, the stabilising power of arbitrage is challenged, because the arbitrageurs amplify the positive feedback trading, i.e. arbitrageurs buying more today with the superior information will stimulate buying more tomorrow, so as to drive prices above fundamental values. The model of positive feedback trading affects the bubble as a result of price-chasing-up

[8] The negative sign is caused by the behaviour of the underreaction which means the stock price doesn't react sufficiently to the shock, leaving the price below the fundamental value.

behaviours after the arbitrageurs' anticipatory pumping up of the price.

Scheinkman and Xiong (2003), as well as Hong, Scheinkman and Xiong (2006), defined a bubble equivalent to the resale option value which depends on the current difference between the beliefs of the other group's agents and the belief of the current owner. In their theory, bubbles can be presented as follows:

$$B \equiv \begin{cases} \dfrac{f_0^A - f_0^B}{2} + E_0^A[H(l_1^A, \dfrac{Q}{\eta^\tau})], & if\ l_1 > \dfrac{Q}{\eta^\tau} \\ \dfrac{\sum^A - \sum^B}{\sum^A + \sum^B}\dfrac{(f_0^B - f_0^A)}{2} + \dfrac{\sum^B}{\sum^A + \sum^B} E_0^A[H(l_1^A, \dfrac{Q}{\eta^\tau}) + \dfrac{\sum^A}{\sum^A + \sum^B} E[H(l_1^B, \dfrac{Q}{\eta^\tau})], & if |l_1| \le \dfrac{Q}{\eta^\tau} \\ \dfrac{f_0^B - f_0^A}{2} + E_0^B[H(l_1^B, \dfrac{Q}{\eta^\tau})], & if\ l_1 < -\dfrac{Q}{\eta^\tau} \end{cases}$$

Where f_0^A and f_0^B are the prior beliefs of group A and B at t=0; $\dfrac{Q}{\eta^\tau}$ is the risk discount; $l_1^A = f_1^B - f_1^A$ and $l_1^B = f_1^A - f_1^B$ represent the difference in opinions between the investors in group A and B at t=1; $\sum^A$ and $\sum^B$ are the next-period price change variances under two groups' beliefs.

Stock prices only reflect the belief of optimists. Given that group A investors are optimists at t=0, in Case 1, the bubble is concerned with embracing two parts: the optimism effect ($\dfrac{f_0^A - f_0^B}{2}$) and the resale option effect ($E_0^A[H(l_1^A, \dfrac{Q}{\eta^\tau})]$); in Case 2, both groups of investors are at long position at t=0 so that the bubble component is a weighted average of the resale options of groups A and B ($\dfrac{\sum^B}{\sum^A + \sum^B} E_0^A[H(l_1^A, \dfrac{Q}{\eta^\tau})] + \dfrac{\sum^A}{\sum^A \sum^B} E_0^B[H(l_1^B, \dfrac{Q}{\eta^\tau})]$), but the bias in price due to initially different beliefs depend on the difference in the perceived variances of the two groups for holding the stock between t=0 and t=1. In Case 3, group B investors are optimists and so the optimism bias is given by ($\frac{f_0^B - f_0^A}{2}$), and the resale option is determined by group B investors ($E_0^B[H(l_1^B, \frac{Q}{\eta^\tau})]$).

The theory of Scheinkman and Xiong (2003), as well as Hong, Scheinkman and Xiong (2006), is superior to others in that they innovatively modelled the formation of bubbles with two effects: the optimism effect and the resale option effect, which stem from an opinion of heterogeneous beliefs among investors. Moreover, they concluded that the magnitude of bubbles changes with float (Q) as investors anticipate the change in asset float over time and speculate on the degree of insider selling.

3.1.3 Summary

With the purpose of collecting empirical evidence of inefficiency, and of picturing the true behaviours in financial markets, the school of rational bubbles and behavioural researchers breathe new life into the financial area. The school of rational bubbles has been trying to verify the existence of bubbles, and the researchers of the behavioural finance have been enriching the quantitative price model with categorised traders' behaviours. In other words, behavioural finance studies market inefficiency by examining the cause of investors' behaviours rather than verifying its existence which is the aim of the school of rational bubbles. However, it seems a vain attempt to integrate concepts and terms in these two research areas, since contradictive descriptions may be given respectively in these two approaches to the similar behaviours. For example, a rational bubble is defined as the outcome of self-fulfilling behaviours, i.e. investors buy stocks and drive the price up, with a belief that the price will increase. This plausible scenario exhibits a similar phase with some professionally defined behaviours in behavioural theories, such as the positive feedback trading and the arbitrageurs' anticipatory trading[9], which are deemed as noise trading or irrationality in behavioural finance.

Among the three research layers of the inefficient market described at the beginning of the review, the rational bubble researchers and the school of behavioural finance have been dedicated to the first and third layers. The second topic is still a gap and attracts us to fill it.

3.2 Theoretical Basis of Value Frontier Framework

Following the route of bubble research, there are two opposite arguments: existence of bubbles and no bubbles. The school of arguing against bubbles has a subjective opinion. They are trying to construct a fundamental estimation model which matches the observed price very well by processing ample historical data. For example, Donaldson and Kamstra (1996) used the neural network technique to conduce to a satisfactory result. However, their simulated fundamental path still fails to overlap with the observed actual price movement, although their bubble-dismissing result is verified on the basis of the unit root test, the robustness of the method is questionable.

Intuitively, the argument for bubbles should be continuing if we believe that a stock price consists of two parts: the fundamental value and the excess value over the fundamental value. The statistical failure in verifying the presence of bubbles may be due to the inappropriate econometric technique applied, which is a time-series-data-based testing method. This method has a fatal problem. It merely

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[9] Positive feedback trading: The behaviour of buying securities after prices rise and selling after prices fall. (Shleifer, 2000, page 155)
Arbitrageur's anticipatory trading: When arbitrageurs receive good news, they realize that the initial price increase will stimulate buying by positive feedback traders tomorrow. In anticipation of these purchases, informed arbitrageurs buy today and so drive price above the fundamental news warrants. (Shleifer, 2000, page 156)

enables us to test the existence of bubbles over a time period and not to estimate bubbles at a particular point of time. This problem imposes a serious discrepancy in studying bubbles and, in particular, on studying what determines bubbles due to the failure of the method in estimating bubble changes over time. To challenge the problem, it calls for rethinking of current methods in estimating bubbles. Can we really estimate the magnitude of bubbles at a point in time? Against the question, we take an innovative approach to investigate bubbles, which is fundamentally different from the existing time-series-data-based approach in terms of its theoretical framework and statistical estimation method.

The fundamental concern of our work is that bubbles persist in the stock market. This opinion can be traced to the work of Binswanger (1999), in which persistent bubbles are considered to be sustainable if bubbles move with the development of a real economy. His empirical work in 2000 further verified and highlighted the persistent bubbles since the early 1980s. Also, McFadden (1998) raised an idea that human judgement not always leads to reasonable answers; the axioms of rational choice are often consistently violated by sophisticated as well as naive respondents and the violations are often large and highly persistent. Summers (1986) documented that both theoretical and empirical considerations suggest the existence of frequent and substantial deviations from fundamental values; and this deviation is being made continuously. In fact, many researchers, such as West (1988), Shiller (1984), and Debondt and Thaler (1985), have already realised that there is a significant stationary component in a stock price which is documented to be suggestive of fads. Furthermore, Lee (1998) and Chung and Lee (1998) empirically identified fads in several stock markets. However, there is no general agreement concerning the distinction between fads and bubbles. For example, following Cochrane (1991), Lee (1998) and Chung and Lee (1998) considered price deviations which slowly return to fundamental values as fads, whereas bubbles are expected to continue until bursts occur. Different from them, Shiller (1988) defined a bubble as a fad if the contagion of the fad occurs through price. Faced with this confusion, Bingswanger (2004) didn't make a distinction between bubbles and fads. Instead, he interpreted the persistent deviations of stock prices from fundamental values as bubbles. Our work follows Bingswanger's view (2004) that any non-fundamental components in stock prices, except for statistical noises, will be recognised as bubbles which are persistent in a stock market and these assumptions exclude exceptional shocks at a point in time. This belief leads us to an innovative work of measuring bubbles.

Our work will follow the school of bubbles and will stem from three basic opinions: firstly, the traditional theory of market efficiency focuses on the study of information revealing efficiency. The assumptions of homogeneous and rational investors are the basis of its modeling. However, in reality, the response of investors to the information is neither fully rational nor homogeneous, and the research of bubbles (or inefficient markets) should be traced to a study of responding inefficiency. Secondly, it is concerned that heterogeneous beliefs produce heterogeneous fundamental valuation. Thus, the determination of fundamental values is the most crucial part in our bubble estimation. Finally, bubbles persist in stock markets since they are result from optimistic beliefs and speculative behaviours which dominate the market always. In addition, the market friction may also cause the price to deviate from its fundamental value.

In addition, it is worth highlighting that the above three opinions jointly show a new framework combining the arguments of rational bubbles and behavioural theories as bubbles are deemed to be produced by the rational distortion (the basic opinion of the rational bubble school) and irrationality (the central issue of behavioural researches). This section will discuss in detail the above three arguments which provide the theoretical foundation of our alternative approach to estimate bubbles.

3.2.1 Information Revealing Efficiency and Responding Inefficiency

In the traditional framework where agents are rational and there are no frictions in a market, a security's price equals its "fundamental value" (Thaler, 2005). There are two underlining assumptions to this statement: information revealing efficiency and responding efficiency (investors correctly process all available information in forming expectations). The hypothesis that actual prices reflect fundamental values is the Efficient Markets Hypothesis (EMH). However, the rational bubble school documents that there can be rational deviations of the price from its fundamental value, which are called rational bubbles (Blanchard and Watson, 1982). In addition, behavioural researchers argue that some features of asset prices are most plausibly interpreted as deviations from fundamental value, and these deviations are brought about by the presence of traders who are not fully rational (Thaler, 2005). In our study of stock bubbles, the value frontier theory is a compromise between the bubble school and EMH, which can be explained as follows.

In theory, information revealing efficiency means that the information in a stock market is identical to all participants who are led by the information, and the technique of fundamental valuation is common knowledge in the market. Information responding efficiency reflects that the response of investors to the information is rational and homogeneous. The EMH implies that the stock price can fully reflect all available information under the assumption of homogenous investors. In our value frontier theory, it has relaxed the homogenous assumption because investors are heterogeneous in responding to the given information in evaluating stocks. The efficient market theory doesn't deny the price deviation in the short term. However, in the long run, the arbitrageur is considered "smart" enough to drag the deviated price back to the fundamental value and the irrationality will be squeezed out of the market. Our theory is partially consistent with EMH in terms of information revealing efficiency, which is the assumption of the value frontier modelling. However, in our view, the information responding efficiency cannot be fulfilled in stock markets since the arbitrageur can also overestimate the fundamental value in the long run, so as to cause the stock price to always deviate up from the fundamental value. This, to some extent, is in accordance with the argument of rational bubbles. Blanchard and Watson (1982) clarified that rationality does not imply that the price of an asset is equal to its fundamental value, and there can be rational deviations of the price from this value, rational bubbles. Moreover, the irrationality is significant and cannot be completely wiped off, which is in support of the behavioural researchers who verified that irrationality can have a substantial and long-lived impact on prices (Thaler, 2005). Thus, the price deviation can be caused by the interaction of rationality and irrationality.

In the empirical modelling, our idea is consistent with the argument of Shiller (1981). EMH is conceived of an equilibrium situation, which is the fundamental value of our models, though the observed stock prices are believed to always be deviating from it.

3.2.2 The Determination of Fundamental Values

Having analysed the failure of the traditional assumption of homogenerity, we turn to the crucial problem of the value frontier estimation – the determination of fundamental values.

Theoretically, following the rational bubble school (for example: Flood and Garber, 1980; Blanchard and Watson, 1982), the market fundamental value of an asset is defined as the present value of expected future dividends. However, in contrast to their theory which is based on an assumption of homogeneous investors, we believe that stock prices originate from the expectation of the over-optimistic investors who own heterogenous beliefs and inefficiently make the decision very often in responding to information. There are two reasons that can result in this heterogeneity among investors in analysing the fundamental values. Firstly, the information may be not identically available to all investors which will lead to heterogeneous perception of fundamental values. Blanchard and Watson (1982) proposed that each agent will have his own perception of the fundamental value and there will be agent specific fundamental values when the information received by investors is not the same. This opinion also can be viewed in the argument of myopic rational expectation equilibrium in Tirole (1982) who gave rise to an equilibrium of a stock market with heterogeneous information in which the market fundamental values of different traders are not generally equal. Secondly, even if the information is available to all investors, different people will make their own inferences from the information so as to produce heterogeneous beliefs. This argument can be proved by extensive psychological findings, such as those by Alpert and Raiffa (1982), Fischhoff, Slovic and Lichtenstein (1977), Lichtenstein, Fischhoff and Phillips (1982), Gervais and Odean (2001), and Thaler (2005), which show that people normally exhibit overconfidence to form beliefs in practice.[10] As Hong, Scheinkman and Xiong (2006) noted, one of the tractable ways to generate the heterogeneous beliefs is 'overconfidence'. Hirshleifer (2001) also put forward that mistaken beliefs can be caused by overconfidence, representativeness, conservation etc. When investors are heterogeneous, mistaken beliefs may exist.

Therefore, although the standard formula of calculating fundamental values, which is the present value of expected future dividends, are utilised by investors in their fundamental valuations, heterogeneous beliefs/expectation will produce investors' specific fundamental values. To clarify the fundamental valuation in the value frontier modeling, we divide the heterogeneous beliefs/expectations into three scenarios: the optimistic expectation, the pessimistic expectation and the neutral expectation. The optimistic investors expect that the fundamental value of a stock in the future will be better than the present; on the contrary, the pessimistic investors

[10] Overconfidence can be learnt as two biases, self-attribution bias and hindsight bias. (see Thaler, 2005)

believe that the fundamental value of a stock will be worse in the future, and the expectation that the future will be neither better nor worse than the present is called neutral beliefs/expectations. The pessimistic investors will sit out of the market because of short-sales constraints.[11] This group of investors may exist in the short run but will quit from the market in the long run. Thus, we utilise the fundamental valuation of investors with the neutral expectation to formulate the fundamental value in our bubble estimation model. Under this fundamental valuation mechanism, the difference between the optimistic valuation and the neutral expectation is treated as one source of bubbles.

3.2.3 The Forming Process of Bubbles

Before discussing the value frontier framework and its statistical methodology to measure the magnitude of bubbles, we first discuss how bubbles can be formed or determined.

We believe that the stock prices result from two processes: the "investor decision process" and the "market transmission process", and we name the efficiencies in these two processes the "decision efficiency" and the "transmission efficiency" accordingly.

The "decision efficiency" means that investors make the correct trading decision according to the existing information driving stock prices equal to their fundamental values. The heterogeneous response to the information and the speculation will cause stock bubbles called the "investor-made bubble". The heterogeneous beliefs of investors are the essential reason for stimulating and sustaining bubbles. This idea follows the basic argument of Scheinkman and Xiong (2003) and Hong, Scheinkman and Xiong (2006) who attributed the formation of bubbles to two effects which are

[11] Scheinkman and Xiong (2003) summarized three reasons that short-sales constraints arise often in reality. Our assumption in terms of short-sales constraints is in line with Harrison and Kreps (1978), Scheinkman and Xiong (2003) and Hong, Scheinkman and Xiong (2006).

led by heterogeneous beliefs: the optimism effect and the resale option effect. The optimism effect means that investors have different initial beliefs about fundamental values. The explanation to the resale option effect is that investors pay higher prices than their own valuation of future dividends since they anticipate finding a buyer willing to pay even more in the future. The support to the effects of heterogeneous beliefs in stock markets can be also found in other literatures, such as Miller (1977), Chen et al (2002) etc. Their common opinion about heterogeneous beliefs in stock markets implies that stock price generally contains bubbles as bubbles are generated by the heterogeneous beliefs of investors. To some extent, it further supports the assumption of our work: bubbles persist in stock markets. Furthermore, to study the causes of bubbles in a deeper level, Scheinkman and Xiong (2003) and Hong, Scheinkam and Xiong (2006) raised a psychological explanation to the heterogeneity among investors. They indicated that overconfidence generates disagreements among investors regarding asset fundamental values. In fact, overconfidence is merely one factor of forming beliefs in practice. Thaler (2005) summarised seven psychological factors of affecting investors' beliefs: overconfidence (e.g. Alpert and Raiffa, 1982; Fischhoff, Slovic and Lichtenstein, 1977), optimism and wishful thinking (e.g. Buehler, Griffin and Ross, 1994), representativeness (e.g. Kahneman and Tversky, 1974), conservatism (e.g. Edwards, 1968), belief perseverance (e.g. Lord, Ross, and Lepper, 1979), anchoring (e.g. Kahneman and Tversky, 1974) and availability biases (e.g. Kahneman and Tversky, 1974). Although these psychological conceptions are not described in a comprehensive and explicit manner, they are no doubt playing a crucial role in supporting our argument in terms of the causes of bubbles.

Withstanding the above opinions, however, it is worth noting that bubbles can also be learnt about from another point of view. A large amount of literature suggests that in stock markets, rationality and irrationality interact. DeLong et al. (1990) propose three types of agents, feedback traders, passive investors and speculators who are argued by Haruvy and Noussair (2006) to interact in a market to form persistent bubbles. The feedback trading, as Lei et al. (2001) and Haruvy and Noussair (2006) documented, provides a plausible and precise structure for the "irrational" behaviour. Passive investors who trade based on fundamental values and speculators who speculate in a market are more likely to be rational. Therefore, it claims that the causes of bubbles can be divided into two types: rational distortion and irrationality (or bounded rationality)[12]. Rationality is clarified by Thaler (2005) as two things. First, agents perceive the information correctly in the manner described by Bayes's law. Second, given beliefs, agents make choices that are normatively acceptable. A similar opinion can be also found in the research of Blanchard and Watson (1982), in which rationality is described respectively as rational expectations and rational behaviours. Thus, in the sense of Blanchard and Watson (1982) as well as Thaler (2005)'s notion, irrational bubbles can be caused either by the failure in correctly perceiving information to form beliefs, or by unacceptable choices with certain beliefs. In particular, the choices are not necessarily based on their beliefs. Meanwhile, rational bubble supporters (e.g. Blanchard and Watson, 1982) stated that there can be rational deviations of the price from its fundamental value, which are rational bubbles. Rational bubbles are thought of as part of the stock prices due to self-fulfilling prophecy.

From a theoretical viewpoint, it is hard to integrate the above two angles of research for two reasons: Firstly, the discussion on the meaning of rationality is not clear-cut. McFadden (1998) analysed the distinction between the attitudes of psychologists and economists on rationality. Between them, the latter ones give a much more specific meaning within a framework of maximisation; and the former ones define rational behaviours in a broad meaning of being sensible, planned and consistent. Although the assumption of rationality, to some extent, speeds up the theoretical progress in terms of using mathematical techniques, the normative models do not give an

[12] Simmon described that limited calculationg power and the complexity of decision problems prevent fully rational decisions, which leads to the bounded rationality.

integrated and convincible explanation on the notion of rationality. Hammond (1997) pointed out that the "rationality" is an over-used and misused word in economics. Obviously, it is hard to use the criteria of rationality and irrationality to describe investors' decisions in a descriptive model[13]because the debate on understanding the word of "rationality" is still ongoing.

Secondly, a huge amount of literature on decision theory and behavioural finance documents the fact that people are not fully rational and the irrationality (or bounded rationality) is the norm in humans forming decision patterns. Some reputable economists, such as Adam Smith, Fisher and Keynes have already raised the opinion at an earlier time that individual psychology affects prices (Hirshleifer, 2001). Hirshleifer (2001) argued that heuristic simplification, self-deception, and emotional loss of control provide a unified explanation for most known judgement and decision biases which suggests the limitation of Bayesian Law in explaining the human behaviour, and presented asset-pricing theories based on imperfect rationality. Ritter (2003) and Thaler (2005) summarised that cognitive psychology is one building block of behavioural finance and financial phenomena that can be better understood using models in which agents are not fully rational. Thus, we are concerned that the interaction of rationality and irrationality not only appears at the market level but also exists in the decision process of a single investor. To this extent, it can be argued that separating the rationality and the irrationality in the study of bubble formation is unfeasible and meaningless.

From the above analysis, it is easy to see that the study on bubbles focuses more on the investor psychology rather than examining how the assumption of rationality fails. Therefore, we conclude that the "investor-made bubble" can be formed and inflated through three reasons: optimistic fundamental valuation (the optimism effect),

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[13] Hammond (1997) labeled the psychological model the "descriptive model" in contrast to the "standard normative model".

speculation (the resale option effect) [14] and other random behaviours (such as noise trading, the feedback trading and manipulation etc). The optimism effect, which results from heterogeneous initial beliefs on fundamental values, will drive the price bias upward since stock prices only reflect the beliefs of the optimistic group and the pessimistic group simply sit out of the market due to short-sales constraints (Hong, Scheinkam and Xiong, 2006). Stock market speculation is the behaviour of purchasing a stock with the sole purpose of selling it to someone else at a higher price. The feedback traders, who make purchases and sales independent of fundamental values, buy assets when prices have been rising so as to inflate bubbles (Haruvy and Noussair, 2006). Manipulation differs from other behaviours, which is an illegal behaviour of attempting to affect or control the price of a stock through aggressive trading. Briefly, speculators act in response to prices and, in contrast, manipulators are trying to act in influencing or controlling. It is worth noting that we give consideration to the "manipulation" in our work, which is missing in most other bubble studies, since many researchers, such as Aggarwal and Wu (2003), have shown that the stock market manipulation has important impacts on market efficiency.

Having studied the "decision process", the latent demands of investors are ultimately translated into transactions by a process. During the past two decades, many academic literatures have been focusing on the study of this process, the so-called research of market microstructure. Inspired by theories in this area, we believe that bubbles are not only produced by the investors' decision but are also generated in this process, the so-called "transmission process". Madhavan (2000) stated that asset prices need not equal full-information expectations of value because of a variety of "frictions" in the market. If this process is efficient, the prices will perfectly reflect the investors' decision. Otherwise, the "market-made bubble" appears due to the

[14] Hong, Scheinkam and Xiong (2006) marked it using an alternative label - the "resale option". We still use the word of "speculation" because it is more understandable within our framework.

"friction" of markets (such as slow transaction, bid-ask bias and the limitation of rules). Furthermore, he pointed out that the market structure, such as rules governing the trading process and trading systems[15], does influence the liquidity of a market and the expected returns must reflect a compensation for illiquidity. The support can be found in the work of Uno et al (2002), in which differences in trading systems are verified to affect pricing and liquidity in the Japanese stock market. The institutional design, such as the degree of short selling, can also affect bubbles. For example, Ackert (1993) found that the ability to short sell drives prices close to fundamental values; Haruvy and Noussair (2006) argued that short selling may overcompensate for bubbles and make prices lower than fundamental values. Therefore, in the extent of stock bubbles, the "mispricing" caused by the market structure is deemed as the "market-made bubbles".

In summary, it is shown that bubbles are composed of the "investor-made bubble" and the "market-made bubble" which are generated respectively in the "decision process" and the "transmission process" due to the decision and transmission inefficiency. In the "decision process", heterogeneous beliefs of investors incontrovertibly raise a stock price in excess of its fundamental curve, and the psychological properties of investors, such as overconfidence[16], are the major sources of this disagreement. To some extent, these psychological properties of the human thinking mechanism can further prove the general existence of irrationality which is one of the major forces driving the market price deviating from the fundamental value in stock markets. This view is supported by Shiller (2002) who clearly states: "human patterns of less-than-perfectly-rational behavior are central to financial market behaviours, even among investment professionals".

[15] Types of worldwide trading systems are: continuous, floor-based, dealer presence and multilateral trading systems.
[16] Overconfidence: the belief of an agent that his information is more accurate than in fact it is.

3.2.4 Value Frontier Framework

Having demonstrated the bubble forming process, our study moves further to discuss the theoretical basis of a new bubble measurement methodology - value frontier estimation framework.

Suppose that investors are optimistic in response to a series of information available in the market with an intention to minimise their decision errors. Share prices driven by investors' decisions contain two basic components: share fundamental values and bubbles. The fundamental value is defined as "a value with the deterministic relation to a set of company's fundamentals". The deterministic relation means only one fundamental value can be accepted in response to a company's set of fundamental variables at a point of time. The property of the fundamental value implies that given the set of fundamental variables, there is no other fundamental-related value above the fundamental value except bubbles or other statistical random noises. As clarified in Section 3.2.2, the fundamental value is calibrated by the fundamental valuation of investors with neutral beliefs/expectation on the future dividend income. In the theoretical structure of the value frontier model, fundamental values are represented by the value frontier. Since the pessimistic investors will sit out of markets under the short-sales constraint, any values below the value frontier are theoretically impossible in the long run but are possible in the very short term. As a consequence, the observed price reflects both share fundamental values and excessive value perceived by investors. It can be viewed as the sum of two components: frontier value P^f and bubbles B.

The first component is equivalent to the fundamental value which is determined by a set of the fundamental variables, x, and $P^f = f(x_1,...,x_N)$. P^f is the value deterministically associated with the fundamental variables, $\boldsymbol{x}$. We call P^f the frontier value since it represents the best value obtained from a market perceptive valuation technique. In theory, the frontier value equals the fundamental value and a line to connect frontier values in corresponding to different $\boldsymbol{x}$ is called a value frontier.

In Figure 3.1, the relationship between the observed stock price, P, a frontier value P^f on the value frontier line, and bubble, B is drawn up.

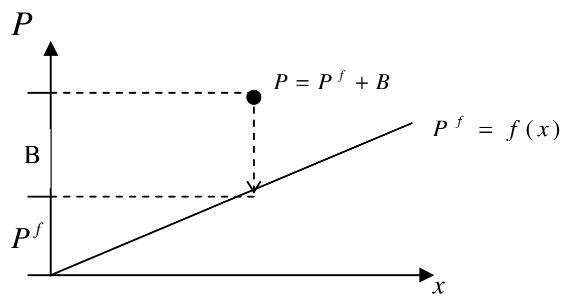

Figure 3.1 The Value Frontier of A Stock

The value frontier framework is assumed to satisfy the following three conditions:

First, as documented in Section 3.2.1, the market is partially efficient in terms of its information revealing process but not for investors' responses to information which are heterogeneous. The fundamental valuation technique is a common knowledge, i.e. the standard formula of fundamental valuation, which is the present value of expected future dividend stream, is accepted by all investors. However, the investors' beliefs in expecting the future dividends are heterogeneous due to the psychological properties of humans, such as overconfidence, representativeness and conservatism etc. In other words, even though the information is identical to all participants in the market, they can respond differently. This information-responding heterogeneity in forming the expectation can be mainly caused by the "expectation distortion" (or optimistic valuation) and speculative tradings.

Second, the values on the value frontier reflect the best combination of fundamental variables $f(x)$, and $P^f = f(x)$. Any other combinations of fundamental variables $g(x)$ must be under the line of value frontier, i.e. $g(x) \leq f(x)$. In addition, the frontier curve is not required to be concave, convex or linear. This assumption implies that the combination of fundamental variables making up the value frontier is the optimal function in calculating fundamental values, and any other functions will lead to the underestimation of fundamental values. The relationship among these fundamental variables can be linear or nonlinear.

Third, the bubble B represents the difference between an observed price and the value frontier, and its function is $B = P - P^f$, $B \geq 0$. The assumption of the non-negative value of bubbles means that underestimation of a stock price relative to its fundamental value cannot exist in the long run since pessimistic investors will quit markets when short selling is restricted. This idea is in line with Hong, Scheikman and Xiong (2006) who argue that "a stock price will be upwardly biased when there is a sufficient divergence of opinion because it will only reflect the valuation of optimists, as pessimists simply sit out of the market instead of short-selling". The same opinion can be also found in the work of Miller (1977), Chen, Hong and Stein (2002), and Mei et al (2005). In addition, asymmetric effects of arbitrageurs in response to the undervalued and overvalued price may be another explanation to non-negative bubbles. It is felt that if restrictions on short sales are tight, optimistic investors will make the purchase but few pessimist will sell stocks, which makes the "pessimistic bubble" impossible (Haruvy and Noussair, 2006). Thus, with the short-sales constraint, arbitrageurs appear more efficient in correcting the undervalued stock prices than the overvalued ones, since it is always easier to buy than to sell with the restriction of short selling. In detail, the short selling of pessimistic investors can drive down the overvalued stock price; however, in the absence of short selling, the price will simply be determined by the most optimistic trader with sufficient funds (Haruvy and Noussair, 2006). This is because the cost constraint on buying is smaller than on selling with the short-sales restriction. The selling needs to meet two constraints. One is a new buyer's expectation constraint: buying a share with an expectation of higher prices after buying. Another is the constraint of a seller's incurred losses if the seller sells shares below his/her purchase price. We know that sometimes arbitrageurs have to face potentially uncontrollable steep losses when the selling position occupies the market. This can also make them extremely cautious before liquidating their positions. As a result, the undervaluation of stock prices is likely to exist in the short term but not in the long term, since it is most likely to be corrected by arbitrageurs. However, the overvaluation of prices can be held for a long time in the market, which brings out the picture of positive bubbles. It is worth noting that although some researchers, such as King et al. (1993), Ackert et al. (2001) and Haruvy and Noussair (2006), documented the significant effects of short selling on asset price bubbles, the restriction of short-sales is extensively considered to arise from many distinct sources in reality (Scheikman and Xiong, 2003)[17]. In addition, if the price of a stock is undervalued to a certain extent, the management buyout becomes increasingly likely, which may also reduce the probability of negative bubbles. In fact, the assumption of non-negative bubbles has been utilised in the theory of rational bubbles in that negative bubbles are not allowed in an autogressive bubble path with limited liability[18].

3.2.5 Summary

The value frontier framework gives a value benchmark which is called the value frontier to represent the fundamental value. As long as this benchmark is nominated, the bubble, which identifies the level of upward mispricing in a stock market, can be estimated and compared. This can be obtained empirically by applying the stochastic frontier estimation technique.

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[17] Scheikman and Xiong (2003) imposed three major sources of the short-sale restriction.
[18] Limited liability: investors can not lose more than the amount invested.

3.3 Stochastic Frontier Estimation and Its Application to the Value Frontier Framework

Having discussed the theoretical basis of value frontier framework, this section is devoted to applying the theory to identify a statistical method as a new approach to estimate bubbles. The methodology of the stochastic frontier estimation for examining technical inefficiency can be applied to the value frontier framework so as to eventually measure out bubbles.

3.3.1 Critical Review of Stochastic Frontier Estimation

The stochastic frontier analysis (SFA) model, which is proposed firstly by Aigner, Lovell and Schmidt (1977), is initially developed to estimate technical efficiency (TE) that is defined as the deviation of the actual value of output from its optimal value for given input. The comparison is taken into two orientations. One is called output-augmenting orientation which is a ratio of observed to maximum potential output obtainable from the given input. Another is the ratio of minimal potential to the observed input required to produce the given output, which is named input-conserving orientation (Kumbhaker & Lovell, 2000 p43). Accordingly, the econometric models for SFA embrace a stochastic production frontier and a stochastic cost frontier.

The development of the frontier models underwent two stages. In the early research, the stochastic elements are neglected in the model, and accordingly this model is called the "deterministic frontier". Under the interpretation of the deterministic frontier, the random elements, which are out of the control of producers, are analysed as the inefficiency. Some imperfections in the specification of the model may also be treated as the inefficiency.

A more reasonable model compared to the deterministic frontier was developed in the second stage of the research - the "stochastic frontier model". Aigner, Lovell and Schmidt (1977) who proposed the stochastic production frontier (ALS frontier model) carried out the pioneering work using a stochastic frontier model. The basic framework is written:

$$y_i = f(x_i;\beta)\cdot \exp(v_i \pm u_i) \quad \textbf{(3.14)}$$

$$TE_i = \frac{y_i}{\{f(x_i;\beta)\cdot \exp(v_i)\}} = \exp(\pm u_i) \quad \textbf{(3.15)}$$

where β is a vector of parameters and i stands for producers. The composite error is $e = v\text{-}u$ for production function. v_i is the random disturbance that is assumed to be independently and identically distributed as N (0, σ^2). $u_i \geq 0$, following non-negative half normal distribution, represents the technical inefficiency. A simple transformation from the stochastic production frontier model to a stochastic cost frontier model can be extrapolated by changing the sign of the inefficiency error component u_i from negative to positive. y_i is scalar output and x_i is a vector of inputs or function of inputs in the production frontier model and interchanges their meanings in the cost frontier model. The deterministic frontier is $f\ (x_i;\ \beta)$ and the stochastic frontier is $\{f\ (x_i;\ \beta)\ exp\ (v_i)\}$. The frontier performance represents the optimised output or cost without inefficient elements, which is shown as $f(x,\beta)\cdot \exp\{v\}$.

The basic distributional assumptions of the "composed error" are:

(i) $v_i \sim iid \quad N[0,\sigma_v^2]$.

(ii) $u_i \sim iid \quad N^+[0,\sigma_u^2]$[19].

[19] ALS considered both half normal distribution and exponential distribution. Other distributional assumptions, such as a normal—truncated-normal $u_i \sim iid \ N^+(\mu,\sigma_\mu^2)$ (Stevenson, 1980), or normal-gamma model $u_i \sim iid \quad gamma$ (Afriat and Richmond, Greene, 1980 a,b) were also considered.

(iii) v_i and u_i are distributed independently of each other, and of the regressors.

The model (3.14) can be written in a logarithmic form which is the standard formula of its econometric model:

$$\ln y_i = \ln f(x_i;\beta) + (v_i \pm u_i) = \ln y_i^f \pm u_i \qquad \textbf{(3.16)}$$

The inefficiency term u can be interpreted as the percentage deviation of observed performance y from its frontier y^f

$$U_i = \exp(\pm u_i) = \frac{y_i}{y_i^f} \qquad \textbf{(3.17)}$$

Addition (+) is cost frontier, minus (-) is production frontier.

With panel data, the foregoing basic framework can be extended into three different models to estimate u: (1) fixed effects frontier model; (2) random effects frontier model; (3) the latent class frontier model. Under the panel data estimation technique, at least one producer at one time is assumed to be 100% efficient, i.e. U=1, and the efficiencies of other producers are measured relative to this mark point.

The fixed effects and random effects frontier models are generated with the popularity of panel data. The technique starts from an estimation of the time-invariant inefficiency component. Afterwards, Cornwell, Schmidt, and Sickles (CSS) (1990) and Kumbhakar (1990) first proposed a stochastic production frontier panel data model with time-varying efficiency. The estimation has been pursued in a maximum likelihood approach. Therefore, the equation (3.16) becomes:

$$\ln y_{it} = \alpha_{it} + \ln f(x_{it};\beta) + v_{it} \qquad \textbf{(3.18)}$$

$$u_{it} = \alpha_0 - \alpha_{it} \text{ or } \alpha_{it} - \alpha_0 \qquad \textbf{(3.19)}$$

where α_0 is the intercept common to all individuals and α_{it} is the intercept of individual i in period t.

Lee and Schmidt (1993) reckoned the technical efficiency term could use a more flexible formulation than the CSS model:

$$u_{it} = \beta(t) \cdot u_i \qquad \textbf{(3.20)}$$

where $\beta(t)$ is specified as a set of time dummy variables β_t.

Greene (2002a,b) showed the serious bias caused by the incidental parameters' problem in the fixed effects frontier model. However, the existing evidence reveals that the biases are serious only when the observed period is small (five in Greene's two applications).

The third approach of the frontier model for panel data is the latent class stochastic frontier model (LCSFM). The conventional measurements of the efficiency stand on the assumption of a common technology available to all producers. However, individual firms may use different technologies in the real world giving rise to the unfavourable and biased estimations. To reduce the misspecification caused by the technology variances, a two-stage estimation is employed by classifying the sample observations into certain categories. LCSFM comprising a single-stage approach is a parsimonious alternative to the two-stage estimation. The latent class model may be expressed as the mixture of the stochastic frontier model and a model for the mixing probabilities, which are written as (3.21) and (3.22) respectively:

$$y_{it}\left|class = j\right) = \alpha_j + \beta_j x_{it} + v_{it}\left|j \pm u_i\right|j \quad \textbf{(3.21)}$$

$$v_{it} = N[0, \sigma_{vj}^2]$$

$$u_{it} = N^+[0, \sigma_{uj}^2]$$

$$prob\left[individual \quad i \quad is \quad a \quad member \quad of \quad class \quad j\right] = F_{ij} \quad \textbf{(3.22)}$$

The latent class stochastic frontier model combines the stochastic frontier approach and a latent class structure. In practical terms, LCSFM is somewhat less flexible and its advantage as an empirical tool remains to be verified as it's still in the inception period (Greene 2001a,b).

Among the three extensions of the stochastic frontier model, the fixed effects frontier model is regarded as a more efficient estimator, though the random and latent class models are particularly versatile and have great potential (Greene, 2002a).

On the basis of the above models, some applied studies were made in various areas. Luis Orea and Subal C. Kumbhakar (2003) presented an application of the latent class stochastic frontier model by data on the Spanish banking system in which different types of banks coexist. Yougesh Khatri et al (2002) used the frontier model in an area of corporate performance and governance. A dataset of 31 non-financial companies listed on the Kuala Lumpur stock exchange in the periods between 1995 and 1999 was examined. The frontier model has also been applied to sport economics. Sam Richardson (2002) modelled two separate frontier models to two groups of different football teams and found the existence of a home-ground advantage. William Greene (2003) explored a large number of recently developed approaches on frontier models with panel data, and applied them to the WHO data, which consisted of 191 countries with a five-year panel.

3.3.2 Application of Stochastic Frontier Estimation to the Value Frontier Framework

The critical review above on the production/cost frontier function helps us compare the SFA with the value frontier theory.

As defined, technical inefficiency U_{it} in setting the cost for producing a given level of output at time t is:

$$U_{it} = \frac{C_{it}}{C_{it}^{f}(z_{it}, \beta)} \qquad U_{it} \geq 1 \qquad \textbf{(3.23)}$$

where, for given output z, C is the actual level of costs, and C^{f} is the cost frontier which is the optimal level of costs expected by the optimal theory of production, i.e. it means the best use of inputs in production. Therefore, U_{it} implies the cost in excess of the optimal level, which results from the inefficient use of inputs.

In comparison to U_{it}, a variable BI representing the bubble index which is the deviation of a market value from the fundamental value at time t can be stated as:

$$BI_{it} = \frac{P}{P^{f}(x)} \qquad BI_{it} \geq 1 \qquad \textbf{(3.24)}$$

where, given the set of fundamental variables x, P is the observed actual price of a stock and P^{f} is the frontier value that is entirely determined by the given fundamental variables. The value frontier indicates the value that is fundamentally recognised by the market from a valuing-technique perception for the fundamental variables. With this perception, no other values can be formed below the fundamental level. Any values in excess of the fundamental value or the value frontier are called “bubbles”, which result from the overoptimistic expectation to fundamental values, speculation and noise trading etc. It is worth noting that BI in (3.24) is defined as the percentage deviation of a stock price from the value frontier, which is not the absolute value of bubbles B. In this sense, we name BI the “bubble index” or the “estimated bubble”.

The comparison between the technical inefficiency of a firm in cost setting and the decision inefficiency in forming a market value enables us to extend the application of stochastic frontier technique from estimating the cost inefficiency in production to estimating the stock price inefficiency driven by inefficient investment decision. To make the cost inefficiency estimable, U_{it} is redefined as:

$$U_{it} = \exp(u_{it}) = \frac{C_{it}}{C_{it}^{f}(z_{it}, \beta) \cdot \exp(v_{it})} \tag{3.25}$$

The statistical model is written in a logarithmic format:

$$\ln C_{it} = \ln C_{it}^{f}(z_{it}, \beta) + u_{it} + v_{it} \qquad \text{with } u_{it} \geq 0 \tag{3.26}$$

For the same analogy, the bubble index can be expressed in a statistically estimable term as:

$$BI_{it} = \exp(b_{it}) = \frac{P_{it}}{P_{it}^{f}(x_{it}, \gamma) \cdot \exp(\varepsilon_{it})} \tag{3.27}$$

or $$\ln P_{it} = \ln P_{it}^{f}(x_{it}, \gamma) + b_{it} + \varepsilon_{it} \qquad \text{with } b_{it} \geq 0 \tag{3.28}$$

ν_{it} in (3.26) and ε_{it} in (3.27) capture the random disturbances in setting the cost and the stock price, with normal distribution of $\nu_{it} \sim N(0, \sigma_{it}^2)$ and $\varepsilon_{it} \sim N(0, \varpi_{it}^2)$ respectively.

The underlying assumptions to apply (3.26) in estimating the cost inefficiency is that the production technology and input factors are identical in the product market for every firm, and at least one producer at one time is assumed to be least inefficient, i.e. the lowest inputs consumed for a given output relative to others in the market. This enables us to interpret U_{it} as excess costs or inefficiency relative to the best level of the industry or market. Thus, U_{it} is a relative term in (3.26). The same is true for underlying assumptions to estimate (3.28), in which the stock valuation technique and fundamental information are the common knowledge that is applied in the stock market to value the fundamental values of each company. At least there is one stock with the lowest price relative to others for the given fundamental variables. This lowest stock price is chosen to present the value frontier which is regarded to be closest to the fundamental value among all observed stock prices. Therefore, we take this value as "the proxy of fundamental value" in the empirical estimation. The above assumptions ensure that the property of (3.26) can be applicable to (3.28), which allows us to interpret BI_{it} as the excess value relative to the closest value to the fundamental level of a sample. So BI_{it} is also a relative term in (3.28) which is relative to the closest value to the fundamental value perceived technically by the market.

If the stock valuation technique becomes common and identical knowledge applied for valuing fundamental values of each stock, the fundamental value of each stock can then be perceived commonly by the market. Under this circumstance, for the given fundamental values, any difference between stock prices reflects the value exaggeration of one relative to another. Hence, in the empirical estimation, the deviation of a price relative to the lowest price for given fundamental values can be interpreted as "excessive value" which has resulted from an inefficient value decision such as over-optimistic expectation or irrationalities etc. In this sense, the lowest price of given fundamental values is defined as a "benchmark" to represent the value frontier of the sample, which is assumed as a best proxy of the fundamental value.

3.3.3 Summary

The critical review of the stochastic frontier theory enables us to identify the comparable structures and properties between two theories of cost frontier and value frontier. The similar properties of two theories and the same analogy of underlying assumptions applied in both theories lead us to make a breakthrough in extending the application of the frontier technique from estimating cost inefficiency to the estimation of value inefficiency. This breakthrough is profound in terms of developing a bubble estimation method to enrich the current financial research. The new development enables us to go beyond the verification of bubbles to estimate the magnitudes of bubbles, which facilitates more in-depth research in looking at bubble movements rather than merely in testing bubbles.

3.4 Summary and Conclusion

Ongoing researches in stock bubbles can be divided into two groups: the study of rational bubbles and behavioural finance. The school of rational bubbles has been trying to verify the existence of bubbles based on diversified assumptions of bubble path and advanced econometrical techniques. Meanwhile, as the opposite of EMH, behavioural finance argues that deviations of asset prices are brought about by the presence of traders who are not fully rational (Thaler, 2005). However, none of them have studied bubbles in light of measuring their magnitudes. The school of rational bubbles focus on the statistic test of the presence of bubbles, while the behavioural researchers try to model the stock market with individual trading behaviours. Standing along with these two schools advocating the stock market inefficiency, we put the research attention innovatively on establishing the value frontier framework that lays theoretical foundation for bubble measurement.

This chapter contributes to the research of bubbles by refining the theories of fundamental valuation and bubble formation within a well-acknowledged stock price framework (prices equal to fundamental values plus bubbles). To define the fundamental value in the value frontier framework, the heterogeneous investors are categorised into three types: optimists, pessimists and investors with the neutral expectation. The fundamental value is determined by the fundamental valuation of investors with the neutral expectation. The pessimists may always sit out of the market under the short sales constraints which keep bubbles non-negative in the long run. Meanwhile, based on the views of Hong, Scheinkman and Xiong (2006), the formation of bubbles are attributed to three effects: the optimism effect, the speculation effect and the effect of other random trading (e.g. noise trading, positive feedback trading and manipulation etc.). These arguments provide a sound justification for accommodating the stochastic frontier estimation technique to financial theories.

However, the value frontier framework is just a conceptual structure which could be further improved with the development of financial theories. Particularly, designing a more comprehensive fundamental valuation structure in the value frontier model should be the focus in the future.

In addition, it is worth mentioning that the value frontier approach proposed in this chapter is largely descriptive since the empirical estimation doesn't need to model the formation of bubbles in detail. Although the theoretical description is sufficient for studying the measurement of bubbles in this work, it will show the limitation in studying the formation of bubbles. Therefore, a strictly derived model about bubble formation is expected to enhance the theoretical foundation of the value frontier framework so that a theory of stock market inefficiency underpinning the bubble estimation could finally be well established.

Chapter 4 Application of the Value Frontier Methodology I: Estimation of Market-level Bubbles Around the World

The value frontier model paves a new way to expand bubble studies since it stands to reverse a declining trend of research in the recent time due to the methodological limitation. This chapter aims to apply the new approach discussed in Chapter 3 to empirically identify the magnitude of bubbles in each market at a point in time relative to the proxy of fundamental values at the market aggregate level. The estimated bubbles enable us to plot their movements over time and compare them amongst different markets. This chapter is arranged as follows. Section 4.1 conducts the time-variant cross-country estimation of stock bubbles; Section 4.2 pertains to comparatively analyze bubble movements across the sample markets; Section 4.3 snaps some real-world pictures conformable to the bubble results with the purpose of enhancing the confidence to the bubble estimation methodology; Section 4.4 deals with the summary and conclusions.

4.1 Bubble Estimation for 37 Countries Around the World

4.1.1 Models

In the ongoing bubble research, the stock price is defined under the rational expectation framework, which considers that, in an efficient market, the stock price should be determined by the following relationship (West, 1987):

$$P_t = k \cdot \mathrm{E}\left(P_{t+1} + D_{t+1}\right) \mid I_t \quad \textbf{(4.1)}$$

P_t is the observed real stock price at the beginning of period t; k is the instantaneous discount rate, $0 < k = 1/(1+r) < 1$, r is the constant expected return;

$\mathrm{E}(\cdot)$ is the market's expectation. P_{t+1} and D_{t+1} is the observed real price and real dividend paid in the period of t+1 respectively. I_t represents the information known in period t. (4.1) can be specified as:

$$P_t = \sum_{i=1}^{n} k^i \mathrm{E} D_{t+i} \middle| I_t + k^n \mathrm{E} P_{t+n} \mid I_t \qquad \textbf{(4.2)}$$

Derived by applying the transversality condition,

$$\lim_{n\to\infty} k^n \mathrm{E} P_{t+n} \mid I_t = 0 \qquad \textbf{(4.3)}$$

and assuming a constant dividend growth rate of g, (4.2) successively converges to:

$$P_t = \sum_{i=1}^{\infty} k^i \mathrm{E} D_{t+i} \middle| I_t = \lambda D_t \qquad \textbf{(4.4)}$$

with $\lambda = \dfrac{kg}{1-kg}$, $D_t = gD_{t-1}$

(4.4) implies that if the transversality condition of (4.3) holds, the observed real stock price equals the fundamental value, i.e. rational bubbles are ruled out. Rational bubbles ($\dot{B}$) are accordingly defined as the deviation of observed real prices (P) from fundamental values (P^*), which is defined as:

$$P_t = P_t^* + \dot{B}_t \qquad \dot{B}_t > 0 \qquad \textbf{(4.5)}$$

However, under the new value frontier theory, as discussed in Chapter 3, the bubble variable (*BI*) is modelled as the observed price divided by the value frontier P^f which is a function of a set of fundamental variables $\boldsymbol{x}$. The mathematical expression is:

$$P_t = P_t^f \times BI_t = f(x) \times BI_t \quad \text{with} \quad BI_t \geq 1$$

$$BI_t = \frac{P_t}{f(x)} \tag{4.6}$$

If the frontier value P^f is presented by the fundamental variable x, it seems that the new bubble definition is consistent with the traditional theory, since (4.6) is a nonlinear expression of (4.5). However, it is worth noticing that, although the concept of the frontier value is identical to the fundamental value in theory, these two values are not exactly the same empirically, since the value frontier is the lowest stock price for given fundamental variables $\boldsymbol{x}$ in a sample, and this lowest value is regarded empirically as a proxy of the fundamental value, which may or may not equal the fundamental value. However, if negative bubbles do not exist in the long run, using the lowest-valued stock in a sample should be acceptable as a benchmark to represent the fundamental value of the sample. In this sense, it is understood that the estimated bubble *BI* is relative to the sample-defined benchmark of the fundamental value. When every observed stock price is compared with the sample benchmark or the value frontier, the value deviation relative to the value frontier can appear at a range from 0 to a positive number. This relative deviation is the "bubble" of a sample, known as the "bubble index" or the "estimated bubble".

In order to identify the fundamental value empirically at the market level, and following antecedent modelling of market-level fundamental values (for example, Flood and Garber, 1980; Shiller, 1981; and West, 1987 etc.), the dividend (*D*), as the classical market-level fundamental variable, is defined as the determinant of the value frontier P^f. Following West (1987), the frontier value can be formulated as the present value of expected future dividends (Eq. 4.4). As documented in Section 3.2, the fundamental value is determined by the fundamental valuation of investors with the neutral expectation. Thus, P^f can be stated as:

$$P_t^f = \sum_{i=1}^{\infty} k^i \mathrm{E} D_{t+i} \big| I_t = \alpha D_t \tag{4.7}$$

with $\alpha = \dfrac{kg}{1-kg}$, $D_t = gD_{t-1}$ $\qquad g = 1$

and thus (4.6) can be transformed to:

$$P_{it} = P_{it}^{\ f} \times BI_{it} = \alpha D_{it} \times BI_{it} \qquad \text{with} \quad BI_{it} > 1 \tag{4.8}$$

where the value frontier is specified as $P_{it}^f = \alpha D_{it}$.

Taking a logarithmic form, (4.8) becomes:

$$\ln P_{it} = \ln(\alpha D_{it}) + \ln BI_{it} + \varepsilon_{it} = \alpha' + \beta \ln D_{it} + b_{it} + \varepsilon_{it} \tag{4.9}$$

where $b_{it} = \ln BI_{it}$ with $b \sim iidN^+(\mu, \sigma_b^2)$ and $\varepsilon \sim iidN(0, \sigma_\varepsilon^2)$. *i* denotes an individual market and *t* represents a point of time.

Lovell (1993, p7) suggested that the efficiency estimation could combine dummy variables in frontier models, under which the fluctuated time-variant efficiency can be estimable without inventing any new frontier technique. Following Lovell's idea, the individual dummy variables (A_i) are liable to attend the model to capture the specific effect of a market. Meanwhile, time dummies (T_t) can pick up the global shock on a particular year in the estimation. Therefore, the final model is specified as:

$$\ln P_{it} = A_i + T_t + \beta \ln D_{it} + b_{it} + \varepsilon_{it} \quad \textbf{(4.10)}$$

where P is the observed stock price, D is the dividend and A and T represent the individual and time dummies.

In order to control the size-effect of markets, the number of shares (N) in each sample market is inserted into the model (4.10):

$$\ln P_{it} = A_i + T_t + \beta \ln D_{it} + \delta N_{it} + b_{it} + \varepsilon_{it} \quad \textbf{(4.11)}$$

Another extension is to divide P_{it} and D_{it} *by* N_{it} before transforming them into the logarithmic form:

$$p = \ln\left(\frac{P_{it}}{N_{it}}\right) = A_i + T_i + \beta \ln\left(\frac{D_{it}}{N_{it}}\right) + b_{it} + \varepsilon_{it} \quad \textbf{(4.12)}$$

For the robust test, another model is also taken into account:

$$p = \ln\left(\frac{P_{it}}{P_{i2000}}\right) = A_i + T_t + \beta \ln\left(\frac{D_{it}}{D_{i2000}}\right) + b_{it} + v_{it} \quad \textbf{(4.13)}$$

where P_{i2000} and D_{i2000} are the observed stock price and dividend respectively in 2000.

For a descriptive convenience, it refers (4.10), (4.11), (4.12) and (4.13) to models A, B, C and D respectively in the discussion below.

4.1.2 Data

Published empirical researches on the study of bubbles are based on time-series data of stock prices and dividends (e.g. Shiller, 1981; West, 1984; Campbell and Shiller, 1987; Evans, 1991; and McQueen and Thorley, 1994 etc.). The stock price of a market is represented by stock price indices including Standard & Poor's Index, the modified Dow-Jones Index, the Hang Seng Index and the Shanghai Stock Index. [20] Real monthly returns for both equally and value-weighted portfolios of all New York Stock Exchange (NYSE) stocks were also used (see McQueen and Thorley 1994).

In contrast, the main dataset employed by this chapter is a panel pooled by 37 countries from Datastream Global Indices[21]. The annual market value (*MV*) and dividend yield (*DY*) data from 1983 to 2002 are employed.[22] The dividend (*D*) is worked out by the product of the market value and the dividend yield. This is an unbalanced panel set of 624 observations, since missing data exist in some markets uncoordinatedly. In order to control the effect arising from the different number of constituents amongst markets, the annual constituent number of each index (*N*) has been obtained. In addition, the annual data of the price index (*PI*), price/earning ratio (*PE*) and price/dividend ratio (*PD*) are also acquired to estimate the relationship between them and the estimated bubbles (*BI*).

4.1.3 Empirical Estimation and Results

In this section, with the assumption that bubbles exist generally, the stochastic cost frontier technique is applied in the estimation, which enables us to estimate bubbles and compare them across markets.

[20] The observed prices and dividends from Standard & Poor's index are frequently adopted by researchers, such as Shiller (1981), West (1987), Froot and Obstfeld (1991), and Donaldson and Kamstra (1996). Flood and Hodrick (1986) developed a new empirical analysis using S&P and the modified Dow Jones Index respectively.
[21] See Appendix 4.1 for the definition of Datastream Global Indices data.
[22] In order to enlarge the dataset to achieve the unit root test in time series, the data were updated to the period of 1965 to 2005. However, only model A was re-examined by the expanded dataset and the major bubble estimation remains unchanged, since it's nothing more than a repetition if the new results are consistent with the initial ones.

Before moving into the estimation of bubbles, it is interesting to highlight some arguments made by previous studies, such as Diba and Grossman (1988b), Hamilton and Whiteman (1985) and Campbell and Shiller (1987). On the basis of a residual-based unit root test between stock prices and dividend payments, one argument is that the evidence that the first differences of stock prices are stationary and/or stock prices are co-integrated with dividends would be the evidence against the existence of rational bubbles. However, the failure of obtaining this evidence does not mean the existence of rational bubbles, since the non co-integration between stock prices and dividends could result from the non-stationarity of unobservable fundamental variables, such as the consideration of the future tax treatment of the dividend income.

However, in our view, the evidence of co-integrated stock prices and dividends, which supports the view for the non-existence of bubbles, is only a result of the stationary combined error which is composed of the bubble and the statistical residual. Furthermore, the evidence on co-integration between dividends and stock prices is questionable.

To verify our viewpoint, this study repeats the co-integration test using our new sample data. We randomly selected six markets (Australia, Hong Kong, the Netherlands, South Africa, the United Kingdom, and the United States) to apply the unit root test in a time series dataset.[23] Before the test, in order to reduce the bias resulting from the accumulated market value (*MV*) and dividend data (*D*), two transformations were made to the data: the relative ratio with the fixed base (*dMV* and *dD*) and the logarithmic transformation (*LMV* and *LD*). The ADF test was applied for the study of variable stationarity, and the Augmented Engle-Granger test (Engle and Granger, 1987) was utilised for the co-integration analysis.

[23] In order to diversify, three countries were chosen with values of the estimated bubble of I(0), and another three with values of the estimated bubble of I(1). The results of the stationary test for the estimated bubble are shown in Table 4.4 B and C.

The results of the co-integration tests of bubbles are shown in Table 4.1, where six markets (Australia, Hong Kong, the Netherlands, South Africa, the United Kingdom and the United States) are examined. In order to jointly analyse three strategies achieving the unit root test which are the regression with intercept, with intercept and trend, or with neither an intercept nor a time trend, these three strategies are applied to all tests. Argued by Elder and Kennedy (2001), all the strategy tests proposed by some experts, such as Perron (1988), Dolado, Jenkinson, and Sosvilla-Rivero (1990), Holden and Perman (1994), Enders (1995) and Ayat and Burridge (2000), are more complicated than they need to be. Therefore, no attempt is made here to test strategies. Instead, the simple graph plots of the data and the coefficient tests for the time trend and the intercept give the justification to the strategy. Meanwhile, as Davidson and Mackinnon (1993) mentioned, the strategy without the intercept is "extremely restrictive, so much so that it is hard to imagine ever using it with economic time series". So, the results from the tests without trend and intercept are rarely analysed unless the data show that the consideration is necessary.

The data show that among four variables, *dMV, dD, LMV* and *LD*, there are obvious trends in *dMV* and *dD*, and their first differences normally diminish the trend. Therefore, in stationary tests, the trend is likely to be considered at the level, not at the first difference for *dMV* and *dD.* Withstanding this, however, one should still keep in mind that, as explained by Thomas (1997), the trend does not always disappear after the first difference. As to *LMV* and *LD*, the trend is ignored at the level, since conducting the logarithmic form has already reduced the trend of the data. Only the significant coefficients of the trend or the intercept become the evidence of supporting the trend or intercept strategy. Based on the above principles, the strategies chosen are highlighted in bold in Table 4.1. The statistics of the stationary tests for the level variables cannot reject the unit root, but reject it at the first difference, i.e. *dMV, dD, LMV* and *LD* in these six markets are stationary to the first order (I(1)) but not stationary at the level.

[Table 4.1 is about here]

Table 4.1 also shows the results from residual-based co-integration tests. Engle-Granger (1987) method is applied. No co-integration is concluded in South Africa and the United States, and the results among the other four markets are mixed (in Australia, Hong Kong, the Netherlands and the United Kingdom, the results are inconsistent between logarithmic model with *LMV LD* and the difference model with *dMV dD*). This inconsistency can be explained by two reasons. Firstly, the co-integration technique itself is inconclusive and the development of this technique is still a big area of research. Secondly, Campbell and Shiller's argument is plausible.

From the above mixed results, it is easy to see that the tests following Campbell and Shiller's argument seems have nothing in relation to the support of EMH, in that the co-integration technique itself is still plausible to some extent. In addition, it is worth noting that the unobserved variables considered as the reason for no co-integration in their work are rather the reason of inflating bubbles than the elements of enriching the fundamental values. Furthermore, from the standpoint of econometrics, the co-integration between share prices and dividends only means a long-term relationship between these two variables, not evidence of the non-existence of bubbles, since bubbles may be stationary and mixed in the stationary residual set, so that it is weak to discuss the existence of bubbles on the basis of the co-integration test between stock prices and dividends.

In summary, the blurry results in our tests verify that the previous co-integration test of bubbles is questionable. The evidence of co-integration of stock prices and dividends does not prove the non-existence of bubbles, since the bubble is a part of the residual and exists persistently. It can be stable over time so as to be stationary as well.[24]

Having identified the discrepancies in the co-integration test of bubbles by repeating the former test for our sample, we turn to the bubble measurement using the frontier estimation technique, which can help to prove the existence of bubbles as well as to identify the magnitudes of bubbles. Hausman's specification test has been applied to prove that the fixed effects model is a better choice to ensure the optimal model for the sample data. In Table 4.2, the results of the Hausman test on models A, B, C and D significantly reject the null hypothesis of the random effect panel, i.e. the data have been verified to fit the fixed effects better than the random effects.

[Table 4.2 is about here]

After checking qualification of models, the estimations are conducted using the models A, B, C and D respectively. The parameters estimated from these four models are listed in Table 4.2. The estimated bubble BI_{it} is also measured out according to models A, B, C and D using the stochastic cost frontier technique, which provides a common ground for the later analysis. However, it's still necessary to bear in mind the real meaning of the estimated bubble *BI*, which is the percentage deviation of the observed price from the value frontier, and it is a relative measure of bubbles.

After plotting the values of BI_{it} derived from these four models, the four lines are perfectly co-moving with each other in all the sample markets (Figure 4.1), which shows that bubble results from models A, B, C and D are consistent. The average values of the estimated bubble are listed in Table 4.3.

[Table 4.3 and Figure 4.1 are about here]

[24] Froot and Obstfeld (1991) stressed that for a given level of exogenous fundamentals, the bubble will remain constant over time. They name it the 'intrinsic bubble'.

However, one may ask that, in the stock market analysis, does the bubble variable BI_{it} contain information which other variables cannot capture, such as price/earning ratio (*PE*) and price/dividend ratio (*PD*)? Furthermore, is it possible that the bubble variable is just a duplication of the price tendency? To answer these questions, the long-term and short-term relationship between the estimated bubble and *PE*, the estimated bubble and *PD*, and the estimated bubble and the price index *PI* have been investigated. The three groups of co-integration tests are employed respectively to examine their long-term relationship. Before testing the co-integration, stationary tests for these variables are conducted for 17 markets.[25] The short-run relation can be tested by running three OLS regressions between the first difference of *BI* and the first difference of *PI, PE* and *PD* respectively.

Table 4.4 shows the results from both the stationary and co-integration tests. The stationary tests on the panel data show that estimated bubbles are I(0) (Table 4.4A). The result may be inconclusive because of the strict precondition of cross-sectional independence imposed by the recent developed panel unit root testing technique. Thus, a major concern has been put on the results from the time-series tests. The values of the bubble variable in 17 markets that have time-series data over 33 years have been examined. Table 4.4 B and C respectively show the markets with the estimated bubbles of I(0) and of I(1). Only five out of the 17 markets show the estimated bubbles of I(1), and these are Australia, Canada, Japan, the Netherlands and the United States. Since the test on the bubble variable shows I(1) in five markets, the stationary tests for *PI*, *PE* and *PD* are pursued only for these five markets. Table 4.4 D, E and F reveal that these three variables are non-stationary at level, but stationary in the first difference.

[25] The markets containing more than 33 years' data are chosen (only the U.K. market embraces 41 years' data in the sample. The data for the rest of chosen markets are all from 1973 to 2005).

[Table 4.4 is about here]

The statistics exhibited in Table 4.4 G consistently fail to reject the null of no co-integration except for one number highlighted in bold in the table, which brings the conclusion that the estimated bubble has no long-term relationship with *PI*, *PE* and *PD*.

In Table 4.5, the results from the short-term study are different. The results from the panel data regression demonstrate the significant relation between *BI* and *PI*, *PE* or *PD* in the short run. However, the results from the time-series-based regression show that the estimated bubble significantly correlated with *PI* in all of these five markets, but the significant correlation between *BI* and *PE* or *PD* are only shown in the Netherlands and the United Sates.

[Table 4.5 is about here]

From the above empirical analysis about the relationship between the estimated bubbles and *PI*, *PE* and *PD*, we can conclude that there is certainly a short-term correlated relationship to some extent, but the existence of a long-term relation is not supported by our empirical evidence.

It is also worth stressing that the evidence of short-term correlation between prices and estimated bubbles validates the conjecture of overreacting investors. When good news comes out, the investors' over-optimistic behaviours cause the price to climb sharply. The gap between the fundamental value and the real price is widened out as the real price fluctuates more heavily than the fundamental value. When bad news is exposed, over-pessimistic investors drag down the price hastily. The decreasing rate of the observed price is much higher than the fading of fundamental values, so that the bubbles are diminishing. Thus, it can be seen that the bubble path and the price track probably run in the same direction if all news is known by investors. In the long run, accumulatively, the different magnitudes of overreaction can lead the two lines to move separately. Moreover, the effect of shocks from irrationality in the long run can be significant. Therefore, not only does the non-cointegration in the long run show the effect of uncertainty on investors' decisions, but also implies the existence of significant irrationality.

Having verified the unique feature of the estimated bubbles, the values of the estimated bubble in 37 markets are plotted against the sample average (Figure 4.2). Furthermore, based on the classification of the World Bank Indicator (WDI), the investigation about the economic and the regional variability of bubbles is carried out by examining the mean and variance of estimated bubbles for each year (figures 4.3 and 4.4). With the bubble plots, additional attention has been drawn on some real world occurrences so as to support the legitimacy of the estimated bubbles specified by the value frontier theory. These will be detailed in sections 4.2 and 4.3.

4.2 Examinations of Estimated Bubbles

4.2.1 Interpretation of the Average Movement of Estimated Bubbles

Table 4.6 shows the average value of the market price, dividend and the estimated bubble over the period of 1994 to 2002. The average values of the estimated bubble *BI* fluctuate between 1.121 and 1.125. As documented in Section 4.1.3, the estimated bubble *BI* measures the percentage deviation of the observed price from the value frontier, and it is a relative measure of bubbles. Thus, these values of *BI* in Table 4.6 signify an approximate 12 per cent deviation of stock prices from fundamental values on average among sample markets, i.e. the worldwide average levels of bubbles over the period of 1994 to 2002 are persistently about 12 per cent higher than fundamental values.

[Table 4.6 is about here]

Obviously, the average levels of bubbles do not change substantially over time, and they are far more stable than the estimated bubble of each individual market, which can be detected from Figure 4.2. This finding may be explained by the behaviour of the cross-market arbitrage. Bubbles of a market are stimulated by a huge capital inflow. The soaring bubble can no doubt produce a higher excess return so attracting arbitrageurs to alter their positions from the market with a lower return to this high bubble market. Certainly, the inflow of more funds will further enrich the soaring bubble of this market, which, however, is finally achieved by sacrificing the market value of other markets. Overall, the limited supply of funds will, on average, produce a stable level of stock bubbles worldwide, since the climbing bubbles in one market can always be offset by the falling bubbles in another market.

[Figure 4.2 is about here]

This finding can be further analyzed by the "sustainable bubble" documented by Binswanger (1999). He proposed that stock bubbles exist persistently, since fundamental values of stocks are uncertain. Moreover, a "sustainable bubble" can positively facilitate the growth of an economy, and the bubble is "sustainable" (no crash happens in a sudden) in a long run only if its movements are consistent with real economic activities. This implies that a "healthy" stock market, which benefits the economy, is expected to move with the real economy. To put this simply, bubbles which move with the real economy can facilitate economic growth. From Table 4.6, it is easy to see that although bubbles remain at 12% over the period of 1994 to 2002 on average, it is argued that the bubble is not sustainable, since the movement of the sample average bubble is not consistent with the movement of GDP growth rates of both the sample average and the world, which, in the case of Binswanger (1999), implies that the worldwide stock markets don't function well on average in terms of facilitating economic growth, and average bubbles worldwide over the period of 1994 to 2002 are not "sustainable", though their fluctuation is very light.

4.2.2 Bubble Movements in 37 Countries

In this section, estimated bubbles in 37 countries over the period of 1994 to 2002 are plotted.[26] First, the arithmetic average value of *BI* over the sample for every particular year is calculated and the comparison is conducted between each country's *BI* and this average value. The bubble movements over time in every country are exhibited in Figure 4.2.

Next, with the graphs in hand, the 37 countries are classified as rising, falling, fluctuating, high-level and low-level bubble countries according to their movement paths of bubbles between the periods of 1994 and 2002.

The countries where the bubble levels are higher in most years than the average ones are put into the group of high-level bubble countries, and those with bubbles lower than the average make up the group of low-level bubble countries.

The bubble levels of Denmark, Japan, New Zealand, and the United Kingdom maintain under the average line in the observing period. Belgium, Germany, Italy, Venezuela, Taiwan, Australia and Finland perform in the low bubble level most of the time, and only show the temperate sharp soar in certain years. Also, among the low-level bubble countries, European countries show similar patterns which are nearly in accordance with the sample average movement. By contrast, Hong Kong, Mexico, Switzerland and Thailand can be put into the high-level bubble group, where the bubbles generally move above the sample mean, though the short-term sudden

[26] Since no missing data exist from 1994 to 2002, only nine years' results are examined.

breakthrough may appear in the graphs.

Over the period of 1994 to 2002, markets that experience a switch from a low level to a high level of bubbles relative to the average are selected into a bubble rising group, which consists of Canada, France, Greece, Ireland, Spain, Turkey, U.S, Norway and the Chinese B&H-share markets[27]. Among them, bubbles in U.S. show extremely obvious upward movements. Despite a gentle sway downward after the year 2000, the upward bubble path in Norway becomes the leading trend. The countries with the contrary bubble tendencies compose a bubble falling group which contains Argentina, Austria, Chile, Indonesia, Malaysia, Philippines, Singapore, South Africa and the Netherlands. It is worth noting that bubbles in the Netherlands decrease obviously in the early years, but rebound from 2000 and break through the average level in 2002. In addition, the bubbles of most East Asian countries in the sample have similar dropping tendencies. They all touch the bottom in 1998, which is obviously ascribed to the Asian Financial Crisis.

Bubbles in South Korea, Portugal and Sweden fluctuate heavily, from which no trend can be discerned.

4.2.3 Bubbles and Economic Conditions

Having interpreted the worldwide average movements of the estimated bubbles in link with the global economic performance, the study goes further at a deeper level to verify the conjecture that the different levels of bubbles may be associated with

[27] The Chinese stock market is a segmented market. The A-share market is its main body which has 94% of total market values. Thus, the bubble results from the B&H-share sample hardly represent the bubble tendency of the whole Chinese stock market. However, the data of Chinese A-share wasn't employed by Datastream Global Indices when we empirically computed the bubble index at market level. In our recent amendments, this problem is considered and solved by duplicating a market level regression while the data of A-share are available in the recently renewed Datastream Global Indices. The bubble tendencies of A-share and B&H-share from the new estimation can be viewed in Figure 4.4-1. These two figures provide a direct comparison of bubble movements between the A-share market and the B&H-share market, which in turn enables us to link the new bubble result of A-share market to the previous bubble results in Figure 4.2. The Chinese stock market and its bubble movements will be further analysed and examined in detail in Chapter 7 of this thesis.

levels of economies or regions. Thus, what should be investigated next are the variability of bubbles in various economies and regions.

According to the classification by the World Bank, 36 countries are classified by incomes and regions, as middle-income and high-income economies, and as East Asia and Pacific, Europe and Central Asia, and America.[28] The average values and the variances of *BI* in each category per year from 1994 to 2002 are plotted and shown in Figure 4.3 and 4.4.

[Figure 4.3 and 4.4 are about here]

The first light shown is the comparisons between the high-income and middle-income countries in Figure 4.3. Binswanger (1999) documented that, in the long run, the development of a real economy can carry stock bubbles persistently, since the over-optimistic expectation is supported by the sustainable economic growth. Thus, it is expected that, in the long run, the more robust an economic growth is, the more likely stock bubbles are higher. The evidence of this argument can be detected in Figure 4.3, in which the average levels of bubbles in middle-income countries are higher than the high-income ones over the period of 1994 to 1997. The gap between them has been shrinking since 1997. In fact, after a sudden increase and drop appeared respectively in middle-income and high-income countries in 1998, bubbles in these two groups of countries moved closer and finally overlapped each other in 2000. The soaring bubble of middle-income countries before 1997 is precisely correlated with the robust growth of some Asian countries in the first half of the 1990s, such as Thailand, Malaysia, Indonesia and South Korea. The conversion after that is undoubtedly attributed to the Southeast Asian crisis which gave rise to a negative economic growth, on average, in middle-income

[28] See Appendix 4.3 for details. Taiwan is not included in the country classification of the World Bank. Since only China in the sample is classified into the low-income group, only the comparison between the middle-income and high-income countries is considered.

countries in 1998. The data in Table 4.7 clearly show that the economic decline reduced investors' confidence so as to drag down the stock price, but didn't diminish the dividend payment. As a result, after the crisis, the average value of estimated bubbles in middle-income countries landed on a level close to the bubble in high-income countries.

[Table 4.7 is about here]

Figure 4.3 also shows that bubbles' variances in high-income countries are generally lower than the middle-income economies, which means that the countries contained in the middle-income category are more diversified in terms of bubbles than in the high-income countries. This reasonably shows a common sense that the developed markets are more integrated in terms of economic development. This opinion can also be proved by the variance of the GDP growth rate shown in Table 4.8, in which the variances of the GDP growth rate in high-income countries are far less than in middle-income countries. However, the increased variances of bubbles between 1997 and 2000 signal the weakening and instable trend of this integration in high-income countries during this period of time, which is once again in accordance with the increasing variance of GDP growth rate in high-income countries over the period of 1997 to 2000.

[Table 4.8 is about here]

Figure 4.4 shows the regional comparisons of bubbles in the period between 1994 and 2002. The figure of bubble mean exhibits a bubble converging tendency among these three regions. The variances in East Asia may be considered regularly wavy from 1992 to 2002. Apart from the extreme behaviour of 1997, the bubble diversification of American countries is quite little. Compared with the other two areas above, it appears relatively stable among European countries, though from

1999 to 2002, a sudden heave becomes evident. Although the above characters are carefully drawn out by the regional comparative study, one can claim that bubbles do not seem to behave regionally. At least, the regional differences among countries produce lower variation in bubbles in comparison with the income level, which further verifies the close relationship between bubbles and real economies.

Being aware of the relationship between bubbles and economies, one may expect to gain more support for the estimated bubble from the real world. In other words, the new bubble theory and its estimation methodology will be more convincible if the bubble performances pictured by the estimated bubble are conformable to the real world economic performance. Therefore, two real events are discussed in the section below.

4.3 Bubbles and the Expectation of Economic Conditions: Case Study of Some Countries

In the study of bubbles, it is expected that investors' expectations are influenced by real economic events. Good news will make investors over-optimistic and bad news will lead them to be over-pessimistic. Therefore, intuitively, bubbles should be moving in accordance with changes in the expectation of economic conditions.

To check this argument, in this section the bubble movements of some countries are discussed in connection with the changes in the expectation of their economic conditions in the late nineties, such as the dot-com bubbles in United States and the financial crisis in East Asia. The coherence between bubble movements and economic shocks are expected in our analysis below.

4.3.1 "Bull" of the 1990s in the United States

In his book, Mahar (2003) documented the bull market in the United States during much of the 1990s, especially between 1998 and 2000, when the technology stocks were "fantastically expensive", which is comprehensively accepted as the "new economy". However, between 2000 and 2002, Americans suffered a decline in their stock market investments totalling $4.5 trillion on the New York Stock Exchange and NASDAQ alone.[29] In fact, some financial analysts already claimed that share prices no longer reflected fundamental values. In 1997, Dudack, the chief market strategist at UBS Warburg, warned that the equity market was fairly valued until October 1996. Warren Buffett also stated in 2000 that the values of companies had been destroyed, not created.[30]

Between 1997 and 2000, the high expectation of investors were boosted by the "New Economy" in which the technology innovation gave rise to a hasty increase of productivity, though the profitability of companies was diminished due to the problem of over-capacity.

After the crash of the "New Economy" in 2000, the American economy ran in a slack manner. An economic report in 2003 from a U.S. senator, Dianne Feinstein, mentioned that the income of families in the middle of the income distribution declined in 2001 for the first time in a decade by 2.2 per cent. The median California family's income fell by nearly $900 in 2001, and was flat in most other states in 2002. The number of unemployed workers increased from 5.7 million at the end of 2000 to more than 8.3 million, while the average length of time that people are without work increased to 18 weeks. Only 15 per cent of questionnaire respondents described economic conditions as "good."[31] Brenner (2002) reported that the problem of over-capacity in the era of the American "New Economy" chased manufacturing

[29] Source: http://www.aarp.org/bulletin/yourmoney/a2003-06-25-timetogetback.html.
[30] Source: Marhar (2003).
[31] The report can be found in the website of http://feinstein.senate.gov/booklets/Nations_Econ_Book.pdf.

profit rates downward by 20 per cent between 1997 and 2000, and the lower productivity growth after the crash further squeezed the profitability of American manufacturing. Between the first half of 2000 and the first half of 2001, the fall of profits in manufacturing accounted for about 46 per cent. It was one disaster after another, and in 2001, after the "911-World Trade Center Attack", people's confidence in the American economy was almost scrubbed up. Without investors' positive prospect of stock returns, the stock bubble is hardly sustainable.

The effects of these changes in the expectation of economic conditions to the U.S. stock market were also addressed by Louis Rukeyser, an experienced American financial commentator, in 2003. He attributed the bear market of the early 2000s in the U.S. to several events, such as the bursting of the internet bubble with its "ludicrous" stock prices, the economic recession and the events of 9/11, among which the attack of 9/11 was believed to have the most lasting effect.[32]

As shown in Figure 4.2, there was a smooth and stable increase in the bubble level of the United States in the 1990s. In 1997, the bubble level broke through the sample average line, hit its peak in 2000 and dropped after that. In this case, the bubble results match the real event.

4.3.2 Financial Crisis in Southeast Asia

Most analysts agree that the most serious economic crisis since the Second World War was the economic burst in Thailand from the period of 1997 to 1999. Many researchers, such as Corsetti, Pesenti and Roubini (1999), Flood and Marion (1999), Krugman (1998), Kaminsky and Reinhart (1999), Radelet and Sachs (1998), Sachs, Tornell and Velasco (1996), have documented the causes and impact of this crisis.

Indonesia and South Korea were severely affected. In addition, the "storm" also

[32] See http://www.aarp.org/bulletin/yourmoney/a2003-06-25-timetogetback.html.

spread to Hong Kong, Malaysia and Philippines. Although the rest of the economies in this region, such as China, India, Taiwan, Singapore and Japan, were relatively untouched by the crisis, they all went through their own economic recession at the end of 1990s.

The era of crisis has reverberated through the bubble graphs in Figure 4.2. Bubbles in most of the relevant markets experienced a sudden crash between 1997 and 1998, and obtained the rebound in 1999.[33] In order to have a deeper insight into the real occurrences, the three most severely affected countries - Thailand, South Korea and Indonesia - are discussed below.

Thailand

Thailand experienced high economic growth of 10% per year, on average, from 1987 to 1995 (Fischer, 1998). In 1995, goods and wages in the real estate and financial sectors were highly overvalued, which seems to be a bubble waiting to burst (Bhaopichitr, 1997). Meanwhile, the stock price climbed to an extreme point. From then on, a shadow stealthily moved over what had been long praised as the "Asian Miracle". In 1996, some signs of a weakening economy turned up. The total outstanding external debt of this year reached 94.3 billion US dollars (50.9% of GDP), and it was only 28.8 billion US dollars (33.8% of GDP) in 1990 (Sussangkarn, 1998). In addition, some of Thailand's newly established financial companies went bankrupt due to the accumulated large quantities of bad loans (Lai, 2000). Furthermore, Thailand's government abandoned the currency policy of a dollar peg in order to promote exports when the US dollar appreciated. In 1997, with speculative attacks on the baht, the Thai government was forced to devaluate the baht,

[33] China uniquely shows a contrary trend. Because of the inconvertibility of Chinese currency, the shares counted for the Chinese stock market in Datastream Global Indices are B-share and H-share which are traded in US dollars or Hong Kong dollars. However, the A-share traded in Chinese Yuan, which accounts for the majority of the Chinese stock market (more than 90% of the total numbers of shares are A-share), is excluded from the data. Thus, the results here do not reflect the Chinese stock market bubble. The detailed investigation to Chinese stock market will be conducted in Chapter 7 by taking the A-share into account.

which almost drained its foreign reserves (Sussangkarn, 1998). These attacks on Thai's stock market shook the confidence of its investors in Thai's economy and bubbles sustained by investors' expectations finally collapsed. Two months later, its stock market dropped 10 per cent in a week and the crash spread over Southeast Asia. The financial crisis began. In the first month of 1998, a new round of financial turmoil swept the stock market again and the plunge continued. The economy of Thailand only began recovery and showed signs of positive growth in 1999.[34]

According to the course of the Thai economic crisis, the bubble path in the Thai stock market between the periods of 1995 and 1999 is examined. From Figure 4.2, one can clearly see the bubble fluctuation between 1995 and 1999. In 1995, bubbles reached a peak and then started to fall. In 1997, the bubble level fell below the average level of sample countries and landed at the bottom in 1998. A rebound emerged after 1998. In 1999, the bubble rushed to a new peak.

South Korea

In South Korea, despite the sound macroeconomics, the East Asian Crisis worsened the credit rating of South Korea in 1997, which eventually led to the bankruptcy of some Korean conglomerates, the so-called chaebols, such as Hanbo Iron and Steel, Kia Motor, Jinro, and Haitai (Koo and Kiser, 2001). After that, with extensive financial reforms, its economy bounced back quickly from the crisis, and won a growth rate of 10% in 1999 and 9% in 2000.[35] However, the plaudits to the superficial recovery were immediately shadowed by the crash in the New York Exchange in 2000. Kirk (2000) mentioned that the decline in share prices on the New York Stock Exchange undermined the confidence in South Korea's stock market. The shock from abroad once again drew investors' attention to the fragile companies which hadn't recovered from the crisis of 1997-98. Koo and Kiser (2001) addressed

[34] See Wikipedia: http://en.wikipedia.org/wiki/asian_financial_crisis.
[35] Source: Wikipedia: http://en.wikipedia.org/wiki/asian_financial_crisis.

that in 1999; 18 of the 27 largest chaebols had financial expenses that exceeded operating profits and seven of those had not been profitable for three years. Thus, uncertainties clouded the Korean stock market soon after the short boom of 1999.

In Figure 4.2, the bubble plot clearly pictures the economic shakes of South Korea at the end of 1990s. After the early 1990s, the bubble in the Korean stock market had persistently moved down until the crisis finally burst out, which suggests that a pessimistic expectation was already formed in this market earlier than the crisis. The bubble showed an extensive rebound in 1999, but soon after, it dropped back again in 2000 due to the uncertainties in both the domestic market and abroad.

Indonesia

Following Thailand, Indonesia was entangled with the crisis as a result of a free-floating exchange rate arrangement in August 1997. The undermined confidence in the East Asian finance and economy led to the rupiah crash which brought the hyperinflation to erode the fundamental value of the economy (Radelet and Sachs, 1998). Although the economy touched the bottom in mid-1999, the new political pattern and the structural economic reform targets successfully brought the confidence back.[36]

However, unlike Thailand and South Korea which already underwent the bearish situation before the crisis, the bubble of Indonesia seemed to be carrying an optimistic economy before 1997. Radelet and Sachs (1998) reported that over the period of 1990 to 1996, Indonesia's current account deficit remained basically unchanged relative to the earlier time when most Southeast Asian countries suffered from the increasing deficits. There was no sign of a crisis and the international credit ratings remained high and positive after they had cut back the loans to Thailand and

[36] See Wikipedia: http://en.wikipedia.org/wiki/asian_financial_crisis.

Korea in the early part of 1997.

In Figure 4.2, the sudden crisis of Indonesia is reflected by the sharp drop of bubbles between 1997 and 1998, and a slight recovery in 1999 is shown, which is consistent with the real achievement of the new political and economic strategies which continued to take effect afterwards.

The case discussions above illustrate that bubbles are influenced by changes in the expectation of economic conditions. Meanwhile, the consistent movement between the estimated bubbles and the well-known bubble events highlights a primary success of our new methodology of bubble measurement.

4.4 Summary and Conclusions

There are numerous ways of conducting empirical tests on bubbles which are time-series-based. However, the current studies do not estimate magnitudes of bubbles directly. This limitation calls for an alternative research on bubbles which is an aim of our study in this chapter.

In this chapter, based on the theoretical discussion of the value frontier methodology in Chapter 3, the estimation technique of the stochastic cost frontier is applied to estimate the bubbles of each market relative to the value frontier. By innovatively applying the technique of stochastic frontier estimation to the bubble estimation, the comparative studies in bubble movements across countries become feasible.

However, some considerable limitations of this chapter are highlighted as follows. Firstly, the fundamental valuation structure utilised in the market level estimation is a well-acknowledged basic framework, in which dividends are the only fundamental variable to capture the fundamental value. It is expected that a more comprehensive fundamental valuation structure could be developed in the future to improve the market level model. Secondly, a recent progress on the frontier estimation technique provides a way to correct the heteroskedasticity of the inefficiency term and the statistical error as the heteroskedasticity problem can affect the parameters as well as the inefficiency term (Kumbhakar and Lovell, 2000). Apparently, it is a potential technique problem which should be handled in the future estimation. In addition, another technique matter also needs to be considered. Kumbhakar and Lovell (2000) documented that the maximum likelihood estimates of all parameters and the rankings of the inefficiency term tend to be consistent when a sample is large enough. Thus, it is worth trying the estimation in a bigger sample so as to further validate the bubble results.

Being aware of the above limitation in the market level estimation, however, the success of estimating the bubble index could open a new path for academic research in finance. Specifically, the bubble index can help us to learn about the relationship between the real economy and bubbles (for example: the "stock bubble-inflation relation"), which will be investigated thoroughly in the next chapter.

Appendices

Appendix 4.1: Definition of Variables

Dividend Yield (DY)
Dividend yield is derived by calculating the total amount of dividend for a market and expressing it as a percentage of the total market value for the constituents of that market. This provides an average of the individual yields of the constituents weighted by market value. It is calculated as follows:

$$DY_t = \frac{\sum_{1}^{n}(D_t * N_t)}{\sum_{1}^{n}(P_t * N_t)} * 100$$

Where:

DY_t =aggregate dividend yield on day t; D_t =dividend per share on day t

N_t =number of shares in issue on day t; P_t = unadjusted share price on day t

n = number of constituents in index

Market Value (MV)
These market values are calculated from the constituents of the sector/market lists. Index market value on Datastream is the sum of share price multiplied by the number of ordinary shares in issue for each index constituent.

For equity indices, the calculation used is:

$$MV_t = \sum_{1}^{n}(P_t * N_t)$$

Where:

N_t =number of shares in issue on day t

P_t =unadjusted share price on day t

Appendix 4.2: Stochastic Frontier Estimation: Normal-Truncated Normal Distribution [37]

The normal-truncated normal formulation was introduced by Stevenson (1980). Under the assumption of normal-truncated normal distribution, the stochastic production frontier model can be describe

$$y = \alpha + \beta x + v - u \qquad u > 0 \tag{1}$$

(i) v ~ iid $\mathrm{N}\left(0, \sigma_v^2\right)$

(ii) u ~ iid $\mathrm{N}^{+}\left(\mu, \sigma_\mu^2\right)$

(iii) u and v are distributed independently of each other, and of the regressors.

where v is the two-sided "noise" component, and u is the nonnegative technical inefficiency component, of the error term.

A maximum likelihood method is used to estimate three parameters: σ_u, σ_v and μ. There is a two-step procedure, in which the first step involves the use of OLS to estimate the slope parameters, and the second step involves the use of maximum likelihood to estimate the intercept parameters and the variances of the two error components. The distributional assumption is used in the maximum likelihood estimation, which is the second step of the two-step procedure.

The truncated normal distribution assumed for u generalizes the one-parameter half normal distribution, by allowing the normal distribution, which is truncated below at zero, to have a non zero mode.

The density function of v is

[37] Appendix II is abstracted from "Stochastic Frontier Analysis" by Kumbhakar and Lovell, 2000

$$f(\nu)=\frac{1}{\sqrt{2\pi}\sigma_\nu}\cdot\exp\left\{-\frac{\nu^2}{2\sigma_\nu^2}\right\} \tag{2}$$

The truncated normal density function for $u \geq 0$ is given by

$$f(u)=\frac{1}{\sqrt{2\pi}\sigma_u\Phi(\mu/\sigma_u)}\cdot\exp\left\{-\frac{(u-\mu)^2}{2\sigma_u^2}\right\} \tag{3}$$

where μ is the mode of the normal distribution, which is truncated below at zero, and $\Phi(\cdot)$ is the standard normal cumulative distribution function. Thus $f(u)$ is the density of a normally distributed variable with possibly non zero mean μ, truncated below at zero.

The joint density function of u and ν is the product of their individual density functions, and can be written

$$f(u,\nu)=\frac{1}{2\pi\sigma_u\sigma_\nu\Phi(\mu/\sigma_u)}\cdot\exp\left\{-\frac{(u-\mu)^2}{2\sigma_u^2}-\frac{\nu^2}{2\sigma_\nu^2}\right\} \tag{4}$$

The joint density of u and ε is

$$f(u,\varepsilon)=\frac{1}{2\pi\sigma_u\sigma_\nu\Phi(\mu/\sigma_u)}\cdot\exp\left\{-\frac{(u-\mu)^2}{2\sigma_u^2}-\frac{(\varepsilon+u)^2}{2\sigma_\nu^2}\right\} \tag{5}$$

where ε is the composed error, which is $\nu-u$

The marginal density of ε is

$$\begin{aligned} f(\varepsilon)&=\int_0^\infty f(u,\varepsilon)du \\ &=\frac{1}{\sqrt{2\pi}\sigma\Phi(\mu/\sigma_u)}\cdot\Phi\left(\frac{\mu}{\sigma\lambda}-\frac{\varepsilon\lambda}{\sigma}\right)\cdot\exp\left\{-\frac{(\varepsilon+\mu)^2}{2\sigma^2}\right\} \\ &=\frac{1}{\sigma}\cdot\phi\left(\frac{\varepsilon+\mu}{\sigma}\right)\cdot\Phi\left(\frac{\mu}{\sigma\lambda}-\frac{\varepsilon\lambda}{\sigma}\right)\cdot\left[\Phi\left(\frac{\mu}{\sigma_u}\right)\right]^{-1} \end{aligned} \tag{6}$$

where $\sigma=\left(\sigma_u^2+\sigma_\nu^2\right)^{1/2}$, $\lambda=\sigma_u/\sigma_\nu$, and $\phi(\cdot)$ is the standard normal density function.

$f(\varepsilon)$ is asymmetrically distributed, with mean and variance

$$\mathrm{E}(\varepsilon) = -\mathrm{E}(u) = -\frac{\mu a}{2} - \frac{\sigma_u a}{\sqrt{2\pi}} \cdot \exp\left\{-\frac{1}{2}\left(\frac{\mu}{\sigma_u}\right)^2\right\} \tag{7}$$

$$V(\varepsilon) = \mu^2 \frac{a}{2}\left(1 - \frac{a}{2}\right) + \frac{a}{2}\left(\frac{\pi - a}{\pi}\right)\sigma_u^2 + \sigma_v^2 \tag{8}$$

respectively, where $a = [\Phi(\mu / \sigma_u)]^{-1}$

The log likelihood function for a sample of I is

$$\ln L = \text{constant} - I \ln \sigma - I \ln \Phi\left(\frac{\mu}{\sigma_u}\right) + \sum_i \ln \Phi\left(\frac{\mu}{\sigma\lambda} - \frac{\varepsilon_i \lambda}{\sigma}\right) - \frac{1}{2}\sum_i \left(\frac{\varepsilon_i + \mu}{\sigma}\right)^2 \tag{9}$$

where $\sigma_u = \lambda\sigma / \sqrt{1+\lambda^2}$. The log likelihood function can be maximized with respect to the parameters to obtain maximum likelihood estimates of all of the parameters.

The conditional distribution $f(u|\varepsilon)$ is given by

$$f(u|\varepsilon) = \frac{f(u,\varepsilon)}{f(\varepsilon)} = \frac{1}{\sqrt{2\pi}\sigma_* [1 - \Phi(-\tilde{\mu}/\sigma_*)]} \cdot \exp\left\{-\frac{(u-\tilde{\mu})^2}{2\sigma_*^2}\right\} \tag{10}$$

$f(u|\varepsilon)$ is distributed as $\mathrm{N}^+(\tilde{\mu}_i, \sigma_*^2)$, where $\tilde{\mu}_i = (-\sigma_u^2 \varepsilon_i + \mu\sigma_v^2)/\sigma^2$ and $\sigma_*^2 = \sigma_u^2 \sigma_v^2 / \sigma^2$. Thus either the mean or the mode of $f(u|\varepsilon)$ can be used to estimate the technical efficiency, and we have

$$\mathrm{E}(u_i|\varepsilon_i) = \sigma_* \left[\frac{\tilde{\mu}_i}{\sigma_*} + \frac{\phi(\tilde{\mu}_i / \sigma_*)}{1 - \Phi(-\tilde{\mu}_i / \sigma_*)}\right] \tag{11}$$

and

$$\mathrm{M}(u_i|\varepsilon_i)=\begin{cases}\tilde{\mu}_i & if \quad \tilde{\mu}_i \geq 0\\ 0 & otherwise\end{cases} \tag{12}$$

Point estimates of the technical efficiency of each producer can be obtained by substituting either $\mathrm{E}(u_i|\varepsilon_i)$ or $\mathrm{M}(u_i|\varepsilon_i)$ into following equation

$$\begin{aligned} TE &= \mathrm{E}(\exp\{-u_i\}|\varepsilon_i) \\ &= \frac{1-\Phi[\sigma_* - (\tilde{\mu}_i/\sigma_*)]}{1-\Phi(-\tilde{\mu}_i/\sigma_*)}\cdot \exp\left\{-\tilde{\mu}_i + \frac{1}{2}\sigma_*^2\right\} \end{aligned} \tag{13}$$

Appendix 4.3: Country Code

Countries	Codes
Argentina	AR
Australia	AU
Austria	OE
Belgium	BG
Canada	CN
Chile	CL
China	CH
Denmark	DK
Finland	FN
France	FR
Germany	BD
Greece	GR
Hong Kong	HK
Indonesia	ID
Ireland	IR
Italy	IT
Japan	JP
Korea	KO
Malaysia	MY
Mexico	MX
Netherlands	NL
New Zealand	NZ
Norway	NW
Philippines	PH
Poland	PO
Portugal	PT
Singapore	SG
South Africa	SA
Spain	ES
Sweden	SD
Switzerland	SW
Taiwan	TA
Thailand	TH
Turkey	TK
UK	UK
US	US
Venezuela	VE

Appendix 4.4: World Bank Country Classification by Income and Region

Income groups	**Subgroups**	**Sub-Saharan Africa**		**Asia**		**Europe and Central Asia**		**Middle East and North Africa**		**America**
		East and South Africa	**West Africa**	**EastAsia and Pacific**	**South Asia**	**Eastern Europe and Central Asia**	**Rest of Europe**	**MiddleEast**	**NorthAfrica**	
Low-income		Angola Burundi Comoros Eritrea Ethiopia Kenya Madagascar Malawi Mozambique Rwanda Somali Sudan Tanzania Uganda Zaire Zambia	Benin Burkina Faso Cameroon Central African Republic Chad Congo Rep. Cote d`Ivoire Eq. Guinea Gambia Ghana Guinea Guinea-Bissau Liberia Mali	Cambodia China Lao PDR Mongolia Myanmar Vietnam	Afghanistan Bangladesh Bhutan India Nepal Pakistan Sri Lanka	Albania Armenia Azerbaijan Bosnia and Herzegovina Georgia Kyrgyz Republic Tajikistan		Yemen		Guyana Haiti Honduras Nicaragua

Income groups	Subgroups	Sub-Saharan Africa		Asia		Europe and Central Asia		Middle East and North Africa		America
		East and South Africa	West Africa	EastAsia and Pacific	South Asia	Eastern Europe and Central Asia	Rest of Europe	MiddleEast	NorthAfrica	
		Zimbabwe	Mauritania Niger Nigeria Sao Tome and Principe Senegal Sierra Leone Togo							

Income groups	Subgroups	Sub-Saharan Africa		Asia		Europe and Central Asia		Middle East and North Africa		America
		East and South Africa	**West Africa**	**EastAsia and Pacific**	**South Asia**	**Eastern Europe and Central Asia**	**Rest of Europe**	**MiddleEast**	**NorthAfrica**	
Middle-income	Lower	Botswana Djibouti Lesotho Namibia Swaziland	Cape Verde	Fiji Indonesia Kiribati Korea Dem. Marshall Islands Micronesia, Fed. Sts. Papua New Guinea Philippines Solomon Islands Thailand Tonga Vanuatu Western Samoa	Maldives	Belarus Bulgaria Estonia Kazakhstan Latvia Lithuania Macedonia, FYR* Moldova Poland Romania Russian Federation Slovak Rep. Turkmenistan Ukraine Uzbekistan Yugoslavia, Fed. Rep.**	Turkey	Iran, Islamic Rep. Iraq Jordan Lebanon Syrian Arab Rep. West Bank and Gaza	Algeria Egypt, Arab Rep. Morocco Tunisia	Belize Bolivia Colombia Costa Rica Cuba Dominica Dominican Republic Ecuador El Salvador Grenada Guatemala Jamaica Panama Paraguay Peru St. Vincent Grenadines Suriname Venezuela

Income groups	Subgroups	Sub-Saharan Africa		Asia		Europe and Central Asia		Middle East and North Africa		America
		East and South Africa	**West Africa**	**EastAsia and Pacific**	**South Asia**	**Eastern Europe and Central Asia**	**Rest of Europe**	**MiddleEast**	**NorthAfrica**	
	Upper	Mauritius Mayotte Seychelles South Africa	Gabon	American Samoa Malaysia		Croatia Czech Republic Hungary Slovenia	Greece Isle of Man Malta	Bahrain Oman Saudi Arabia	Libya	Antigua and Barbuda Argentina Barbados Brazil Chile Guadeloupe Mexico Puerto Rico St. Kitts and Nevis St. Lucia Trinidad and Tobago Uruguay

Income groups	Subgroups	Sub-Saharan Africa		Asia		Europe and Central Asia		Middle East and North Africa		America
		East and South Africa	West Africa	EastAsia and Pacific	South Asia	Eastern Europe and Central Asia	Rest of Europe	MiddleEast	NorthAfrica	
High-income	OECD countries			Australia Japan Korea, Rep. New Zealand			Austria Belgium Denmark Finland France Germany Iceland Ireland Italy Luxembourg Netherlands Norway Portugal Spain Sweden Switzerland United Kingdom			Canada United States

Income groups	Subgroups	Sub-Saharan Africa		Asia		Europe and Central Asia		Middle East and North Africa		America
		East and South Africa	**West Africa**	**EastAsia and Pacific**	**South Asia**	**Eastern Europe and Central Asia**	**Rest of Europe**	**MiddleEast**	**NorthAfrica**	
	Non-OECD countries	Reunion		Brunei French Polynesia Guam Hong Kong Macao New Caledonia N. Mariana Is. Singapore OAE ***			Andorra Channel Islands Cyprus Faeroe Islands Greenland Liechtenstein Monaco	Israel Kuwait Qatar United Arab Emirates		Aruba Bahamas, The Bermuda Cayman Islands French Guiana Martinique Netherlands Antilles Virgin Islands(U. S.)
Total	210	27	23	34	8	27	28	14	5	44

Tables and Figures

Table 4.1 Test of Bubbles: Co-integration Test in Time Series

Stationary Test—Australia

ADF Tests	dMV	Δ(dMV)	dD	Δ(dD)
NON	4.955442 [1.0000]	1.991779 [0.9861]	5.542432 [1.0000]	1.954092 [0.9850]
Trend & Intercept	**3.321727** [1.0000]	**-5.584243**[38] [0.0006]	**2.497976** [1.0000]	**-806631** [0.0332]
Intercept	4.989519 [1.0000]	0.584546 [0.9861]	5.271136 [1.0000]	-2.450266 [0.1373]
ADF Tests	**LMV**	**Δ(LMV)**	**LD**	**Δ(LD)**
NON	4.315949 [1.0000]	-0.190455 [0.6071]	3.145275 [0.9992]	-2.713916 [0.0083]
Trend & Intercept	-0.745429 [0.9583]	-3.315596 [0.0867]	-4.562066 [0.0051]	-4.672243 [0.0041]
Intercept	**-0.930515** [0.7619]	**-5.598433** [0.0001]	**-0.336473** [0.9078]	**-4.786454** [0.0006]

Note: p values are in square brackets
$dMV=MV_t/MV_0$; $dD=D_t/D_0$

Residual-based Co-integration Test—Australia

Dep. dMV	Intercept	dD	R^2	D-W Stat
	-0.369342	1.110991	0.977191	0.604384

AEG* test	None	Trend & Intercept	Intercept
Null: no cointegration	-2.008602	-1.225286	-0.786318

Dep. LMV	Intercept	LD	R^2	D-W Stat
	2.547517	1.083374	0.984117	1.334859

AEG test*	None	Trend & Intercept	Intercept
Null: no cointegration	-4.095546	-3.916203	-4.069849

Note: *AEG (Augmented Engle-Granger) test: the 5% critical value of the model with only intercept is -3.34 and with both intercept and trend is -3.78. (Davidson and Mackinnon, 1993, Table 20.2)

[38] Fixed 3 legs are used in this test, since the optimal number of legs is 6 which seem too many for the 32 years' data.

Stationary Test--HongKong

ADF Tests	dMV	Δ(dMV)	dD	Δ(dD)
NON	4.842815 [1.0000]	-0.296609 [0.5698]	4.503128 [1.0000]	0.954422 [0.9043]
Trend & Intercept	**0.209758** [0.9969]	**-7.915694** [0.0000]	**-0.088848** [0.9922]	**-6.607724** [0.0001]
Intercept	3.503895 [1.0000]	-5.449279 [0.0001]	4.159244 [1.0000]	-0.289998 [0.9128]
ADF Tests	**LMV**	**Δ(LMV)**	**LD**	**Δ(LD)**
NON	2.767712 [0.9979]	-1.139054 [0.2247]	5.463646 [1.0000]	-2.657256 [0.0096]
Trend & Intercept	-3.504734 [0.0615]	**-6.848705** [0.0000]	-2.087410 [0.5323]	-4.323982 [0.0091]
Intercept	**-0.767412** [0.8139]	-6.875050 [0.0000]	**-0.818934** [0.8001]	**-4.367186** [0.0017]

Note: p values are in square brackets
$dMV=MV_t/MV_0$; $dD=D_t/D_0$

Residual-based Co-integration Test--HongKong

Dep. dMV	Intercept	dD	R^2	D-W Stat
No. of Obv.: 909	-1.214.60	0.961655	0.958500	1.273783

AEG test*	None	Trend & Intercept	Intercept
Null: no cointegration	-4.33104	-4.189565	-4.243681

Dep. LMV	Intercept	LD	R^2	D-W Stat
	2.495026	1.101916	0.970103	1.564995

AEG test*	None	Trend & Intercept	Intercept
Null: no cointegration	-4.603892	-3.098830	-4.518576

Note: *AEG (Augmented Engle-Granger) test: the 5% critical value of the model with only intercept is -3.34 and with both intercept and trend is -3.78. (Davidson and Mackinnon, 1993, Table 20.2)

Stationary Test—Netherland

ADF Tests	dMV	Δ(dMV)	dD	Δ(dD)
NON	-1.449793 [0.1343]	**-2.188273** [0.0302]	2.537294 [0.9963]	0.525368 [0.8217]
Trend & Intercept	**-2.222403** [0.4597]	-2.727093 [0.2353]	**-2.869578** [0.1887]	**-4.163971** [0.0148]
Intercept	-1.871365 [0.3402]	-2.512762 [0.1245]	1.087882 [0.9964]	-1.126747 [0.6870]
ADF Tests	**LMV**	**Δ(LMV)**	**LD**	**Δ(LD)**
NON	2.617557 [0.9970]	-3.389552 [0.0014]	3.375049 [0.9996]	-3.268737 [0.0019]
Trend & Intercept	-1.031148 [0.9246]	-4.893631 [0.0023]	-1.542019 [0.7932]	-4.041178 [0.0176]
Intercept	**-1.599014** [0.4711]	**-4.793075** [0.0005]	**-0.888247** [0.7789]	**-4.108051** [0.0033]

Note: p values are in square brackets
$dMV=MV_t/MV_0$; $dD=D_t/D_0$

Residual-based Co-integration Test—Netherland

Dep. dMV		Intercept	dD	R^2	D-W Stat
		-2.009503	2.116741	0.879264	0.540798
AEG test*	**None**		**Trend & Intercept**		**Intercept**
Null: no cointegration	-3.550773		-4.319481		-3.496172
Dep. LMV		**Intercept**	**LD**	**R^2**	**D-W Stat**
		0.632759	1.306722	0.977184	0.882627
AEG test*	**None**		**Trend & Intercept**		**Intercept**
Null: no cointegration	-3.048080		-2.977328		-2.998699

Note: *AEG (Augmented Engle-Granger) test: the 5% critical value of the model with only intercept is -3.34 and with both intercept and trend is -3.78. (Davidson and Mackinnon, 1993, Table 20.2)

Stationary Test--South Africa

ADF Tests	dMV	Δ(dMV)	dD	Δ(dD)
NON	1.375551 [0.9542]	**-1.932191** [0.0522]	1.943718 [0.9855]	**-1.843129** [0.0629]
Trend & Intercept	**-2.615668** [0.2765]	-2.676996 [0.2523]	**-0.883387** [0.9454]	-2.867173 [0.1861]
Intercept	0.520876 [0.9847]	-2.311107 [0.1751]	3.230577 [1.0000]	-2.342257 [0.1659]
ADF Tests	**LMV**	**Δ(LMV)**	**LD**	**Δ(LD)**
NON	2.546075 [0.9964]	-3.762377 [0.0005]	2.294141 [0.9931]	-3.497157 [0.0010]
Trend & Intercept	-2.001309 [0.5785]	-4.311483 [0.0094]	-3.748016 [0.0348]	-3.586927 [0.0501]
Intercept	**-0.601058** [0.8568]	**-4.386252** [0.0016]	**-1.557271** [0.4900]	**-3.588414** [0.0130]

Note: p values are in square brackets
$dMV=MV_t/MV_0$; $dD=D_t/D_0$

Residual-based Co-integration Test--South Africa

Dep. dMV	Intercept	dD	R^2	D-W Stat
	-1.449670	1.299695	0.911873	0.635061
AEG test*	**None**	**Trend & Intercept**	**Intercept**	
Null: no cointegration	-2.354144	-2.333938	-2.313477	
Dep. LMV	**Intercept**	**LD**	**R^2**	**D-W Stat**
	1.257804	1.272889	0.930093	0.632476
AEG test*	**None**	**Trend & Intercept**	**Intercept**	
Null: no cointegration	-2.939216	-3.111956	-2.898854	

Note: *AEG (Augmented Engle-Granger) test: the 5% critical value of the model with only intercept is -3.34 and with both intercept and trend is -3.78. (Davidson and Mackinnon, 1993, Table 20.2)

Stationary Test--United Kingdom

ADF Tests	dMV	Δ(dMV)	dD	Δ(dD)
NON	2.077596 [0.9896]	-3.579668 [0.0007]	5.021923 [1.0000]	-2.768270 [0.0069]
Trend & Intercept	**2.413353** [1.0000]	-4.979322 [0.0015]	**-0.494743** [0.9796]	-5.314876 [0.0006]
Intercept	1.157668 [0.9973]	**-4.228931** [0.0020]	2.934745 [1.0000]	**-3.638827** [0.0094]
ADF Tests	**LMV**	**Δ(LMV)**	**LD**	**Δ(LD)**
NON	3.216113 [0.9994]	-0.722853 [0.3956]	4.215140 [1.0000]	-3.722065 [0.0005]
Trend & Intercept	-2.057198 [0.5526]	-3.399089 [0.0674]	-2.179128 [0.4877]	-4.906709 [0.0016]
Intercept	**-0.286637** [0.9178]	**-3.429239** [0.0163]	**-0.107842** [0.9416]	**-4.975921** [0.0002]

Note: p values are in square brackets
$dMV=MV_t/MV_0$; $dD=D_t/D_0$

Residual-based Co-integration Test--United Kingdom

Dep. dMV	Intercept	dD	R^2	D-W Stat
	-3.334437	1.805698	0.952429	0.609264
AEG test*	**None**	**Trend & Intercept**	**Intercept**	
Null: no cointegration Critical Value	-2.420545	-5.253307	-2.386697	
Dep. LMV	**Intercept**	**LD**	**R^2**	**D-W Stat**
	2.102478	1.111298	0.976809	1.065889
AEG test*	**None**	**Trend & Intercept**	**Intercept**	
Null: no cointegration	-3.070161	-3.658640	-3.026346	

Note: *AEG (Augmented Engle-Granger) test: the 5% critical value of the model with only intercept is -3.34 and with both intercept and trend is -3.78. (Davidson and Mackinnon, 1993, Table 20.2)

Stationary Test--United States

ADF Tests	dMV	Δ(dMV)	dD	Δ(dD)
NON	1.456395 [0.9605]	-2.476673 [0.0151]	4.610090 [1.0000]	2.432630 [0.9948]
Trend & Intercept	**-2.273367** [0.4347]	-3.997706 [0.0203]	**3.274724** [1.0000]	**-4.032963** [0.0197]
Intercept	0.462944 [0.9823]	**-3.698443** [0.0096]	4.686022 [1.0000]	-2.127156 [0.2360]
ADF Tests	**LMV**	**Δ(LMV)**	**LD**	**Δ(LD)**
NON	3.650049 [0.9998]	-4.248578 [0.0001]	10.23155 [1.0000]	-0.704848 [0.4030]
Trend & Intercept	-3.130867 [0.1182]	-6.460083 [0.0000]	-3.476749 [0.0603]	-4.638660 [0.0043]
Intercept	**0.139972** [0.9639]	**-6.655976** [0.0000]	**-1.352394** [0.5927]	**-4.622612** [0.0009]

Note: p values are in square brackets;
$dMV=MV_t/MV_0$; $dD=D_t/D_0$

Residual-based Co-integration Test--United States

Dep. dMV	Intercept	dD	R^2	D-W Stat
	-4.417682	2.372268	0.909886	0.307513

AEG test*	None	Trend & Intercept	Intercept
Null: no cointegration	-3.048040	-2.915756	-2.978946

Dep. LMV	Intercept	LD	R^2	D-W Stat
	-2.430578	1.539374	0.946897	0.349807

AEG test*	None	Trend & Intercept	Intercept
Null: no cointegration	-2.868672	-3.067469	-2.848755

Note: *AEG (Augmented Engle-Granger) test: the 5% critical value of the model with only intercept is -3.34 and with both intercept and trend is -3.78. (Davidson and Mackinnon, 1993, Table 20.2)

Table 4.2 Estimation of Market-Level Bubbles

Dep. Variable p_{it}	Model A	Model B	Model C	Model D
Indep. Variable				
Intercept	4.085 (11.722)	4.079 (13.292)	3.242 (16.670)	-0.2837 (-1.621)
d_{it}	0.673 (26.904)	0.671 (27.096)	0.627 (22.695)	0.9833 (49.297)
N_{it}	/	0.236E03 (0.659)	/	/
Statistics				
Number of Obs.	624	624	624	624
R^2	0.97524	0.97526	0.91335	0.90874
Lagrange Multiplier [H_0: No Group Effects]	1187.99 [0.0000]	639.17 [0.0000]	903.69 [0.0000]	762.34 [0.0000]
Hausman [H_0: Random Effects]	10.19 [0.0014]	36.92 [0.0000]	11.19 [0.0008]	5.84 [0.0156]
AR (t test H_0: Non-Autocorrelation)	0.4554 (12.737)	0.4571 (12.747)	0.3906 (10.902)	0.3838 (11.472)
HET [Breusch-Pagan LM Test H_0 : Homoscedasticity] x^2 $d.f.$=58	373.1307	367.7684	329.8392	553.8903
$\lambda = \sigma_u / \sigma_v$	0.6277	0.6287	0.9438	1.6762
$\sigma = (\sigma_u^2 + \sigma_v^2)^{1/2}$	0.3131	0.3136	0.3397	0.5045
σ_y	1.8113	1.8112	0.9556	1.103
LOGL	-100.9348	-100.8065	-91.502	-188.8268
μ/σ_u	-0.0567	-0.1463	-0.2287	-0.9224

Note: t ratios are in parentheses, and p values are in square brackets;
Time and country dummies are not reported in the table;
Model A: p=lnP d=lnD;
Model B: p=lnP d=lnD;
Model C: p=ln(P/N) d=ln(D/N) ;
Model D: $p=\ln(P_t/P_{2000})$ $d=\ln(D_t/D_{2000})$

Table 4.3 Worldwide Average Values of the Estimated Bubble

Year	Model A	Model B	Model C	Model D
1994	1.124483784	1.10070541	1.14657838	1.19934595
1995	1.124543243	1.10071622	1.14274324	1.18636486
1996	1.121540541	1.09813514	1.1364027	1.17377838
1997	1.121875676	1.09845405	1.1377027	1.18883243
1998	1.125805405	1.10165405	1.14996216	1.19428919
1999	1.123175676	1.09954865	1.14101892	1.21608108
2000	1.125394595	1.10155946	1.14877297	1.35963514
2001	1.123786486	1.10007838	1.14408649	1.21951892
2002	1.123518919	1.09973514	1.14135676	1.20728649

Table 4.4 Long-term Relationships between BI and PI, PE, PD

Stage 1: Stationary Tests

A. Stationary Test for B in Panel

N=37 Obv.=909	BI			ΔBI		
Unit Root Tests	None	Intercept	Trend & Intercept	None	Intercept	Trend & Intercept
LLC *t*-statistics Null: Common unit root	-1.49382 [0.0676]	-8.16025 [0.0000]	-4.73101 [0.0000]	-26.4435 [0.0000]	-33.4588 [0.0000]	-22.5041 [0.0000]
Breitung *t*-statistics Null: Common unit root	-0.60376 [0.2730]	-4.60080 [0.0000]	-1.65471 [0.0490]	-11.0856 [0.0000]	-26.9110 [0.0000]	-11.6807 [0.0000]
IPS W- statistics Null: Individual unit root	-	-7.93045 [0.0000]	-6.03260 [0.0000]	-25.4369 [0.0000]	-	-19.5853 [0.0000]
ADF-Fisher x^2-statistics Null: Individual unit root	62.6859 [0.8229]	202.150 [0.0000]	165.327 [0.0000]	631.854 [0.0000]	1019.81 [0.0000]	544.638 [0.0000]
PP-Fisher x^2-statistics Null: Individual unit root	57.0684 [0.9277]	214.387 [0.0000]	175.417 [0.0000]	990.625 [0.0000]	1723.37 [0.0000]	1478.57 [0.0000]
Hadri Z statistics Null: Common no unit root	-	7.08988 [0.0000]	9.07221 [0.0000]	4.00365 [0.0000]	-	14.0062 [0.0000]

Note: p values are in square brackets;
LLC: Levin, Lin & Chu t statistics; IPS: Im, Pesaran and Shin W-statistics.

B. **Stationary Test for BI in Time Series (BG DM FR GM HK IT IR SA SW OE UK)**

Countries	Unit Root Tests	BI		
		None	Intercept	Trend & Intercept
Belgium	ADF Null: unit root	-1.003612	-3.969836	-3.734598
		[0.2763]	[0.0045]	[0.0342]
	PP Null: unit root	-1.246302	-3.969836	-3.734598
		[0.1909]	[0.0045]	[0.0342]
	KPSS Null: stationary	-	0.300149	0.121743
Denmark	ADF Null: unit root	-0.277546 [0.5781]	-3.629178 [0.0106]	-3.555761 [0.0502]
	PP Null: unit root	-0.072852 [0.6508]	-3.688411 [0.0092]	-3.618566 [0.0440]
	KPSS Null: stationary	-	0.116507	0.125640
France	ADF Null: unit root	-0.110027 [0.6381]	-2.389943 [0.1524]	-5.976503 [0.0003]
	PP Null: unit root	-0.107318 [0.6390]	-2.533809 [0.1173]	-2.446847 [0.3504]
	KPSS Null: stationary	-	0.353042	0.054738
Germany	ADF Null: unit root	-0.236993 [0.5929]	-3.421712 [0.0175]	-4.045334 [0.0171]
	PP Null: unit root	0.028659 [0.6846]	-3.376540 [0.0195]	-4.979966 [0.0018]
	KPSS Null: stationary	-	0.362406	0.081061
HongKong	ADF Null: unit root	-0.173415 [0.6150]	-3.997483 [0.0043]	-5.047381 [0.0015]
	PP Null: unit root	-1.296688 [0.1757]	-5.223262 [0.0002]	-5.020429 [0.0016]
	KPSS Null: stationary	-	0.204711	0.102303
Italy	ADF Null: unit root	-0.504573 [0.4898]	-3.352836 [0.0206]	-3.458630 [0.0614]
	PP Null: unit root	-0.248820 [0.5886]	-3.215045 [0.0283]	-3.258696 [0.0915]
	KPSS Null: stationary	-	0.183607	0.102404
Ireland	ADF Null: unit root	0.315170 [0.7704]	-2.616295 [0.1002]	-4.280238 [0.7704]
	PP Null: unit root	0.132726 [0.7175]	-2.670191 [0.0902]	-4.280980 [0.0098]
	KPSS Null: stationary	-	0.523560	0.104728
South Africa	ADF Null: unit root	-0.816309 [0.3539]	-1.874766 [0.3391]	-4.410174 [0.0072]
	PP Null: unit root	-0.625747 [0.4383]	-3.724478 [0.0084]	-4.432481 [0.0068]
	KPSS Null: stationary	-	0.450313	0.135554
Swizerland	ADF Null: unit root	-0.071538 [0.6513]	-2.872432 [0.0598]	-3.315245 [0.0819]
	PP Null: unit root	0.233062 [0.7475]	-2.872432 [0.0598]	-3.315245 [0.0819]
	KPSS Null: stationary	-	0.378097	0.137165

Stationary Test for BI in Time Series (BG DM FR GM HK IT IR SA SW OE UK)-Continuance

Austria	ADF Null: unit root	0.304142 [0.7674]	-2.736852 [0.0790]	-2.850849 [0.1909]
	PP Null: unit root	0.930026 [0.9021]	-2.831534 [0.0651]	-2.876065 [0.1830]
	KPSS Null: stationary	-	0.185572	0.081739
United Kingdom	ADF Null: unit root	-0.195046 [0.6095]	-3.248245 [0.0244]	-3.463918 [0.0573]
	PP Null: unit root	-0.119056 [0.6365]	-3.238541 [0.0250]	-3.460983 [0.0577]
	KPSS Null: stationary	-	0.231373	0.136011

Note: p values are in square brackets
KPSS (Kwiatkowski-Phillips-Schmidt-Shin): the 5% critical value of the model with trend is 0.463000 and with both intercept and trend is 0.146000.

C. Stationary Tests for BI in Time Series (AU CA JP NL US)

	Unit Root Tests	**BI**			**ΔBI**		
		None	Intercept	Trend& Intercept	None	Intercept	Trend& Intercept
AU	ADF Null: unit root	-0.384015 [0.5373]	-1.373645 [0.5816]	-1.605606 [0.7667]	-5.725424 [0.0000]	-6.349871 [0.0000]	-6.233243 [0.0001]
	PP Null: unit root	-0.602072 [0.4486]	-2.255470 [0.1919]	-2.612573 [0.2776]	-5.842289 [0.0000]	-5.755620 [0.0000]	-5.706487 [0.0003]
	KPSS Null: stationary	-	0.438250	0.102106	-	0.083383	0.064879
CA	ADF Null: unit root	0.209893 [0.7405]	-2.462106 [0.1341]	-3.350258 [0.0764]	-7.930415 [0.0000]	-7.828179 [0.0000]	-7.761317 [0.0000]
	PP Null: unit root	0.315627 [0.7708]	-3.241640 [0.0266]	-3.276911 [0.0883]	-8.074409 [0.0000]	-7.966683 [0.0000]	-7.812465 [0.0000]
	KPSS Null: stationary	-	0.135642	0.104468	-	0.154684	0.139869
JP	ADF Null: unit root	-0.567471 [0.4632]	-1.980375 [0.2934]	-2.000737 [0.5781]	-3.669138 [0.0006]	-3.607492 [0.0114]	-3.651942 [0.0415]
	PP Null: unit root	-0.454861 [0.5100]	-1.636483 [0.4529]	-1.517758 [0.8022]	-3.661617 [0.0006]	-3.599630 [0.0116]	-3.698418 [0.0375]
	KPSS Null: stationary	-	0.158300	0.153450	-	0.180625	0.100146
NL	ADF Null: unit root	-0.286840 [0.5746]	-2.174795 [0.2188]	-2.149245 [0.5002]	-4.869458 [0.0000]	-4.787129 [0.0006]	-4.760179 [0.0032]
	PP Null: unit root	-0.288888 [0.5739]	-2.174795 [0.2188]	-2.149245 [0.5002]	-4.872482 [0.0000]	-4.790453 [0.0005]	-4.766334 [0.0031]
	KPSS Null: stationary	-	0.066785	0.064280	-	0.066498	0.057229
US	ADF Null: unit root	-0.596132 [0.4512]	-2.460824 [0.1342]	-2.433954 [0.3564]	-7.150998 [0.0000]	-7.042423 [0.0000]	-6.977473 [0.0000]
	PP Null: unit root	-0.627344 [0.4376]	-2.488019 [0.1277]	-2.371486 [0.3864]	-7.132127 [0.0000]	-7.025016 [0.0000]	-6.979508 [0.0000]
	KPSS Null: stationary	-	0.160757	0.160773	-	0.144504	0.064106

Note: p values are in square brackets
KPSS (Kwiatkowski-Phillips-Schmidt-Shin): the 5% critical value of the model with trend is 0.463000 and with both intercept and trend is 0.146000.

D. Stationary Tests for PI in Time Series (AU CA JP NL US)

ADF Null: unit root	PI			ΔPI		
	None	Intercept	Trend&Intercept	None	Intercept	Trend&Intercept
Australia	4.395183 [1.0000]	3.774865 [1.0000]	-0.172852 [0.9900]	-4.239794 [0.0001]	-4.865406 [0.0004]	-4.117246 [0.0174]
Canada	3.763600 [0.9999]	4.192948 [1.0000]	3.310906 [1.0000]	-2.683230 [0.0090]	-3.178294 [0.0311]	-4.106398 [0.0155]
Japan	-0.154115 [0.6226]	-1.496495 [0.5225]	-1.925326 [0.6182]	-4.600838 [0.0000]	-4.620419 [0.0009]	-4.549371 [0.0053]
Netherland	1.100697 [0.9256]	-0.164075 [0.9329]	-3.617983 [0.0445]	-4.120001 [0.0002]	-4.600775 [0.0009]	-4.586487 [0.0050]
United States	1.067468 [0.9214]	-0.007718 [0.9506]	-2.738523 [0.2292]	-2.746677 [0.0077]	-3.787140 [0.0075]	-3.286969 [0.0934]

Note: p values are in square brackets

E. Stationary Tests for PE in Time Series (AU CA JP NL US)

ADF Null: unit root	PE			ΔPE		
	None	Intercept	Trend&Intercept	None	Intercept	Trend&Intercept
Australia	-0.098546 [0.6420]	1.437552 [0.5516]	-3.087082 [0.1264]	-6.109169 [0.0000]	-6.101287 [0.0000]	-4.253221 [0.0117]
Canada	-0.436969 [0.5171]	-2.320239 [0.1720]	-4.031188 [0.0176]	-6.462921 [0.0000]	-6.455286 [0.0000]	-6.355160 [0.0001]
Japan	-0.582725 [0.4570]	-2.103010 [0.2448]	-1.987496 [0.5858]	-6.007026 [0.0000]	-5.920777 [0.0000]	-6.005701 [0.0001]
Netherland	-0.486939 [0.4971]	-1.592387 [0.4748]	-2.258993 [0.4429]	-6.230048 [0.0000]	-6.160359 [0.0000]	-6.160633 [0.0001]
United States	-0.433292 [0.5185]	-1.290118 [0.6219]	-3.524074 [0.0536]	-7.696839 [0.0000]	-7.660858 [0.0000]	-7.439806 [0.0000]

Note: p values are in square brackets

F. Stationary Tests for PD in Time Series (AU CA JP NL US)

ADF Null: unit root	PD			ΔPD		
	None	Intercept	Trend&Intercept	None	Intercept	Trend&Intercept
Australia	-0.468827 [0.5044]	-2.940867 [0.0518]	-3.247062 [0.0954][39]	-7.852919 [0.0000]	-7.764672 [0.0000]	-7.654031 [0.0000]
Canada	0.214732 [0.7421]	-0.923280 [0.7676]	-2.250208 [0.4475]	-5.295365 [0.0000]	-5.354042 [0.0001]	-5.241515 [0.0010]
Japan	-0.400144 [0.5316]	-1.829768 [0.3599]	-1.672714 [0.7400]	-5.294904 [0.0000]	-5.238399 [0.0002]	-5.275352 [0.0009]
Netherland	0.027842 [0.6844]	-1.321203 [0.6075]	-2.680773 [0.2507]	-4.642475 [0.0000]	-4.647984 [0.0008]	-4.593371 [0.0048]
United States	0.189302 [0.7344]	-1.266599 [0.6322]	-1.999617 [0.5787]	-4.057412 [0.0002]	-4.135751 [0.0030]	-3.996565 [0.0195]

Note: p values are in square brackets

[39] Since the optimal number of lags are 8 which are too many for the 33 years' data, 3 lags are specified in the regression.

Stage 2: Residual-based Co-integration Tests in Time Series (AU CA JP NL US)

G.

AEG* Null: No co-integration	BI and PI			BI and PE			BI and PD		
	None	Intercept	Trend &Intercept	None	Intercept	Trend &Intercept	None	Intercept	Trend &Intercept
Australia	-2.619	-2.575	-1.326	-3.208	-3.157	-1.966	-1.469	-1.448	-1.662
Canada	-2.502	-2.482	-3.329	-3.430	**-3.389**	-3.386	-3.384	-3.335	-3.329
Japan	-1.044	-1.011	-1.652	-1.466	-1.440	-1.683	-1.751	-1.715	-2.474
Netherland	-2.125	-2.083	-2.210	-2.171	-2.131	-2.380	-2.181	-2.137	-2.486
U.S.	-2.718	-2.677	-2.585	-2.371	-2.337	-2.227	-2.729	-2.689	-2.611

Note: p values are in square brackets
AEG (Augmented Engle-Granger) test: the 5% critical value of the model with intercept only is -3.34 and with both intercept and trend is -3.78. (Davidson and Mackinnon, 1993, Table 20.2)

Table 4.5 Short-term Relations between BI and PI, PE, PD

A. Three GLS Regressions with Individual and Time Dummies in Panel Data

No. of Obv.:160	**ΔPI**	**ΔPE**	**ΔPD**
Dep. ΔBI	0.1931873 (5.13)	0.0691497 (2.43)	0.1626923 (3.22)
Breusch-Pagan Test x^2 Null: constant variance	10.77 [0.0000]	14.05 [0.0002]	12.71 [0.0004]
Modified D-W Test Null: no autocorrelation	2.1851936	2.0620999	2.2025153

Note: t ratios are in parentheses, and p values are in square brackets;
The specification test results in the table are calculated before correcting the error terms.

B. OLS Regressions in Time Series Data (AU CA JP NL US)

Countries	*T=32*	**ΔPI**	**ΔPE**	**ΔPD**
Australia	***Dep. ΔBI***	0.110980* (9.578329)	0.049739 (0.722351)**	0.042310 (0.563945)**
	D-W Test (d_U=1.5) Null: no autocorrelation	2.327121	2.137871	2.173317
	White Test Null: no heteroskedasiticity	12.47671 [0.001953]	3.064325 [0.216068]	3.450854 [0.178097]
Canada	***Dep. ΔBI***	0.082038 (0.976714)**	0.060768 (1.290348)**	0.167035* (1.205757)**
	D-W Test (d_U=1.5) Null: no autocorrelation	2.491715	2.678799	2.567321
	White Test Null: no heteroskedasiticity	0.642248 [0.725333]	2.590204 [0.273870]	7.817639 [0.020064]
Japan	***Dep. ΔBI***	0.126596 (1.948099)	0.038849 (0.440756)**	0.157655 (1.631572)**
	D-W Test (d_U=1.5) Null: no autocorrelation	1.884862	1.451468	1.853241
	Breusch-Godfrey LM Test Null: no autocorrelation	-	2.409775 [0.120580]	-
	White Test Null: no heteroskedasiticity	1.572062 [0.455650]	0.248226 [0.883280]	1.056491 [0.589639]
Netherland	***Dep. ΔBI***	0.139812* (11.60581)	0.075749 (2.186589)	0.124864 (2.520896)
	D-W Test (d_U=1.5) Null: no autocorrelation	1.754459	1.874701	2.130727
	White Test (nR^2) Null: no heteroskedasiticity	9.504841 [0.008631]	2.469071 [0.290970]	0.992016 [0.608957]
United States	***Dep. ΔBI***	0.165862 (1.878220)	0.207002 (3.066637)	0.173084 (1.901955)
	D-W Test (d_U=1.5) Null: no autocorrelation	2.469616	2.588673	2.648888
	White Test Null: no heteroskedasiticity	0.061484 [0.969726]	0.875553 [0.645470]	1.080991 [0.582460]

Note: t ratios are in parentheses, and p values are in square brackets;
The specification test results in the table are calculated before correcting the error terms;
***** Applied White heteroskedasticity-consistent standard errors and covariance.
** Insignificant at 10% level.

Table 4.6 Worldwide Average Market Values, Dividends, Estimated Bubbles and Economic Growth

Year	LMV	LD	BI	GDP Growth Rate (Sample Average)	GDP Growth Rate (World)
1994	10.65467547	6.738231612	1.124483784	3.99475	3.301172
1995	10.84977542	7.084566958	1.124543243	4.2642	2.805135
1996	11.05551748	7.213057028	1.121540541	4.41135	3.427737
1997	11.26653578	7.254373764	1.121875676	4.6707	3.676077
1998	11.23986157	7.258380650	1.125805405	1.9717	2.416643
1999	11.52229870	7.395129755	1.123175676	2.5381	3.102582
2000	11.67734860	7.516775734	1.125394595	4.61755	4.00198
2001	11.52723514	7.628831797	1.123786486	1.3463	1.381966
2002	11.37189143	7.633756263	1.123518919	1.74645	1.842704

Note: 1.values of B are measured by model A; 2.Data Source: WDI and Datastream Global Indices.

Table 4.7 Economic Growth and Stock Bubbles (Mean)

year	GDP Growth Rate		Dividend Yield		Stock Price Index		Estimated Bubble	
	HI	MI	HI	MI	HI	MI	HI	MI
1994	4.0333	3.9562	2.0474	1.8655	579.0952	747.2955	1.1132	1.1544
1995	3.7675	4.7609	2.5726	2.2133	565.0230	523.6308	1.1148	1.1537
1996	3.2436	5.5791	2.5996	1.9617	672.8178	596.3067	1.1131	1.1508
1997	3.9179	5.4235	2.2304	1.9408	770.3791	642.9792	1.1128	1.1391
1998	2.3643	-0.3926	2.0396	2.1908	894.0026	560.7242	1.1331	1.1087
1999	3.9407	1.1355	2.0870	2.6900	962.1987	443.7317	1.1220	1.1273
2000	4.5091	4.7260	1.7239	1.7550	1160.0200	689.6350	1.1262	1.1253
2001	1.5986	1.0940	1.9278	1.9533	1030.1896	489.3358	1.1232	1.1243
2002	2.0493	1.4436	2.4126	2.2517	803.7961	369.8175	1.1248	1.1147

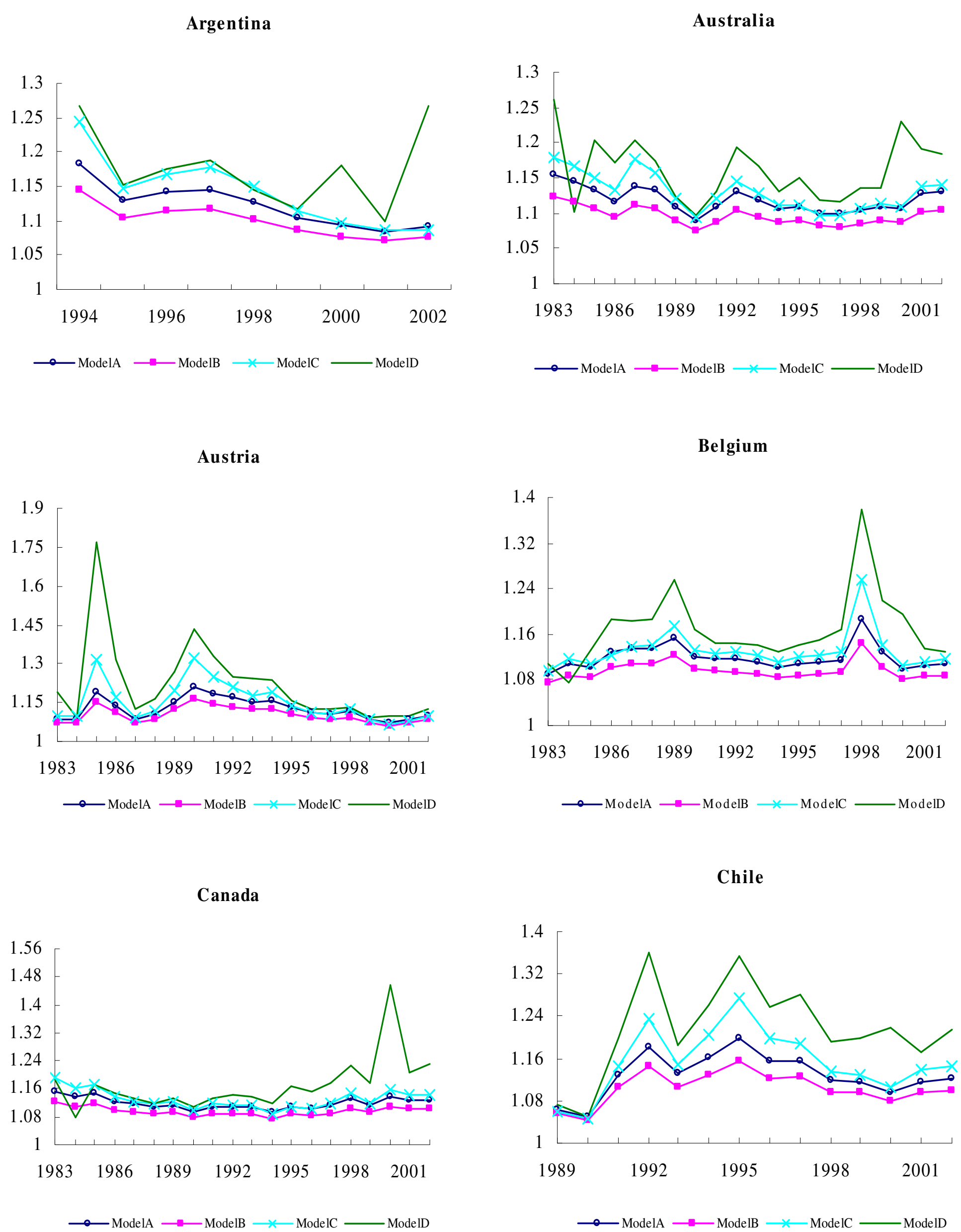
Note: 1.Values of the estimated bubble are measured by model A; 2. Data Source: WDI and Datastream Global Indices.

Table 4.8 Economic Growth and Stock Bubbles (Variance)

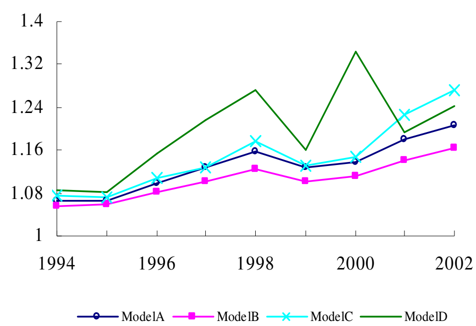
year	GDP Growth Rate		Dividend Yield		Stock Price Index		Estimated Bubble	
	HI	MI	HI	MI	HI	MI	HI	MI
1994	5.9888	20.5440	0.7871	1.1315	147620.5467	450717.5911	0.000676	0.001725
1995	6.1635	26.5428	1.3278	2.3106	125133.8090	147439.5335	0.000282	0.003469
1996	4.7886	6.8307	1.2375	1.3553	180370.8312	218748.4719	0.00023	0.001775
1997	5.3899	7.3965	0.7901	0.9483	239617.8432	246467.9526	0.000304	0.003473
1998	11.2718	41.5843	0.9458	1.1305	389265.1317	346877.5841	0.001355	0.001193
1999	6.0206	16.3882	0.8055	2.6012	429185.3654	195677.2821	0.000951	0.003428
2000	6.1587	5.5536	0.7584	2.3370	526171.8457	482916.0472	0.001947	0.00313
2001	2.6020	12.8806	0.8583	0.9000	520599.7258	250399.1074	0.00052	0.004592
2002	3.6821	31.8789	0.6105	1.0198	296081.5238	145325.2659	0.000446	0.001964

Note: 1.Values of the estimated bubble are measured by model A; 2. Data Source: WDI and Datastream Global Indices.

Figure 4.1 Values of the Bubble Index Estimated from Four Models



China (B&H Share)



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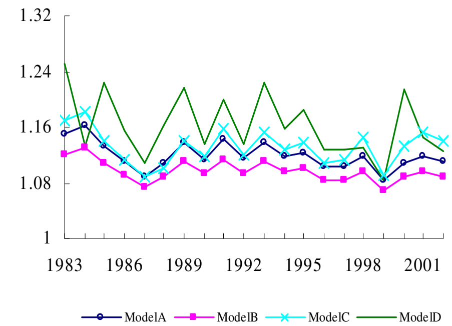

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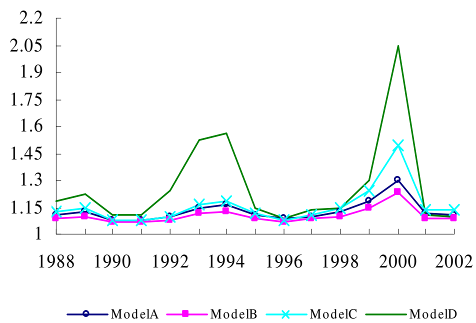

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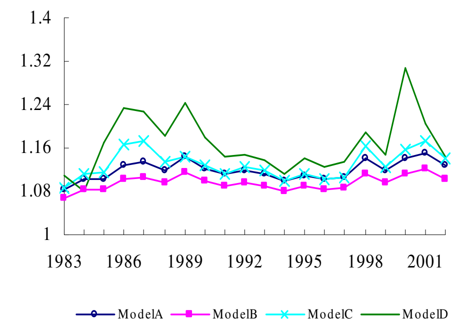

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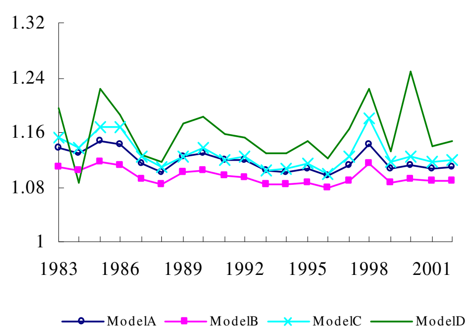
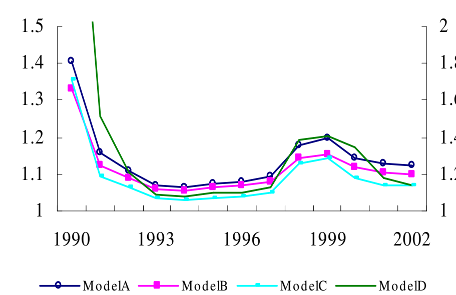
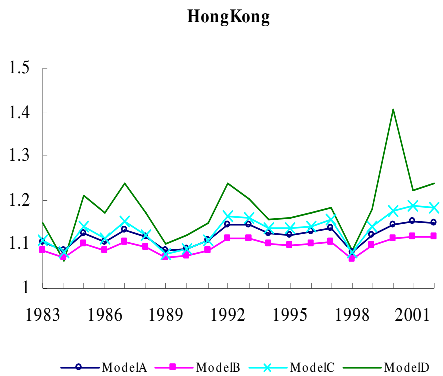


Greece

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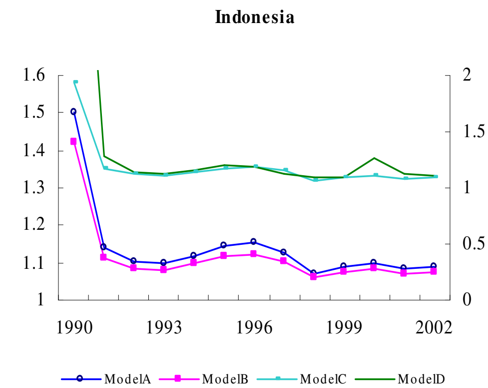
ModelA ModelB ModelC ModelD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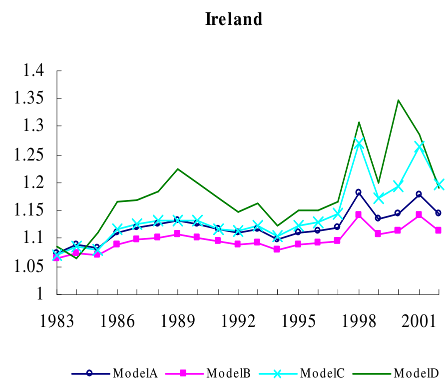
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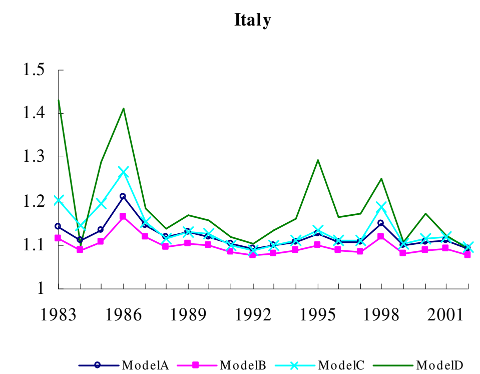
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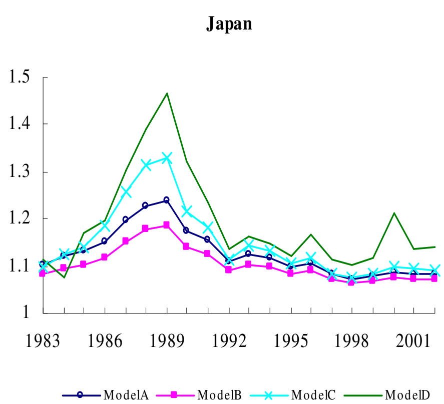
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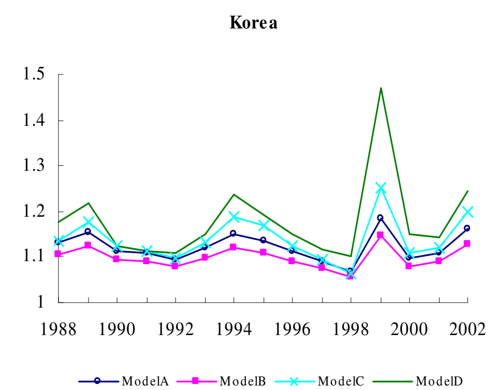
ModelA ModelB ModelC ModelD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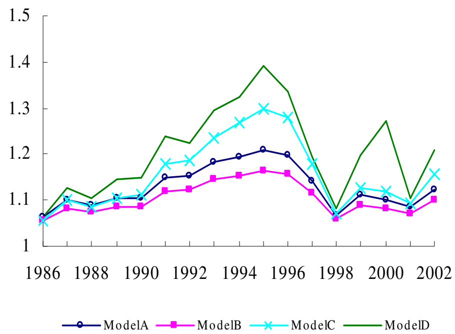
1988 1990 1992 1994 1996 1998 2000 2002
ModelA ModelB ModelC ModelD

Malaysia



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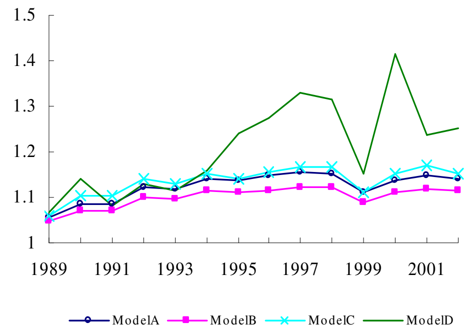

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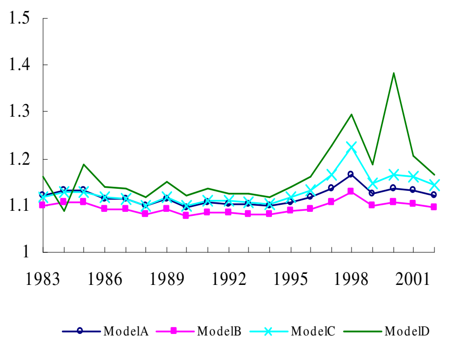

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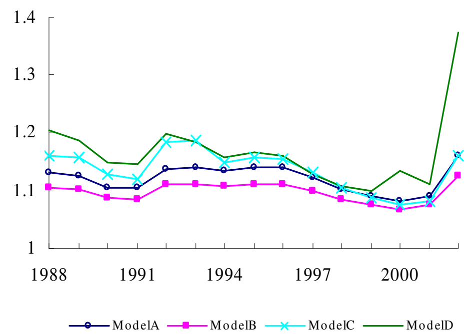

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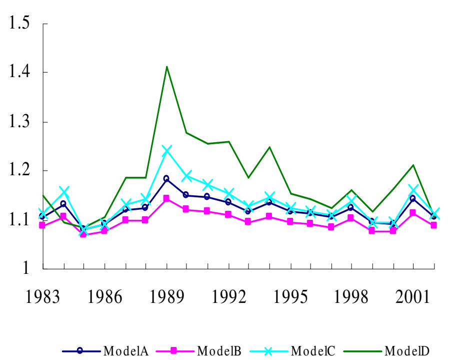

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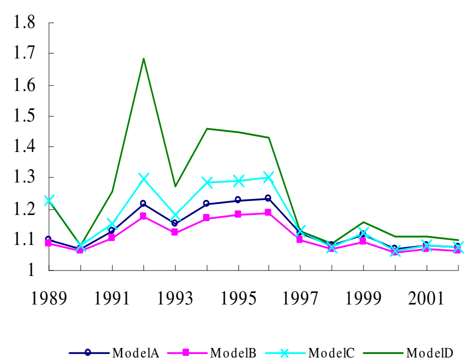

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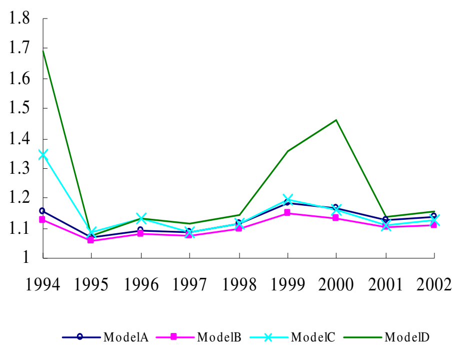

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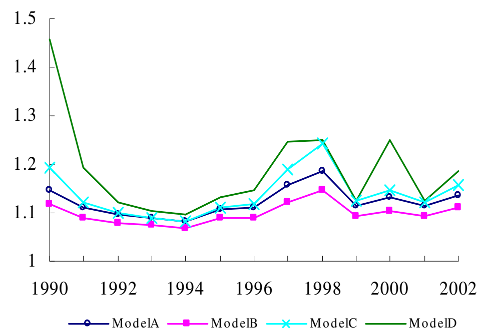

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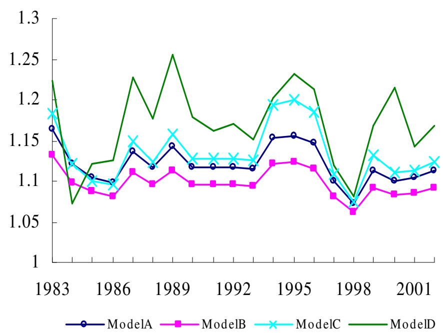

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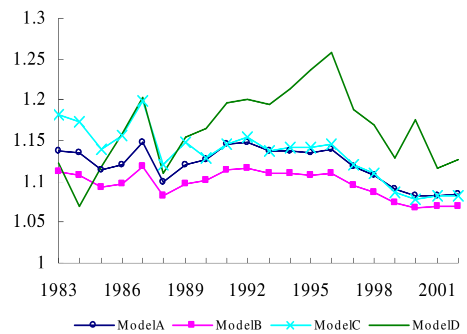

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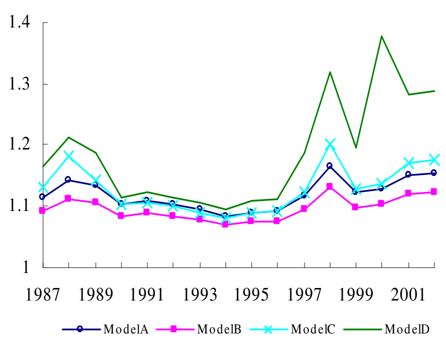
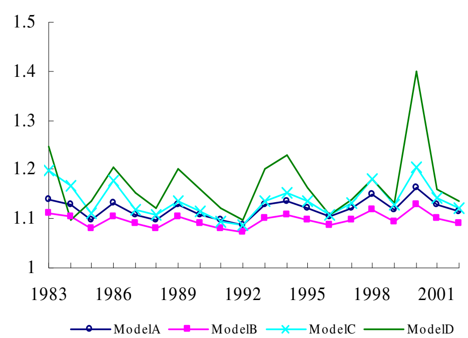
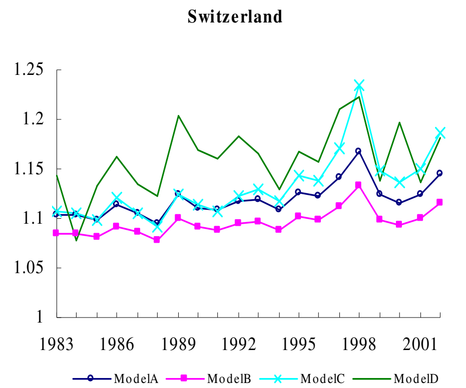
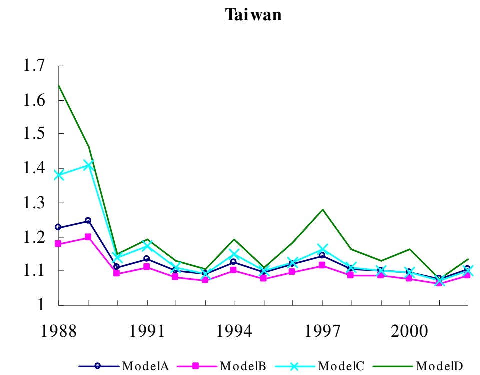
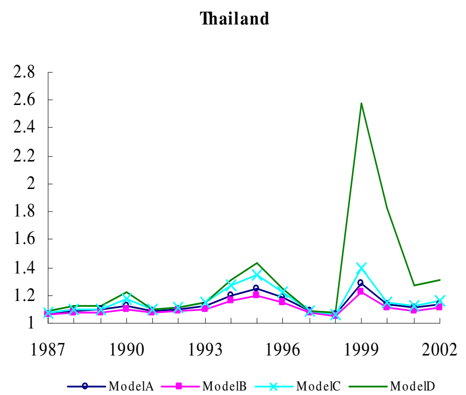


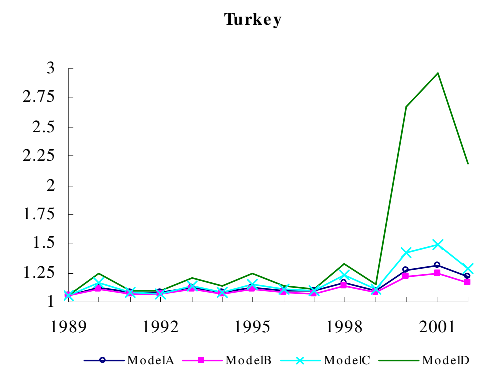
Sweden

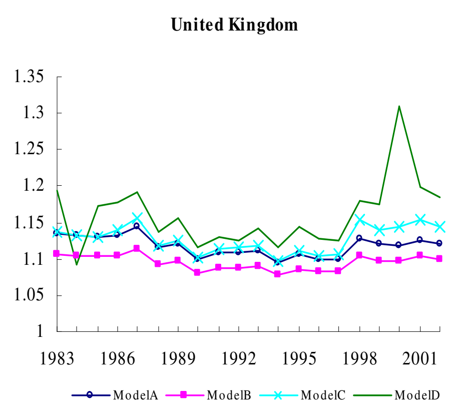



Switzerland
1.25
1.2
1.15
1.1
1.05
1
1983
1986
1989
1992
1995
1998
2001
ModelA
ModelB
ModelC
ModelD


Taiwan
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
1988
1991
1994
1997
2000
ModelA
ModelB
ModelC
ModelD


Thailand
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
1987
1990
1993
1996
1999
2002
ModelA
ModelB
ModelC
ModelD


Turkey
3
2.75
2.5
2.25
2
1.75
1.5
1.25
1
1989
1992
1995
1998
2001
ModelA
ModelB
ModelC
ModelD


United Kingdom
1.35
1.3
1.25
1.2
1.15
1.1
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1
1983
1986
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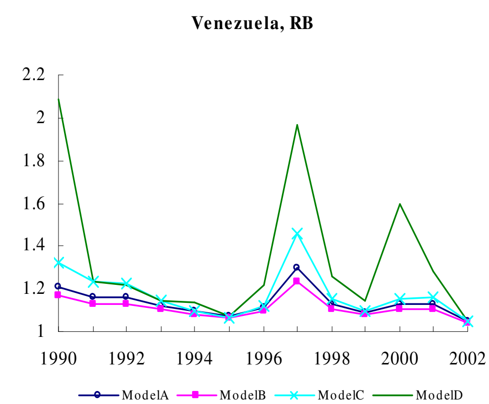
ModelA
ModelB
ModelC
ModelD


Venezuela, RB
2.2
2
1.8
1.6
1.4
1.2
1
1990
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1994
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ModelA
ModelB
ModelC
ModelD

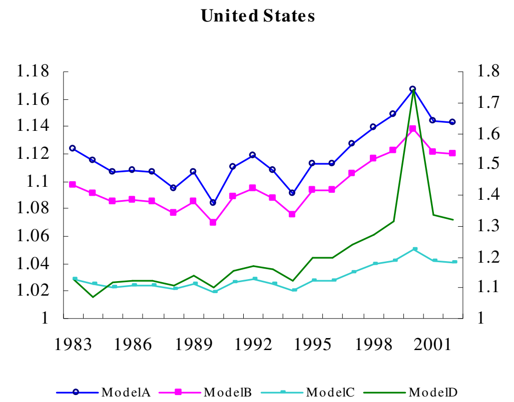
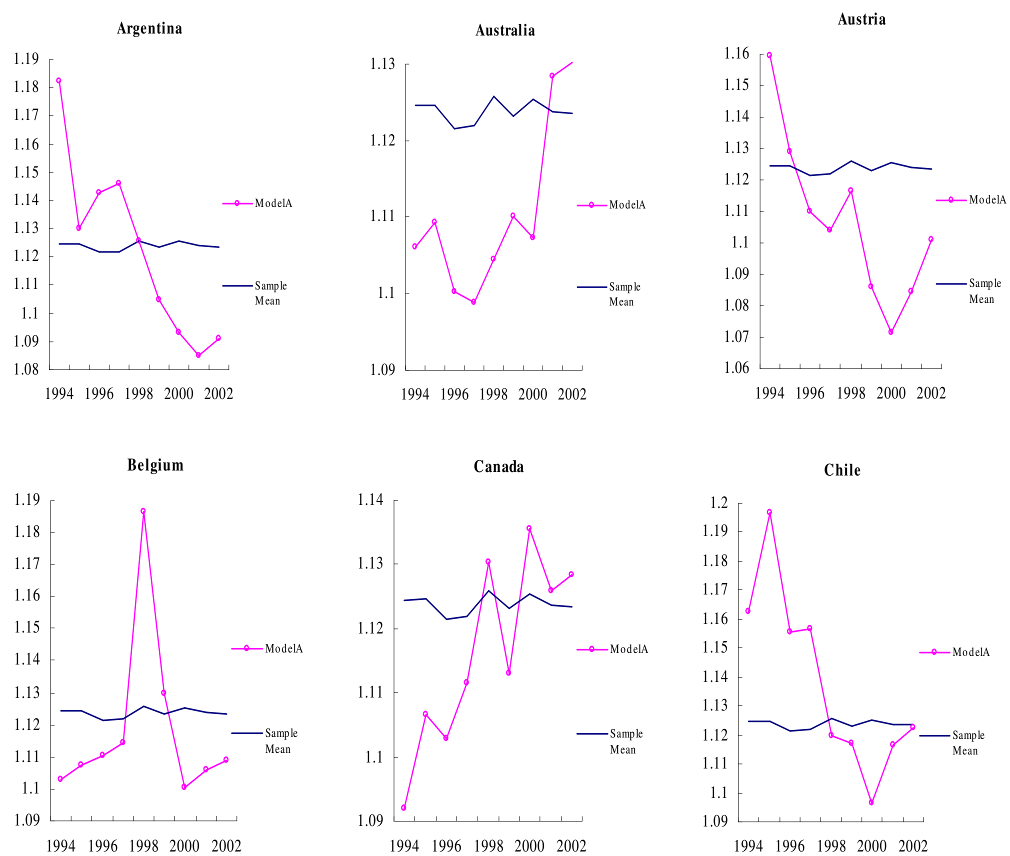
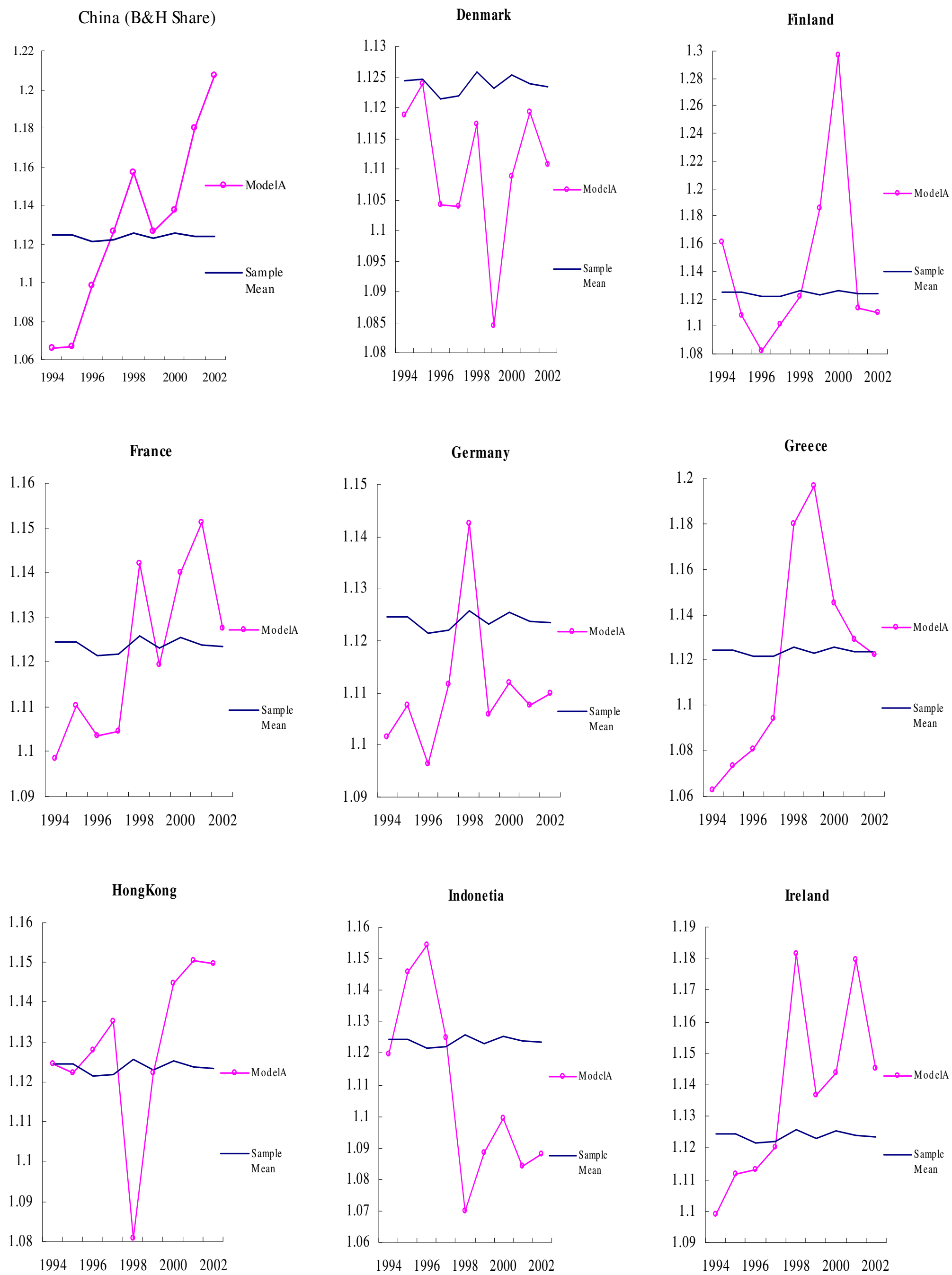
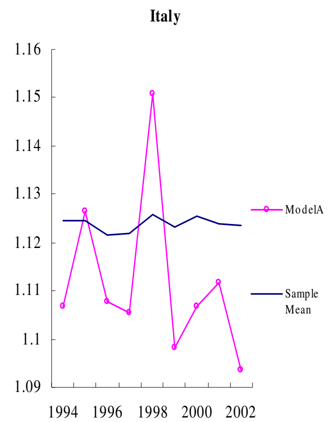
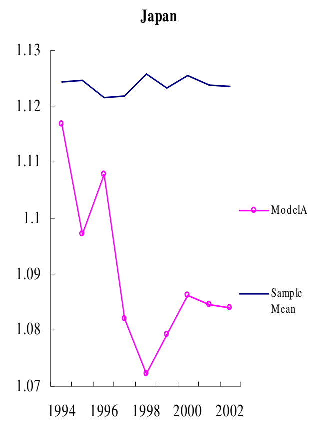


Figure 4.2 Bubbles of Each Individual Country and the Sample Mean




China (B&H Share)
Denmark
Finland
France
Germany
Greece
HongKong
Indonetia
Ireland
ModelA
Sample Mean
1994
1996
1998
2000
2002


Italy
1.16
1.15
1.14
1.13
1.12
1.11
1.1
1.09
1994 1996 1998 2000 2002
ModelA
Sample Mean


Japan
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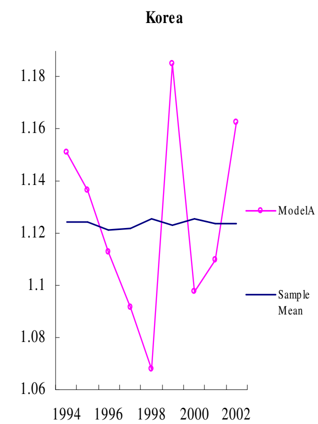
1.12
1.11
1.1
1.09
1.08
1.07
1994 1996 1998 2000 2002
ModelA
Sample Mean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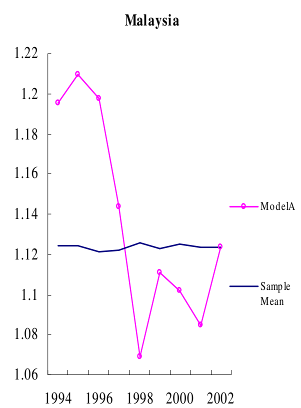
1.1
1.08
1.06
1994 1996 1998 2000 2002
ModelA
Sample Mean


Malaysia
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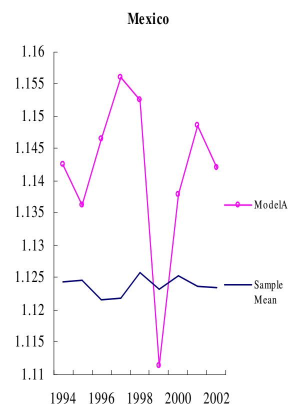
1.1
1.08
1.06
1994 1996 1998 2000 2002
ModelA
Sample Mean


Mexico
1.16
1.155
1.15
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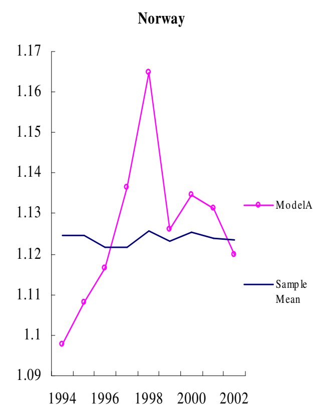
1.14
1.135
1.13
1.125
1.12
1.115
1.11
1994 1996 1998 2000 2002
ModelA
Sample Mean


Norway
1.17
1.16
1.15
1.14
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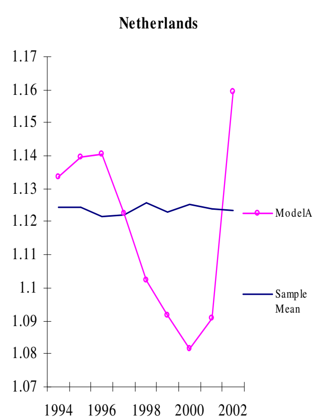
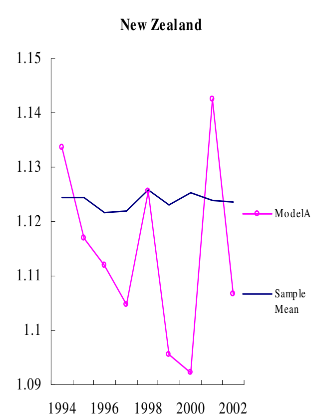
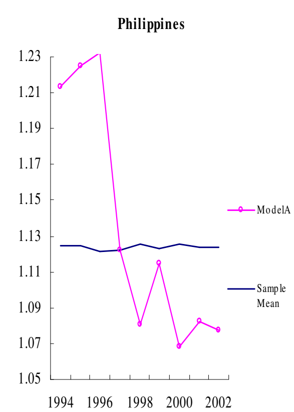
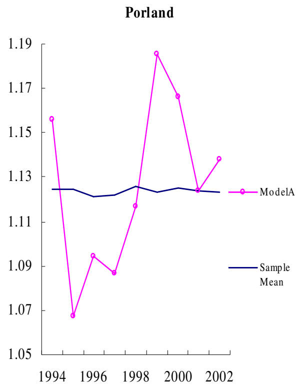
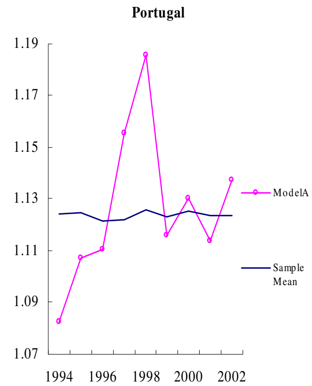
1.12
1.11
1.1
1.09
1994 1996 1998 2000 2002
ModelA
Sample Mean


Netherlands
1.17
1.16
1.15
1.14
1.13
1.12
1.11
1.1
1.09
1.08
1.07
1994 1996 1998 2000 2002
ModelA
Sample Mean

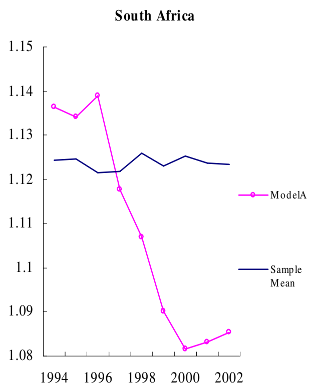

New Zealand
1.15
1.14
1.13
1.12
1.11
1.1
1.09
1994 1996 1998 2000 2002
ModelA
Sample Mean

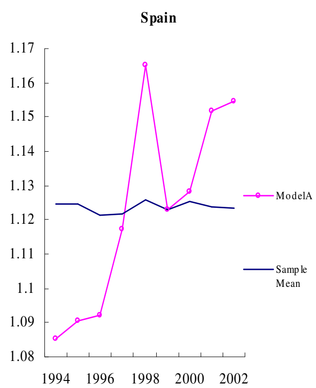

Philippines
1.23
1.21
1.19
1.17
1.15
1.13
1.11
1.09
1.07
1.05
1994 1996 1998 2000 2002
ModelA
Sample Mean

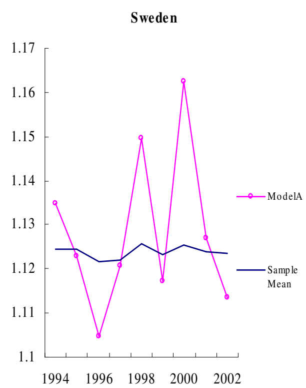

Porland
ModelA
Sample Mean

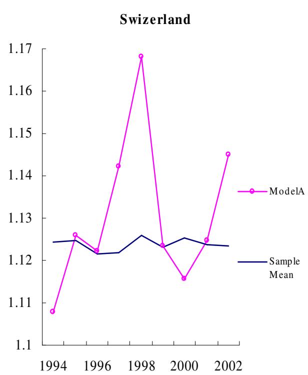

Portugal
ModelA
Sample Mean

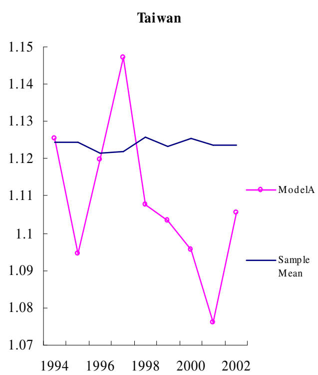

Singapore
ModelA
Sample Mean


South Africa
ModelA
Sample Mean


Spain
ModelA
Sample Mean


Sweden
ModelA
Sample Mean


Swizerland
ModelA
Sample Mean


Taiwan
ModelA
Sample Mean

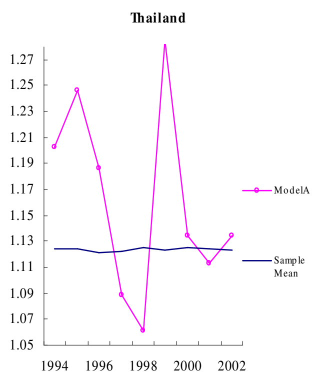
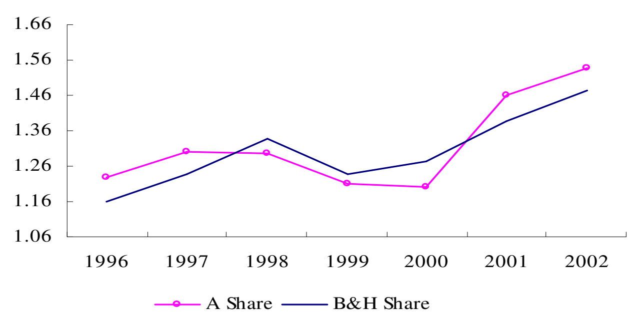

Thailand
ModelA
Sample Mean

Figure 4.2-1 Comparison of Bubbles between A-Share Group and B&H-Share Group (the Chinese Stock Markets)[40]



[40] The results are from a new duplicated estimation at the market level. See footnote 27 for details.

Figure 4.3 Bubbles in High-Income and Middle-Income Countries

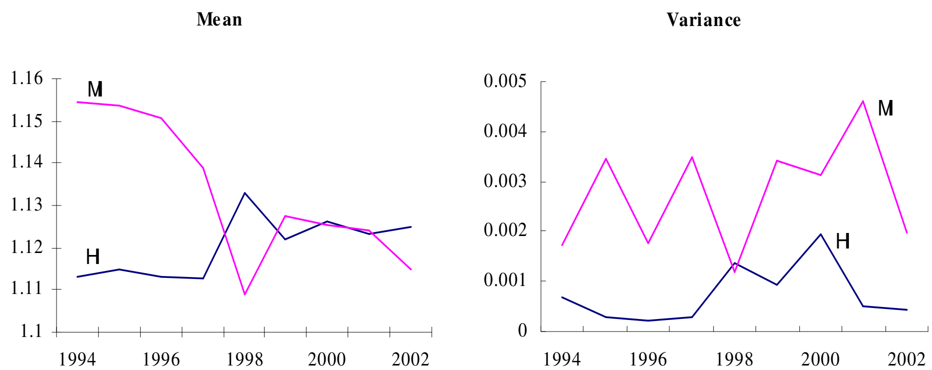
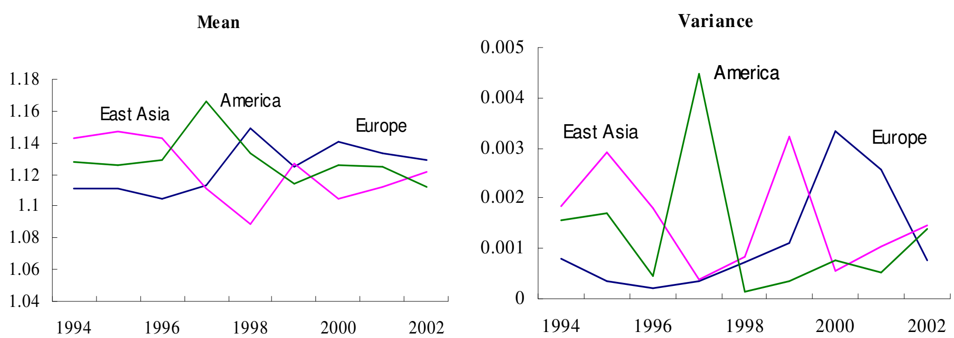


Figure 4.4 Comparisons of Bubbles among Three Regions



Chapter 5 Bubbles and the “Share Price-Inflation Puzzle”

As referred to in the previous chapter, stock bubbles are influenced by changes in economic conditions. In fact, the interaction between the stock market and the economy has been broadly documented. Some topics in this area in particular, such as the “share price-inflation puzzle”, become more and more popular due to the development of the stock market theory and an increasingly capricious fluctuation of stock prices. However, explanations of the interaction between the stock market and the economy are still very limited, since most of the examination is based on EMH which itself has been strongly argued recently by researchers from the perspective of behavioural finance (For example, Shleifer, 2000). To overcome this problem, this chapter aims to investigate the relationship between the stock market and the economy within a framework of stock bubbles. The study intends to add its own view to the longstanding argument of “share price-inflation puzzle” through the application of our bubble measurement. Meanwhile the relations between other economic factors and stock prices, fundamental values and bubbles will also be discussed. The structure of this chapter is as follows: Section 5.1 introduces current influential theoretical explanations to the “share price-inflation puzzle”; Section 5.2 theoretically derives the relation between share prices and inflation based on a bubble framework; Section 5.3 deals with the empirical estimation, in which the theoretical solution is verified; and Section 5.4 reaches the conclusion.

5.1 Current Influential Theoretical Explanations to the “Share Price-Inflation Puzzle”

The relationship between the common goods market and the stock market has been an interesting research topic. In particular, the inverse relationship between price movements in both asset and goods markets and the causality between stock behaviours and real economic activities are the focus of researches. As described in the literature survey of Chapter 2, the reversed relationship between stock prices and inflation, the so-called “economic enigma” is a big puzzle which is well documented but still a great topic of issue. The research can be divided into two divisions. Some financial economists have been trying to “dig out” the reasons by looking into some accounting evidences (for example, Modigliani and Cohn, 1979 and Feldstein, 1980 etc.), while others try to solve it following the macroeconomic route (for example, Fama, 1981 and Geske and Roll, 1983).

The earliest well-acknowledged explanation from the macro standpoint is the “proxy effect” devised by Fama and Schwert (1977). His theory has been treated as a supply side explanation to the issue. Meanwhile, some researchers, such as Danthine and Donaldson (1986), Stulz (1986) and Marshall (1992), have looked into the demand side explanation. By summarising the opinions of others, Hess and Lee (1999) mathematically explain the “puzzle” by combining the macro supply and demand shocks together.

Another well-known explanation is the Modigliani and Cohn hypothesis (M-C) which identifies a mistake in the way that investors make evaluations – “money illusion in investors’ valuation”. This idea sheds light on the bubble research, since the bubble theory stems from a belief that investors rationally misevaluate stocks. From then on, more and more researchers, such as Gordon (1983) and Cohn and Lessard (1981), have examined this topic by admitting the truth that there are expectation distortions in the stock market. However, their theoretical works always concentrate on renewing the traditional valuation model with the inflation effect and neglect the relationship between expectation distortions and inflation.

After several decades of investigation, theories and empirical works give rise to some answers to this topic. However, nearly all the research done ignored an increasingly obvious truth that stock price movements deviate from their fundamental values, and markets are far from efficient. Therefore, stock market researchers should not only be concerned with the movement of stock price/return but also should be attentive to the idea of bubbles and fundamental values. Being aware of this issue, our attention is not only put on the stock price, but also on its components: the fundamental values and bubbles. Based on the ongoing bubble theory, we systematically examine the effects of inflation on bubbles embedded in share prices, and the examination enables us to distinguish the relationships between fundamental values and inflation and between bubbles and inflation. In order to highlight the distinction of our theory from others, some current major theoretical explanations to the "share price-inflation puzzle" are reviewed below, in which some are reconsidered in Section 5.2.2 from the viewpoint of our theory.

5.1.1 Proxy Effect (Fama, 1981)

Fama explains the negative relation between real stock returns and inflation as the consequence of "proxy effects". Stock returns are determined by forecasts of relevant economic activity, and the negative "stock return-inflation" relation is induced by the negative relation between inflation and real economic activities.

The first step of his work is to document the negative relation between inflation and real economic activity by a model derived from money demand theory and quantity money theory. Its empirical model is obtained, as:

$$\Delta \ln p_t = -b_0 - b_1 \Delta \ln A_t - b_2 \Delta \ln R_t + b_3 \Delta \ln M_t + \eta_t \qquad \text{(a-1)}$$

where b_1>0, b_2<0 and b_3=1.0 ; P is the price level, A is a measure of anticipated real economic activity, R is one plus the nominal interest rate, M is the quantities of nominal money, and Δ indicates the difference of the relevant variables.

The second step is to identify the economic variables affecting the stock returns from the capital investment process. In a rational expectation framework, stock market returns respond to new information from the investment process. An increase in the general level of real economic activity puts pressure on the existing capital stock, raising the average return on the existing stock and thus inducing increased capital expenditure. Therefore, the models embrace three explanatory variables: capital expenditures, the average real rate of return on capital and output. The empirical tests show that real stock returns are positively related to the above measures of real economic activity.

The above two-step examination suggests that the real activity is involved between inflation and real stock returns as an exogenous proxy. The negative relationship between stock prices and inflation is formed by the combined effect of the positive relationship between stock prices and economic activities, and the negative "inflation-economy" relationship.

5.1.2 The Combined Effect of Demand and Supply Shocks (Hess and Lee,1999)

The purpose of Hess and Lee's research (1999) was to explore whether the observed relation between stock returns and inflation can be explained as a combination of demand and supply shocks by a mathematical method. Their supply and demand models are based on the models of Blanchard and Quah (1989).

With the assumption that the demand shock ε^d is mainly due to monetary shocks, and the supply shock is due to productivity shocks ε^s, the growth in output (Δy) and inflation (π) are given by:

$$\Delta y_t = y_t - y_{t-1} = \varepsilon_t^s + a\varepsilon_t^d - a\varepsilon_{t-1}^d \qquad \text{(b-1)}$$

$$\pi = p_t - p_{t-1} = -\varepsilon_t^s + \varepsilon_t^d + a\varepsilon_{t-1}^d \qquad \text{(b-2)}$$

After employing Hansen and Sargent's (1980) prediction formulae and present value model of stock prices, they conclude that supply shocks have a positive effect on stock returns, but a negative effect on inflation, which means supply shocks cause a negative relation between stock returns and inflation. In contrast, demand shocks have positive effects on both stock returns and inflation, which results in a positive relation between stock returns and inflation. The final conclusion is that the stock return-inflation relation varies over time and across countries, depending on the relative importance of the two types of shocks.

5.1.3 Money Illusion: M-C Hypothesis (Modigliani and Cohn, 1979)

Modigliani and Cohn (1979) argue that stock market investors suffer from money illusion due to the difficulty of estimating long-term future growth rates of cash flows. They argue that the stock value could be counted either by the nominal dividends and nominal interest rate, or by the real dividends and real interest rate. If investors mistakenly discount the real future cash flow at the nominal interest rate, they will push the value of the stock market down. This "real" versus "nominal" confusion may be the reason for the negative share price - inflation relationship. They also point out that inflation only has a minor effect on market values. The above situation may appear only at times of especially high or especially low inflation.

Overall, the relationship between stock performances and inflation has been studied and explained by researchers from the viewpoint of both macro and micro levels. The opposite effects between demand shocks and supply shocks on the stock return offered a compromised explanation to an instable sign in the empirical estimation of the “share price-inflation relation”. Meanwhile, the opinion of “money illusion” gave rise to a well-acknowledged micro answer to the negative relationship between share prices and inflation. However, no researchers have ever mentioned the existence of bubbles in stock markets when studying this topic. Thus, it is considered that the idea of stock bubbles may contribute a more sound explanation to the “share price-inflation puzzle”. The use of bubbles in examining the relationship between the price movements in both goods and the stock market is the central issue for the next discussion. However, before discovering the main issue, it is worth noting that the causality problem mentioned in antecedent work is the primary thought of our theory.

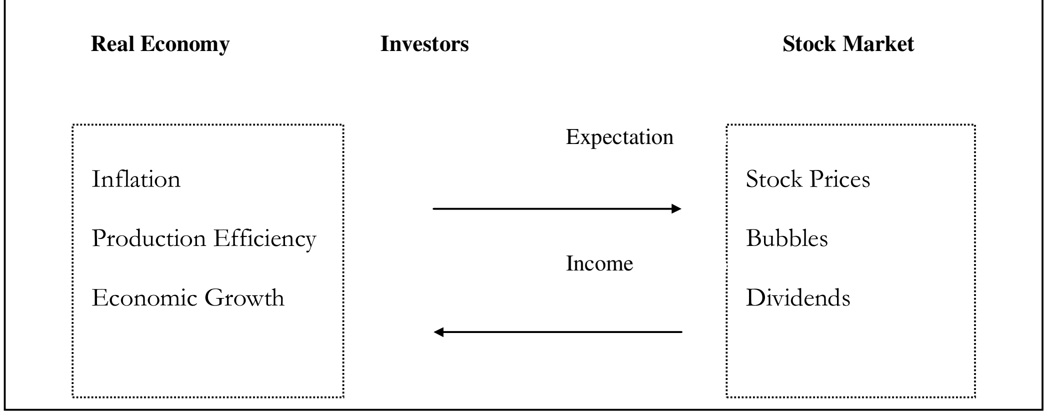
5.1.4 The Question of Causality

Does the movement in the stock market foretell the real activity or is it just an outcome of investors’ expectation in response to the economic signal? Are the two markets linked with a strict causality? These questions embody the long lasting debate plaguing the research.

The researches on the issue of causality are conducted in two directions: one is to answer how economic factors shape investors’ expectations, and the other deals with how the volatility of the stock price remodels the economy. There is a huge amount of literature documenting the effect of economic factors, such as inflation, unemployment, and output on the stock market. For example, Bosworth (1975) addressed the fact that the stock market reflects investors' attempts to forecast economic trends. Gertler and Grinols (1982) examined the effect of unemployment and inflation on stock returns. Fama (1981) concluded that in an efficient market, real variables, such as output or earnings growth, are the primary determinants of stock returns. Also, many literatures about the inflationary impact on the stock market have been reviewed in Chapter 2. Meanwhile, the performance of a stock market can also affect the real economy. Levine (1991) shows that the existence of a stock market tends to raise economic growth by making individuals more willing to invest the given amount of available savings in risky, more productive technology rather than in riskless storage. In contrast, Mauro (1995) incorporated the element of precautionary savings into an endogenous growth model and concluded that a stock market may slower the economic growth by reducing the precautionary motive for savings. Arestis et al (2001) argued that the contribution by the stock market on economic growth has been exaggerated by former studies. Furthermore, Lee (1992) pointed out that there is no causal linkage between stock returns and money supply growth, hence inflation.

In our bubble framework, the stock price is composed of fundamental values and bubbles. The real economy affects the stock market through investors' expectations and judgments to the shares' fundamental values. Also, we believe that a soaring stock market enhances investors' nominal income (although some gains in the stock market haven't been realised yet), which boosts demand and consumption. Therefore, the stock market and the economy simultaneously affect each other. A strict definition of causality is simply a unilateral assumption that naturally results in contestable conclusions. For the ease of understanding, we summarise the above analysis in Box I. Our investigation in this chapter will go with the first line of thought attempting to decipher the impact of economic elements, especially inflation, on the stock market under the framework of the bubble theory.

Box I.



5.2 Refining the "Share Price-Inflation Relation" in the Account of Bubbles: A Theoretical Discussion

The rational bubble advocators commonly define a stock price as the sum of fundamental values and rational bubbles. Standing along with this classical bubble opinion, two issues are reconsidered here.

First, it is easy to see that not all investors react to information (e.g. inflation) so as to affect the size of bubbles. Therefore, the study on the bubble-inflation relation calls for a separate examination on the information-based bubble and non-information-based bubble. Thus, we identify the stock price as:

$$P = P^f + B \qquad \text{with} \quad B = B_r + B_{ir} \tag{5.1}$$

where P^f is the fundamental value, and B denotes bubbles which are composed of an information-based bubble (B_r) and the non-information-based bubble (B_{ir}).

Second, theoretically, the fundamental value P_t^f should be identified by the present discounted value of the expected subsequent dividends:

$$P_t^f = \sum_{j=1}^{\infty} \frac{E_t(D_{t+j})}{r_{t+j}^j} \qquad \textbf{(5.2)}$$

where D_t is the nominal dividend paid in the period of t, and r is the nominal interest rate. As demonstrated in Section 4.1.1 (Eq. 4.7), the fundamental value is defined as a result of a neutral expectation so that (5.2) can also be shown as a function of dividends and interest rate, $P^f = f(D,r)$.

M-C (1979) and Fama (1981) argue that the inflation may influence the stock market through the dividend and the interest rate. If inflation π is considered to influence the fundamental value by affecting the dividend and interest rate, the function of P^f can be accordingly rewritten as:

$$P^f = \frac{D(\pi)}{r(\pi)}$$

(5.3)

In order to understand the inflationary impact on the fundamental value, based on (5.3), the differentiation is taken to the fundamental value P^f with respect to inflation π:

$$\frac{\partial P^f}{\partial \pi} = \frac{1}{r^2(\pi)}[\frac{\partial D(\pi)}{\partial \pi} \cdot r(\pi) - \frac{\partial r(\pi)}{\partial \pi} \cdot D(\pi)] \qquad \textbf{(5.4)}$$

Since a rise in inflation is usually responded to by increasing the nominal interest rate, i.e. $\frac{\partial r(\pi)}{\partial \pi} > 0$, then an inflationary effect on fundamental value will be determined by a sign of the marginal inflationary effect on dividends.

Fama (1981) explains the negative movement of a stock price in response to inflation by the "proxy effect". He highlights that inflation may damage the real economy, and that firms in a declining economy will operate in a slack manner. In this situation, the overall profitability of industry falls, so does the dividend. Based on this expectation, we have:

$$\frac{\partial D(\pi)}{\partial \pi} < 0 \tag{5.5}$$

Under this condition, it is straight to get $\frac{\partial P^f}{\partial \pi} < 0$ in (5.4), i.e. the fundamental value P^f is negatively correlated with inflation π.

However, in the face of high inflation, it is unlikely that every firm will make losses. If inflation is a result of demand shocks, the firms are able to raise prices in response to the increased demand so as to earn more profits and distribute more dividends. Furthermore, firms with a high debt leverage ratio can benefit from high inflation, which can help them to reduce debts in a real term. Nichols (1968) advanced this by showing that the firms with small monetary liabilities but high levels of depreciable assets will perform worst in a situation of inflation. Thus, some firms can be more profitable under inflation, at least in the short term. In this circumstance, the "dividend-inflation" relation can be argued as:

$$\frac{\partial D(\pi)}{\partial \pi} > 0 \tag{5.6}$$

and accordingly the relationship between fundamental values and inflation is obscure in (5.4).

Hence, theoretically, inflation can affect stock fundamental values via dividends. It is likely that in the long run, the inflationary effect on dividends is negative, but in the short term, it can be opposite. For industries, the two possibilities above may occur simultaneously, which may also lead to an overall zero effect of inflation on dividends (i.e. $\frac{\partial D(\pi)}{\partial(\pi)} = 0$), or only one or two of them may occur at one time (i.e. $\frac{\partial D(\pi)}{\partial(\pi)} > 0$ or $\frac{\partial D(\pi)}{\partial(\pi)} < 0$). Therefore, the relationship between inflation and stock fundamental value depends on which situation above is utterly predominant.

The bubble, another component of stock prices, can also affect stock prices. As explained above, bubbles can be divided into information-based and non-information-based bubbles. The non-information-based bubble, which is irrelevant to the information, is formed by the market manipulation and noise trading. The optimistic expectation to the fundamental values and speculation give rise to the information-based bubbles.

Kahneman and Riepe (1998) grouped three areas in which people deviate from the standard decision-making model: attitudes toward risk; non-Bayesian expectation formation; and sensitivity of decision-making to the framing of problems. To be consistent with but simplifying their opinion, we are concerned that the degree of B_r caused by the optimism effect and speculation can be formulated by two elements: the "expectation distortion" and the "risk aversion". Obviously, this distortion can be caused by two reasons: one is an unconscious mistake made by investors due to the deviation of fundamental valuation from the fundamental value determined by the neutral expectation; another one is speculative behaviours. The risk aversion represents investors' attitudes towards the risk. With a certain amount to a gamble with the same expected value, risk-averse investors prefer less risk to more, or at least an equivalent amount (Greenbaum and Thakor, 1995). The higher the risk aversion the more conservative the investor is. In our study, we interpret this conservation as subjectively conscious behaviour by the investors, which means investors intend to lower their expectation to the fundamental value since they are risk-averse. The opinion explained above can be expressed mathematically as:

$$B = B_r + B_{ir} = \frac{h(\pi)}{RAA(\pi)} + B_{ir} \tag{5.7}$$

where h denotes the expectation distortion, and *RAA* represents the risk aversion. Inflation is considered to influence both of them. Since B_{ir} in (5.7) is unlikely to be associated with economic influences, such as economic growth and inflation, we take the first order condition of *B* with respect to inflation π in (5.7), and it gives:

$$\frac{\partial B}{\partial \pi} = \frac{\partial B_r}{\partial \pi} = \frac{1}{RAA^2(\pi)}[\frac{\partial h(\pi)}{\partial \pi} \cdot RAA(\pi) - \frac{\partial RAA(\pi)}{\partial \pi} \cdot h(\pi)] \tag{5.8}$$

(5.8) shows how bubbles can be affected by inflation. According to Fama (1981), investors see inflation as bad news for the economy and firms' performances, so that a rise in inflation can decrease their expectation for future stock returns. This means that the expectation distortion is lower in the face of a relatively high inflation than in a low inflation circumstance, which brings an argument of $\frac{\partial h(\pi)}{\partial \pi} < 0$.

Furthermore, bubbles are generated not only from expectation but also from the investors' opinions toward the risk; i.e. even if two investors have exactly the same opinions about the moving tendency of stock prices, their decisions may still be different due to their distinctive risk aversion. Brandt and Wang (2003) modelled the change in risk attitudes in relation to inflation and found evidence supporting the hypothesis that risk aversion varies in response to the news of inflation. Following Campbell and Cochrane's (1999) "habit formation model", they explained that bad news about inflation raises aggregate risk aversion. and good news about inflation lowers it. Thus, it is expected that inflation will increase investors' caution to future stock returns which drives investors to be more risk averse, i.e. $\frac{\partial RAA(\pi)}{\partial \pi} > 0$.

From the discussion above, combining (5.7) and (5.8) with $\frac{\partial h}{\partial \pi} < 0$ and $\frac{\partial RAA}{\partial \pi} > 0$, the negative relation of bubble-inflation becomes clear in theory. This means that in the long run, the higher inflation there is, the lower bubbles are expected. Meanwhile, the irregular non-information-based bubbles weaken the dependence of bubbles on inflation and other economic factors. That is to say, it is possible to have a very weak link between bubbles and inflation when non-information-based bubbles become dominant in determining stock prices.

From the above line of analysis, the fundamental value and information-based bubbles are expected to change with the news of inflation. However, how does the observed price of a stock fluctuate with the changes of inflation? To answer this question, a joint examination on fundamental values and bubbles is required.

Combining (5.1), (5.3) and (5.7), it gives the observed stock price as a function of inflation as follows:

$$P = \frac{D(\pi)}{r(\pi)} + \frac{h(\pi)}{RAA(\pi)} + B_{ir} \qquad \textbf{(5.9)}$$

In order to decipher the "share price-inflation puzzle", P is differentiated with respect to π in (5.9):

$$\frac{\partial P}{\partial \pi} = \frac{1}{r^2} \cdot [\frac{\partial D(\pi)}{\partial \pi} \cdot r - \frac{\partial r(\pi)}{\partial \pi} \cdot D] + \frac{1}{RAA^2}[\frac{\partial h(\pi)}{\partial \pi} \cdot RAA - \frac{\partial RAA}{\partial \pi} \cdot h] \qquad \textbf{(5.10)}$$

Therefore, the relationship between the share price and inflation can be identified by the sign of $\frac{\partial P}{\partial \pi}$ in (5.10). According to the above analysis about "fundamental value-inflation" and "bubble-inflation" relations, the signs of three terms in (5.10) have been verified, that is: $\frac{\partial r(\pi)}{\partial \pi} > 0$, $\frac{\partial h(\pi)}{\partial \pi} < 0$, and $\frac{\partial RAA(\pi)}{\partial \pi} > 0$. Thus, the "puzzle" of the relation between stock price and inflation will depend on the sign of the $\frac{\partial D}{\partial \pi}$ term:

If $\frac{\partial D(\pi)}{\partial \pi} < 0$, then $\frac{\partial P}{\partial \pi} < 0$, i.e. the "share price-inflation" relation is negative;

If $\frac{\partial D(\pi)}{\partial \pi} > 0$, then the sign of $\frac{\partial P}{\partial \pi}$ is unclear, i.e. the "share price-inflation" relation is obscure;

If $\frac{\partial D(\pi)}{\partial \pi} = 0$, then the sign of $\frac{\partial P}{\partial \pi} < 0$, i.e. the "share price-inflation" is negative.

Apparently, the above solution is intriguing in that it provides us with a theoretical explanation to mixed antecedent empirical findings about the "share price-inflation" relation.

It is worth noting that the above factors influencing fundamental values, bubbles and so prices are also documented by Boyd, Hu and Jagannathan (2005), in which the risk-free rate of interest, the expected rate of growth of earnings and dividends (or growth expectations), and the equity risk premium are primitive factors determining stock prices. These factors are to be contained in the information of unemployment/inflation. They found that bad labour market news (inflation goes down when unemployment goes up) causes expected future interest rates to decline so as to inflate stock prices during expansions, but this need not be the case, since the growth expectation and risk premium are affecting stock prices also. The lower growth expectation caused by higher unemployment (or lower inflation) may be a force driving the stock prices down.

In summary, if taking the efficient market hypothesis for granted, the "proxy effect" raised by Fama (1981) gives a reasonable macro explanation for the empirical evidence of the negative relation between the share price and inflation. However, from the viewpoint of the demand-shock-driven bubbles, the "proxy effect" is only able to reveal a part of the impact of inflation on the observed stock price. Another part of the inflationary influence on the price, which is embedded in bubbles, should also be taken into account, since investors are not able to control the fundamental value of an asset; they can however affect bubbles by changing their expectations in response to various economic conditions.

5.3 Empirical Estimation

Following the line of discussion above, we are concerned that inflation should bear a direct resemblance to the volatility of stock prices, bubbles and fundamental values. Thus, the following study will focus on the estimation of the inflationary effect on stock prices, bubbles and dividends respectively. The empirical work is designed to test the argument developed by our theoretical analysis in the last section. In particular, the test will focus on three theoretical expectations:

(1) a negative relationship between stock prices and inflation if the dividend is negatively or not related to inflation;
(2) a negative, positive or non-relationship between the dividend (a proxy of fundamental values) and inflation;
(3) a negative relationship between the bubble and inflation.

5.3.1 Models

In accordance with our specified tests above, empirical models are designed to examine the relationship between three dependent variables of the observed stock prices, dividends and bubbles, and explanatory variable of inflation respectively. Apart from the major explanatory variable, inflation, several other controlling variables should also be inserted in the model to capture other macro effects. GDP growth rate is consistently used to capture the economic growth by many researchers so that it is included in the model. Following Beck and Levine (2004), the turnover ratio, which is a measure of stock market liquidity and speculation, and the market capitalisation indicating the stock market size, are also included in the model. To measure the bank development, the domestic credit from banking is applied, which is similar to the variable of the bank credit used in Beck and Levine (2004) and Levine and Zervos (1998a)[41]. In addition, since it's expected that the stock market is influenced not only by the economic growth but also by the efficiency of the economy, we first apply the variable of the production efficiency in modelling the relationship between macro factors and stock performances.

[41] The bank credit defined in Beck and Levine (2002) and Levine and Zervos (1998a) equals the bank claims on the private sector by deposit money banks divided by GDP

As explained by the theory, inflation π should be negatively related to the stock price and bubbles, but its influence on dividends is not assured.

The economic growth Q is expected to be positively correlated with the stock price because the economic growth can stimulate bubbles so as to drive up the fundamental values of stocks.

The productivity U is expected to be positively related to the dividend since U can affect the fundamental value of an industry in generating dividends in the long run. Moreover, the effect of U on the stock price can be also made through bubbles. If investors are aware of productivity when forming their expectation to the fundamental value, i.e. U and B are positively correlated, the productivity will then affect bubbles and so positively influence the stock price.

As the proxy of stock market development, the market capitalisation Z should have a positive relation with bubbles; as documented by Durham (2002), Levine and Zervos (1998a, b) and Henry (2000a, b), the development of a stock market is expected to enhance the economic growth and decrease the cost of equity capital in the long run, and these effects will boost the optimism of investors to raise their expectations to the fundamental value, hence bubbles are stirred up. In addition, we are concerned that there are two issues affecting the relationship between market capitalisation and dividends. First, their positive relation can reveal the capital allocation efficiency of a market. If the capital of a market is allocated efficiently, the expanded market size can offer more funds for companies which are most efficient in production to produce more profits, so finally increasing dividends. Second, facing a developed stock market, a company may have the intention to pay fewer dividends, since they know that the lesser risk aversion in a relatively developed stock market can offset the impact of lesser dividends. The overall effect of market capitalisation on dividends may depend on which one of the above two is dominant.

The signal of a stock market speculation *VO* is also certainly related to bubbles, since bubbles are formed and further inflated by speculative behaviours in a market.

The bank development is represented by the variable of domestic credit from banking *DC*, which is documented to positively influence economic growth (Beck and Levine, 2004). However, we are concerned that it is still possible that domestic credit can be negatively related to bubbles, since bank development may relatively reduce the interests and willingness of investment in the stock market. For example, if firms can get enough loans from banks, or individuals can raise as large a mortgage as they like, the speculation in the stock market will be less significant, because there is no need for individuals to risk more in the stock market to cope with their normal living demands. Therefore, the stock market may be less exuberant.

These controlling variables and their expected impact on stock prices, bubbles and dividends are listed below (the definitions of variables are detailed in Appendix 5.1):

(1) economic growth: GDP growth rate (*Q*), which is expected to influence bubbles, dividends and therefore prices;
(2) stock market size relative to GDP: capitalisation over GDP (*Z*), which is expected to positively influence bubbles, and its impact on dividends is uncertain;
(3) degree of market speculation: turnover ratio (*VO*) which is expected to positively affect bubbles;
(4) bank development: domestic credit from banking over GDP (*DC*), which is expected to negatively affect bubbles;
(5) real economic fundamental: production efficiency (*U*) (estimated from the production frontier model), which is expected to positively influence a company's fundamental value (the dividend is its proxy), and if investors

attend the productivity of an industry, it is expected to also positively influence bubbles and therefore prices.

The studies in the next section will test these expectations econometrically. Accordingly, the models of estimation are derived by specifying stock prices *P* as a general function of dividend *D* and bubbles *B*:

$$P = f[D, B] \quad \text{with} \quad D = D(\pi, Q, Z, VO, DC, U) \quad B = B(\pi, Q, Z, VO, DC, U) \tag{5.11}$$

In addition, time and country dummies are inserted into the models to capture the time shocks and the countries' specific characteristics. In the models, economic growth rate and production efficiency function as the form of their lags, because, as commonly admitted, the expectations dominate the stock market. The lags of the two variables represent the investors' expectations to the economy. In other words, investors make the decisions according to past economic performances. Since stock markets are strongly time-dependent, the dynamic models may perform better than the static ones. Thus, a lagged dependent variable is included in our model. Each model is estimated using panel data in a logarithm form:

Model I-A (the reduced form of the stock price model):

$$p_{it} = T_t + A_i + \beta_1 p_{it-1} + \beta_2 q_{it-1} + \beta_3 u_{it-1} + \beta_4 \pi'_{it} + \beta_5 z_{it} + \beta_6 vo_{it} + \beta_7 dc_{it} + \varepsilon_{it} \tag{5.12}$$

Model II-A (the reduced form of the bubble model):

$$b_{it} = T_t + A_i + \alpha_1 b_{it-1} + \alpha_2 q_{it-1} + \alpha_3 u_{it-1} + \alpha_4 \pi'_{it} + \alpha_5 z_{it} + \alpha_6 vo_{it} + \alpha_7 dc_{it} + \varepsilon_{it} \tag{5.13}$$

Model III-A (the reduced form of dividend model):

$$d_{it} = T_t + A_i + \gamma_1 d_{it-1} + \gamma_2 u_{it-1} + \gamma_3 \pi'_{it} + \gamma_4 z_{it} + \gamma_5 vo_{it} + \gamma_6 dc_{it} + \varepsilon_{it}$$

(5.14)

where the lower-case letters represent the logarithmic form. *p* denotes stock prices, *b* is bubbles and *d* is dividends as a proxy of fundamental values. For explanatory variables, *q* is the economic growth rate; *u* is the production efficiency; π' is inflation; *z* is the capitalisation of a market; *vo* is the turnover ratio; *dc* is domestic credit from banking; and *T* and *A* are the time and country dummies. It is worth noting that in model III-A, the lag of GDP growth rate is dropped off due to an obviously strong correlation between the lags of the dividend and the GDP growth rate.

As a robustness check, the production efficiency is removed from the three models. The new models are exhibited as:

Model I-B:

$$p_{it} = T_t + A_i + \beta_1 p_{it-1} + \beta_2 q_{it-1} + \beta_4 \pi'_{it} + \beta_5 z_{it} + \beta_6 vo_{it} + \beta_7 dc_{it} + \varepsilon_{it} \tag{5.15}$$

Model II-B:

$$b_{it} = T_t + A_i + \beta_1 b_{it-1} + \beta_2 q_{it-1} + \beta_4 \pi'_{it} + \beta_5 z_{it} + \beta_6 vo_{it} + \beta_7 dc_{it} + \varepsilon_{it} \tag{5.16}$$

Model III-B:

$$d_{it} = T_t + A_i + \gamma_1 d_{it-1} + \gamma_3 \pi'_{it} + \gamma_4 z_{it} + \gamma_5 vo_{it} + \gamma_6 dc_{it} + \varepsilon_{it} \tag{5.17}$$

Another transformation for the robust check is to remove the variables of inflation and the lag of economic growth rate instead of the production efficiency. These three models can be shown as:

Model I-C:

$$p_{it} = T_t + A_i + \beta_1 p_{it-1} + \beta_3 u_{it-1} + \beta_5 z_{it} + \beta_6 vo_{it} + \beta_7 dc_{it} + \varepsilon_{it} \quad \textbf{(5.18)}$$

Model II-C:

$$b_{it} = T_t + A_i + \alpha_1 b_{it-1} + \alpha_3 u_{it-1} + \alpha_5 z_{it} + \alpha_6 vo_{it} + \alpha_7 dc_{it} + \varepsilon_{it} \quad \textbf{(5.19)}$$

Model III-C:

$$d_{it} = T_t + A_i + \gamma_1 d_{it-1} + \gamma_2 u_{it-1} + \gamma_4 z_{it} + \gamma_5 vo_{it} + \gamma_6 dc_{it} + \varepsilon_{it} \quad \textbf{(5.20)}$$

Having studied the individual impact of economic factors on the stock price, the dividend and the bubble, the estimated bubble is inserted in the price models of (5.12) and (5.15) to identify the inflationary effect on stock prices after controlling the influence of bubbles. The models can be written as:

Model IV-A:

$$p_{it} = T_t + A_i + \beta_1 p_{it-1} + \beta_2 q_{it-1} + \beta_3 u_{it-1} + \beta_4 \pi'_{it} + \beta_5 z_{it} + \beta_6 vo_{it} + \beta_7 dc_{it} + \beta_8 b_{it} + \varepsilon_{it} \quad \textbf{(5.21)}$$

Model IV-B:

$$p_{it} = T_t + A_i + \beta_1 p_{it-1} + \beta_2 q_{it-1} + \beta_4 \pi'_{it} + \beta_5 z_{it} + \beta_6 vo_{it} + \beta_7 dc_{it} + \beta_8 b_{it} + \varepsilon_{it} \quad \textbf{(5.22)}$$

(5.21) and (5.22) enable us to answer one question: does inflation affect stock prices by influencing investors' expectation of fundamental values? In other words, the examination of the "stock prices-inflation relationship" with a participation of bubbles can clarify one doubt that the "stock price- inflation puzzle" may be a puzzle between bubbles and inflation.

5.3.2 Data and Variables

The major dataset employed in this part is the World Bank Development Indicators from which most of the variables are obtained over the years of 1960 to 2002 for 36 countries.[42] The variable of production efficiency cannot be obtained directly from the data source, and is estimated by the stochastic frontier production function. [43]

[Table 5.1 is about here]

In order to expand the panel size, we estimate the bubble for the same 37 countries again using the estimation methodology described in Chapter 4 but with a different time period. Data was collected for each country from the year of inception of a country's stock market trading until 2004.[44] The definitions of variables employed by this part are listed in Appendix 5.1.

5.3.3 Estimation and Interpretation

First of all, the fixed effect panel regressions are applied for these three models. The autocorrelation in the dynamic models may cause biases in the estimation. In addition, the GDP growth rate may be correlated with production efficiency, and the turnover ratio is not strictly exogenous because bubbles and turnover ratio influence each other, i.e. the active behaviours in the market drives up prices, and in the meantime investors are also stirred up by the soaring market. Therefore, the GMM estimation is employed to mitigate the effect of the colinearity and endogenerity problems on estimation.

From tables 5.2, 5.3, 5.4 and 5.5, it is evident that the GMM results in these four tables are consistent. More importantly, the results are consistent with the hypothesis and expectation defined in sections 5.2 and 5.3. Stock prices and inflation are

[42] There is no data for Taiwan in WDI online data.

[43] See Appendix 5.2 for the model and estimation procedure of the production efficiency. The results are shown in Table 5.1.

[44] Following Ritter and Simar (1997) we preferred the relatively simple distribution (such as half normal or exponential) to a flexible distribution (such as truncated normal or gamma), the half normal distribution is assumed in the bubble estimation model instead of truncated normal distributional assumption for the inefficiency error, which is different from my previous estimation. Kumbhakar and Lovell (2000) concluded that the choice amongst the four assumptions is largely immaterial.

significantly correlated with each other negatively, which is in accordance with most of the previous empirical results in analysing time-series data for an individual country, such as the findings by Cohn and Lessard (1981), Gordon (1983) and Fama (1981). In contrast, dividends show a weak relation with inflation. A weak effect of inflation on dividends implies that inflation could play a neutral role in influencing the overall profitability of the industry. This result perfectly supports our expectation which is consistent with the argument of Nichols (1968) that the "inflation hedge" is not true for all stocks and firms with small monetary liabilities but high levels of depreciable assets will perform worst. Besides, the *t* value of inflation in the bubble regression is -1.34 which shows a weak negative relation between bubbles and inflation. This result implies that inflation does affect the investors' decision, but this negative relation could be weakened by the impact of noise trading. The implication of the significant irrationality in stock markets strongly challenges the efficient market theory in which the impact of irrationality on prices can cancel each other out (Shleifer, 2000). It shows the evidence to the opinions of behavioural researchers that many investors react to irrelevant information in forming their demand for securities, i.e. they trade on noise rather than information (Shleifer, 2000; Black, 1986). Hence, the estimated results are consistent with our theoretical expectation in (5.10) that the price impact of inflation can be made through changing a discount rate (i.e. nominal interest rate) if the effect of inflation on both bubbles and dividends is absent, i.e. they are not related to inflation ($\frac{\partial D}{\partial \pi} = 0, \frac{\partial B}{\partial \pi} = 0$). This conclusion can be further proved by the results in Table 5.5, in which the negative inflationary effect on stock prices remains significant after taking into account bubbles. This implies that the inflationary effect on stock prices is irrelevant to bubbles.

[Table 5.2, 5.3, 5.4 and 5.5 are about here]

In addition, it is worth noting that, from tables 5.2, 5.3 and 5.4, the production efficiency affects dividends significantly, but not prices and bubbles. This implies that investors pay more attention to the profitability of an industry than the productivity, i.e. the information of productivity is scarcely embedded in the bubble. As a result, a non-significant link between bubbles and productivity weakens the relationship between the stock price and productivity.

The results for other controlling variables in models also appear to be expected. In tables 5.2, 5.3 and 5.4, the capitalisation (*z*), turnover ratio (*vo*) and domestic credit (*dc*) show the significant relationship with both prices and bubbles. This result supports our expectation that a large stock market and the heavy speculation in this market will stimulate and sustain bubbles. In fact, a high turnover ratio implies significant behaviours of irrationality. The negative impact of domestic credit on bubbles verifies an argument that the bank development may relatively reduce or diversify demand for investment funds from the stock market.

However, for explaining dividends, it shows a different story. The stock market capitalisation and turnover ratio negatively affect dividends, and the bank development (*dc*) has no significant relationship with dividends. These findings imply that the link between stock market development and the goods market is very weak. The weak link suggests that worldwide markets are averagely inefficient in directing funds to invest in most efficient projects or places. The negative signs highlight the company's intention of distributing fewer dividends in a relatively more active and advanced stock market, since fewer dividends in an active market may not substantially change investors' confidence in their investment.

5.4 Summary and Conclusion

The investigation for the interaction between the stock market and the real economy has been seen in previous studies but their findings are not clear-cut, since the existing researches have failed to study a role of bubbles in link with the stock market and the goods market. The study in this chapter applies the bubble theory and the estimated bubbles to explain the relationship between stock markets and real economic activities, especially the relationship between stock prices and inflation when bubbles are taken into account.

Comparing our research with the existing research in this area, our study adds a new contribution to the issue by examining the economic impact on stock bubbles using the estimated bubble. Meanwhile, the long lasting topic of the “share price-inflation puzzle” is theoretically and empirically explained on the basis of the theoretical framework of bubbles. One major finding is that inflation negatively affects stock prices, but not by influencing investors’ expectation of stock values which forms bubbles. Bubbles are neither very much influenced by inflation nor by industry productivity. Rather, they are influenced by the expected economic growth, market speculation and stock market size relative to GDP.

The explanation for the “share price-inflation puzzle” within a bubble framework in this chapter intends to make an example for our argument that the ongoing topics about the relationship between stock markets and real economies may be reexamined under the hypothesis of market inefficiency. Therefore, one should view the findings of this chapter being provisional since it just gives a preliminary look at the relationship between stock bubbles and real economic factors. The results from several regressions for a sample in this chapter are not sufficient to tie up the relationship between bubbles and the real economy. Future attention could focus on developing a strictly derived theoretical model based on the current theories of economics to direct the empirical modeling. Certainly, the bubble index computed from the value frontier model will no doubt make the future empirical estimation more straightforward.

Appendices

Appendix 5.1 Data

A. Definition of Datastream Global Indices data

Dividend Yield (DY)

Dividend yield is derived by calculating the total dividend amount for a sector and expressing it as a percentage of the total market value for the constituents of that sector. This provides an average of the individual yields of the constituents weighted by market value. It is calculated as follows:

$$DY_t = \frac{\sum_{1}^{n}(D_t * N_t)}{\sum_{1}^{n}(P_t * N_t)} * 100$$

Where:

DY_t =aggregate dividend yield on day t

D_t =dividend per share on day t

N_t =number of shares in issue on day t

P_t = unadjusted share price on day t

n = number of constituents in index

Market Value (MV)

These market values are calculated from the constituents of the sector/market lists. Index market value on Datastream is the sum of share price multiplied by the number of ordinary shares in issue for each index constituent.

For equity indices, the calculation used is:

$$MV_t = \sum_{1}^{n} (P_t * N_t)$$

Where:

N_t =number of shares in issue on day t

P_t =unadjusted share price on day t

B. Definition of WDI Online Variables

GDP per capita growth (annual %)

Annual percentage growth rate of GDP per capita based on constant local currency. GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.

Domestic credit provided by banking sector (% of GDP)

Domestic credit provided by the banking sector includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. The banking sector includes monetary authorities and deposit money banks, as well as other banking institutions where data are available (including institutions that do not accept transferable deposits but do incur such liabilities as time and savings deposits). Examples of other banking institutions are savings and mortgage loan institutions and building and loan associations.

Stocks traded, turnover ratio (%)

Turnover ratio is the total value of shares traded during the period divided by the average market capitalization for the period. Average market capitalization is calculated as the average of the end-of-period values for the current period and the previous period.

Gross capital formation (constant LCU)

Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress." According to the 1993 SNA, net acquisitions of valuables are also considered capital formation. Data are in constant local currency.

Inflation, consumer prices (annual %)

Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a fixed basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally used.

Market capitalization of listed companies (% of GDP)

Market capitalization (also known as market value) is the share price times the number of shares outstanding. Listed domestic companies are the domestically incorporated companies listed on the country's stock exchanges at the end of the year.

Labor force, total

Total labor force comprises people who meet the International Labour Organization definition of the economically active population: all people who supply labor for the production of goods and services during a specified period. It includes both the employed and the unemployed. While national practices vary in the treatment of such groups as the armed forces and seasonal or part-time workers, in general the labor force includes the armed forces, the unemployed, and first-time job-seekers, but excludes homemakers and other unpaid caregivers and workers in the informal sector.

Appendix 5.2 Estimations of Production Efficiency

A. Estimations of Capital Stocks—Perpetual Inventory Calculation Method

Step 1: To initialise the capital stock (the initial year is 1960):

$$k_0 = I_0 / (\lambda q + (1-\lambda) q_w + \phi)$$

k : capital stock;

I: fixed investment constant 1995;

q: GDP growth rate.

q_w =4% per year: the average world growth rate;

λ=0.25: a measure of mean reversion in the growth rates following Easterly et al.(1993);

φ=0.05, is the assumed depreciation rate;

Step 2: To estimate the capital stock:

$$k_t = I_t + (1-\phi) k_{t-1}$$

B. Estimations of Production Efficiency: Stochastic Frontier Estimation — Normal-Half Normal Distribution

<u>Model:</u>

$$\ln q_{it} = T_t + A_i + \alpha_1 \ln q_{it-1} + \ln k_{it} + \ln l_{it} - \ln u_{it} + v_{it}$$

(i) $\nu \sim \text{iid}\, N(0, \sigma_\nu^2)$

(ii) $u \sim \text{iid}\, N^+(0, \sigma_\mu^2)$

(iii) u and ν are distributed independently of each other, and of the regressors.

where q is GDP growth rate; k is capital stock; l is labor force; ν is the two-sided "noise" component, and u is the nonnegative technical inefficiency component, of the error term.

Tables

Table 5.1 Estimation of Production Efficiency

Dep.Variable *q*	**Coefficient**	**Standard error**	**t statistics**
q_{it-1}	0.4208	0.0167	25.13**
k_{it}	0.2017	0.0121	16.64**
l_{it}	0.3684	0.0324	11.38**
Statistics			
Number of Obsv.	1269		
Wald Test χ^2	184881.47 [0.0000]		
$\lambda = \sigma_u / \sigma_v$	1.8674		
σ_u	0.1419		
σ_v	0.0760		
σ^2	0.0259		

Log Likelihood	982.4457		
Likelihood Ratio Test H0: $\sigma_u = 0$	33.93 [0.000]		

Note: 1. t ratios are in parentheses, and p values are in square brackets;
2. Time and country dummies are not reported in the table;
3. * Significance of the individual coefficients at the 10% level;
** Significance of the individual coefficients at the 5% level.

Table 5.2 Stock Market and Economy: Model I-A, II-A and III-A

	Price (p_{it})		**Bubbles(b_{it})**		**Dividends(d_{it})**	
	LSDV	**GMM**	**LSDV**	**GMM**	**LSDV**	**GMM**
p_{it-1}	0.5248 (7.04)**	0.9520 (50.4)**	-	-	-	-
b_{it-1}	-	-	0.3342 (5.11)**	0.5940 (11.8)**	-	-
d_{it-1}	-	-	-	-	0.4958 (7.88)**	0.7345 (15.3)**
π'_{it-1}	-0.0758 (-1.64)*	-0.0976 (-5.32)**	-0.0325 (-2.33)	-0.0153 (-1.34)	0.0477 (1.87)*	0.0206 (1.08)
q_{it-1}	0.0541 (2.01)**	-0.0073 (-0.439)	0.0320 (1.72)*	0.0249 (2.65)**	-	-
u_{it-1}	2.1677 (1.93)*	-0.2986 (-0.977)	0.6904 (1.59)	-0.1472 (-0.627)	1.0245 (0.706)	0.8919 (1.87)*
z_{it}	0.2334 (4.28)**	0.0649 (2.79)**	0.1721 (4.88)**	0.0294 (2.51)**	-0.2124 (-4.43)**	-0.0475 (-1.79)*
vo_{it}	0.1202 (3.39)**	0.0514 (3.21)**	0.0501 (1.90)*	0.0190 (2.30)**	-0.0516 (-1.29)	-0.0319 (-2.16)**
dc_{it}	0.1420 (1.74)*	-0.1129 (-3.12)**	0.1206 (1.72)*	-0.0479 (-2.79)**	-0.1970 (-0.948)	0.0682 (1.21)
Statistics						
No. of Obv.	289	289	289	287	311	311
R^2	0.9592	-	0.6561	-	0.7570	-

Wald test χ^2	433.8 [0.000]	5822 [0.000]	286.9 [0.000]	438.1 [0.000]	212.8 [0.000]	275.3 [0.000]
σ^2	0.0529	0.0772	0.0196	0.0269	0.0944	0.1132
Sargan Test	-	16.25 [1.000]	-	17.17 [1.000]	-	11.43 [1.000]
AR(1)	-2.511 [0.012]	-0.0425 [0.966]	-1.362 [0.173]	-0.4821 [0.630]	0.6482 [0.517]	-0.0407 [0.968]
AR(2)	1.998 [0.046]	0.4358 [0.663]	-0.1112 [0.911]	-0.5198 [0.603]	0.5383 [0.590]	1.034 [0.301]
Instrument Set	-	p_{it-3} ~ ; vo_{it-2} ~ ; qr_{it-3} ~	-	b_{it-3}~; u_{it-3} ~ ; qr_{it-3} ~ ; vo_{it-2} ~	-	d_{it-3}~; z_{it-2} ~ ; u_{it-3}~ ; r_{it-2}~ ; vo_{it-2}

Note: 1. t ratios are in parentheses, and p values are in square brackets;

2. All the statistical tests proceed from the estimations are using robust standard errors;

3. Two-step GMM estimators of Arellano and Bond (1991) are applied.

4. * Significance of the individual coefficients at the 10% level;

** Significance of the individual coefficients at the 5% level.

5. Time and country dummies are not reported in the table。

Table 5.3 Stock Market and Economy: Model I-B, II-B and III-B

	Price (p_{it})			Bubbles(b_{it})			Dividends(d_{it})	
	LSDV	**LSDV**	**GMM**	**LSDV**	**LSDV**	**GMM**	**LSDV**	**GMM**
p_{it-1}	0.5991 (11.9)**	0.5767 (8.97)**	0.9539 (54.6)**	-	-	-	-	-
b_{it-1}	-	-	-	0.3967 (7.82)**	0.3507 (16.07)**	0.5815 (11.3)**	-	-
d_{it-1}	-	-	-	-	-	-	0.4834 (7.86)**	0.7351 (15.4)**
π'_{it-1}	-0.0501 (-1.41)**	-0.0782 (-1.71)*	-0.0922 (-5.58)**	-0.0157 (-1.48)**	-0.0309 [-2.23]**	-0.0114 (-0.895)	0.0503 (1.97)**	0.0123 (0.648)
q_{it-1}	0.0436 (2.87)**	0.0657 (2.87)**	-0.0202 (-1.23)	0.0138 (1.11)	0.0372 (1.97)**	0.0182 (2.14)**	-	-
z_{it}	0.3070 (7.05)**	0.2309 (4.83)**	0.0638 (2.86)**	0.1906 (5.43)**	0.1683 (4.89)**	0.0339 (2.81)**	-0.2038 (-4.47)**	-0.0446 (-1.66)*
vo_{it}	-	0.1153 (3.41)**	0.0438 (2.14)**	-	0.0510 (1.87)*	0.0176 (1.96)**	-0.0601 (-1.53)	-0.0308 (-1.94)*
dc_{it}	-	0.1200 (1.29)	-0.1154 (-3.11)**	-	0.1207 (1.67)*	-0.0562 (-2.88)**	-0.2096 (-1.05)	0.0770 (1.36)
Statistics								
Obv.	408	296	296	408	296	296	318	318
R^2	0.9576	0.9589	-	0.6348	0.6526	-	0.7545	-
Wald test χ^2	572.4 [0.000]	478.1 [0.000]	6528 [0.000]	190.2 [0.000]	288.2 [0.000]	234.3 [0.000]	167.8 [0.000]	256.8 [0.000]
σ^2	0.0450	0.0530	0.0784	0.0170	0.0192	0.0264	0.0928	0.1129

Sargan Test	-	-	16.21 [1.000]			14.46 [1.000]	-	14.09 [0.000]
AR(1)	-2.487 [0.013]	-2.682 [0.007]	-0.7795 [0.436]	-0.7417 [0.458]	-1.143 [0.253]	-0.2939 [0.769]	0.8568 [0.392]	-0.1151 [0.908]
AR(2)	1.324 [0.186]	1.879 [0.060]	1.007 [0.314]	0.2137 [0.831]	-0.0280 [0.978]	0.7983 [0.425]	0.5179 [0.605]	0.3676 [0.713]
Instrument Set	-	-	p_{it-3} ~ ; qr_{it-2} ~ ; vo_{it-3} ~	-	-	qr_{it-2}~; vo_{it-2}~; b_{it-3}~	-	dy_{it-3}~; z_{it-3} ~ ; r_{it-2}~ ; vo_{it-2} ~

Note: 1. t ratios are in parentheses, and p values are in square brackets;

2. All the statistical tests proceed from the estimations are using robust standard errors;

3. Two-step GMM estimators of Arellano and Bond (1991) are applied.

4. * Significance of the individual coefficients at the 10% level;

** Significance of the individual coefficients at the 5% level.

5. Time and country dummies are not reported in the table.

Table 5.4 Stock Market and Economy: Model I-C, II-C and III-C

	Price (p_{it})		Bubbles(b_{it})		Dividends(d_{it})	
	LSDV	**GMM**	**LSDV**	**GMM**	**LSDV**	**GMM**
p_{it-1}	0.5368 (8.14) **	0.9627 (44.7)**	-	-	-	-
b_{it-1}	-	-	0.4143 (5.80) **	0.6165 (12.4)**	-	-
d_{it-1}	-	-	-	-	0.4851 (8.08)**	0.7548 (15.4)**
u_{it-1}	1.8604 (1.65)*	-0.2191 (-0.864)	0.1731 (0.213)	-0.1853 (-0.838)	0.0503 (1.97)**	0.0123 (0.648)
z_{it}	0.2572 (5.63) **	0.0833 (2.80)**	0.1653 (5.12) **	0.0313 (2.68)**	-0.2038 (-4.47)**	-0.0446 (-1.66)*
vo_{it}	0.1288 (3.62)**	0.0673 (4.78)**	0.0493 (1.82)*	0.0323 (4.83)**	-0.0601 (-1.53)	-0.0308 (-1.94)*
dc_{it}	0.0488 (0.567)	-0.0666 (-2.16)**	0.0952 (1.02)	-0.0489 (-3.03)**	-0.2096 (-1.05)	0.0770 (1.36)
Statistics						
No. of Obv.	333	333	333	333	333	333
R^2	0.9508	-	0.6096	-	-	-
Wald test χ^2	451.8 [0.000]	3000 [0.000]	1676 [0.000]	356.5 [0.026]	176.2 [0.000]	306.3 [0.000]
σ^2	0.0618	0.0865	0.0224	0.0271	0.0907	0.1108
Sargan Test		24.02 [1.000]	-	18.16 [1.000]	-	17.59 [1.000]
AR(1)	-2.000	-0.4053	-0.2918	-0.3382	0.9887	-0.6190

	[0.046]	[0.685]	[0.770]	[0.735]	[0.323]	[0.536]
AR(2)	-1.495 [0.135]	0.8192 [0.413]	-0.6523 [0.514]	0.3347 [0.738]	-0.2534 [0.800]	-0.4112 [0.681]
Instrument Set	-	$u_{it-3\sim}$; $vo_{it-2\sim}$; $p_{it-3\sim}$		$b_{it-3\sim}$; $u_{it-3\sim}$; $vo_{it-2\sim}$	-	$vo_{it-2\sim}$; $u_{it-3\sim}$; $z_{it-2\sim}$; $dy_{it-3\sim}$

Note: 1. t ratios are in parentheses, and p values are in square brackets;

2. All the statistical tests proceed from the estimations are using robust standard errors;

3. Two-step GMM estimators of Arellano and Bond (1991) are applied.

4. * Significance of the individual coefficients at the 10% level;

** Significance of the individual coefficients at the 5% level.

5. Time and country dummies are not reported in the table;

Table 5.5 Stock Price and Economy: Model IV-A and B

	Model IV-A		Model IV-B	
Dep. Price (p_{it})	**LSDV**	**GMM**	**LSDV**	**GMM**
p_{it-1}	0.4161 (9.63)**	0.9465 (46.4)**	0.4399 (10.5)	0.9448 (50.4)**
b_{it}	0.8350 (6.51)**	0.3899 (3.31)**	0.8773 (6.49)**	0.4036 (3.37)**
π'_{it-1}	-0.0493 (-1.13)*	-0.1076 (-5.16)**	-0.0390 (-1.00)	-0.1002 (-4.86)**
q_{it-1}	0.0339 (1.77)*	-0.0037 (-0.199)	0.0390 (2.16)**	-0.0248 (-1.33)
u_{it-1}	1.8692 (1.93)*	-0.5778 (-1.51)	-	-
z_{it}	0.1322 (3.13)**	0.0619 (2.27)**	0.1378 (3.61)**	0.0625 (2.24)**
vo_{it}	0.0855 (2.44)**	0.0536 (2.84)**	0.0767 (2.25)**	0.0425 (1.92)*
dc_{it}	0.0237 (0.303)	-0.1094 (-2.32)**	-0.0339 (-0.341)	-0.1098 (-2.20)**
Statistics				
No. of Obv.	289	289	296	296
R^2	0.9590	-	0.958585	-
Wald test χ^2	606.3 [0.000]	1228 [0.000]	549.5 [0.000]	5260 [0.000]

σ^2	0.0504	0.06816823	0.05066753	0.06911174
Sargan Test	-	18.31 [1.000]	-	15.60 [1.000]
AR(1)	-1.134 [0.257]	-0.2324 [0.816]	-1.043 [0.297]	-0.6073 [0.544]
AR(2)	0.4968 [0.619]	0.2698 [0.787]	-0.7024 [0.482]	-0.6427 [0.520]
Instrument Set	-	p_{it-3} ~ ; b_{it-2} ~; vo_{it-2} ~ ; qr_{it-3} ~	-	p_{it-3} ~ b_{it-3}~; qr_{it-3} ~ ; vo_{it-2} ~

Note: 1. t ratios are in parentheses, and p values are in square brackets;

2. All the statistical tests proceed from the estimations are using robust standard errors;

3. Two-step GMM estimators of Arellano and Bond (1991) are applied.

4. * Significance of the individual coefficients at the 10% level;

** Significance of the individual coefficients at the 5% level.

5. Time and country dummies are not reported in the table.

Chapter 6 Application of the Value Frontier Methodology II: Estimation of Firm-level Bubbles in Developed Markets

The new approach to estimating bubbles enlarges the research area from verifying the existence of bubbles to quantifying bubbles. In this chapter, we apply the value frontier theory and the cost frontier estimation technique to estimate and analyse firm level bubbles. Estimation of bubbles at the firm level requires particular attention to defining fundamental values, since the dividend used as a proxy to capture fundamental values in the estimation of market level bubbles is not sufficient to capture the performance of each individual firm in the estimation of firm level bubbles. Therefore, the major objective of this chapter is to refine the fundamental valuation through a detailed discussion on how to derive variables related to the fundamental value for the firm level study of bubbles. Having refined the model, the firm level data from the U.S. and U.K. markets are employed for the empirical study of bubbles. The bubble level of every single company in the sample is hence measured out.

The arrangement of this chapter is as follows. Section 6.1 is devoted to discussing the framework of the residual income valuation model for the firm level modelling. This is followed by the empirical work for U.S. and U.K. companies in section 6.2, and results are discussed in section 6.3. Section 6.4 is the summary and conclusion.

6.1 Modelling Value Frontier in the Firm level Approach

In the firm level modelling, a key attention is to look for new variables that enable the capture of fundamental value, since the sparse fundamental variable applied in the market level estimation can hardly work out a convincible result in the firm level application. The inspiration comes from the ongoing market-based accounting research (MBAR) which has been dedicated to relating the accounting numbers of a company with its market value. In this section, the residual income valuation framework is partially employed to model the fundamental value not only because of its parsimony, but also for the reason of its accuracy concluded by some empirical researchers, for example, Francis, Olsson and Oswald (2000).

6.1.1 A Critical Review of Residual Income Valuation Model: Feltham-Ohlson Framework (Ohlson, 1995; Feltham and Ohlson, 1995) (F-O Framework) [45]

Ohlson's (1995) model successfully constructs a framework connecting accounting numbers, such as earnings, book value and dividends, with the market values. In this

[45] Residual income is the earnings left after reducing the capital cost. Feltham and Ohlson (1995) devised a valuation model by employing the idea of residual income, and since then the F-O framework has become the foundation of the residual income valuation research. See section 2.2.2 of Chapter 2 for more details.

framework, the following principles are formulated.

Firstly, the accounting data satisfy the clean surplus relation which states that the change in book value equals earnings minus dividends (net of capital contribution);

$$K_t = K_{t-1} + \Pi_t - D_t \tag{6.1}$$

K represents the book value, Π is the earnings and D_t is the real dividend paid in the period of t.

Secondly, a linear model frames the stochastic time-series behaviour of abnormal earnings, i.e. abnormal earnings at the time of t+1 are the linear equation of its one lag plus an information variable which satisfies an autoregressive process. Abnormal earnings (or residual income) are defined as:

$$\hat{\pi}_t = \Pi_t - rK_{t-1} \tag{6.2}$$
$$\hat{\pi}_t = a\hat{\pi}_{t-1} + \upsilon_t + \varepsilon_{1t} \quad 0 \le a < 1 \qquad \upsilon_t = \gamma\upsilon_{t-1} + \varepsilon_{2t} \quad 0 \le \gamma < 1$$

where $\hat{\pi}$ is abnormal earnings; υ represents the information other than the abnormal earnings. r is investor's required rate of return and rK measures the cost of capital. Based on the above assumptions, the model started from a present value of expected dividends (PVED), formally represented as:

$$P_t = \sum_{k=1}^{\infty} \frac{E_t(D_{t+k})}{\prod_{j=1}^{k}(1+i_{t+j})} \tag{6.3}$$

P_t is the stock price in an efficient market, i.e. the fundamental value at the beginning of period t. $\mathrm{E}(\cdot)$ is the market's expectation. i_{t+j} is the discount rate.

When the clean surplus relation is applied (Eq.6.1) in (6.3), and the discount rate is assumed to be constant, the formula of Ohlson (1995) is reached:

$$P_t = \sum_{\tau=1}^{\infty} \frac{\mathrm{E}_t[\Pi_{t+\tau} - rK_{t+\tau-1}]}{(1+i)^{\tau}} + K_t \qquad \textbf{(6.4)}$$

Combining (6.4) and (6.2), (6.4) gives:

$$P_t = K_t + \sum_{\tau=1}^{\infty} \frac{\mathrm{E}_t[\hat{\pi}_{t+\tau}]}{(1+i)^{\tau}} \qquad \textbf{(6.5)}$$

(6.5) is the foundation of the F-O model, which interprets the fundamental value as a function of its book value K adjusted by the present value of anticipated abnormal earnings $\hat{\pi}$. To make the model practical, (6.5) can be conduced with the assumption of (6.2) to:

$$\begin{aligned} P_t &= K_t + \alpha_1 \hat{\pi}_t + \alpha_2 \upsilon_t + \varepsilon_{3t} \\ \alpha_1 &= a/(1-a+r) \geq 0 \\ \alpha_2 &= (r+1)/(1-a+r)(1-\gamma+r) > 0 \end{aligned} \qquad \textbf{(6.6)}$$

A modified version of (6.6) postulates the current abnormal earnings suffice in the prediction of future abnormal earnings, i.e. $\upsilon \equiv 0$.

$$P_t = K_t + \alpha_1 \hat{\pi}_t + \varepsilon_{3t} \qquad \textbf{(6.7)}$$

As demonstrated by Ohlson (1995), this model and its important assumptions satisfy a number of additional, intuitively appealing properties which coincide with the former theories and the intuition about the real world. In fact, the assumption about the less one and non-negative parameter, *a*, reconciles with the economic rule of decay of abnormal earnings. The clean surplus relation wipes off the effects of accounting principles, because the book value and earnings under aggressive accounting are high at present but low in the future, and a conservative accounting method sets the other way round. Therefore, the low/high forecast number offsets the high/low present number.

Ohlson's (1995) residual income model focuses directly on forecasting future abnormal earnings and avoids having to forecast the timing of future dividend payments, i.e. the research focuses on forecasting future abnormal earnings, rather than on forecasting its components, which embodies the notion that dividend policy is irrelevant to the extent that reinvested earnings generate the cost of capital (Dechow et al, 1999b). Dechow et al (1999a) summarised that existing comments about this model broke new ground on two fronts. First, the model predicts and explains stock prices better than the value predicted by models based on discounting short-term forecasts of dividends and cash flows. Secondly, this model provides a more complete valuation approach than the dividend-discounting model. However, at the same time, they pointed out that the existing empirical applications of the residual income valuation model with the omission of Ohlson's information dynamics are generally similar to the application of the dividend-discounting model in the past. Thus, they conveyed an improved empirical method to cover a gap of ignoring information dynamics in empirical applications of the F-O model. They concluded that Ohlson's model provides a parsimonious guiding framework for future valuation research by incorporating information in earnings, book value and earnings forecasts.

From a practical viewpoint, the F-O model is only the first step and not yet a fully developed theoretical framework: “It is only a point of departure, not where near a complete structure, but then, getting off to the right start can be crucial” (Bernard, 1995). Frankel and Lee (1998) used I/B/E/S consensus of earning forecast as a proxy for the market expectation of future earnings. Furthermore, by investigating the reliability of long-term I/B/E/S consensus earning forecasts, they found some evidence of over-optimism in the analysts’ forecast and developed a prediction model for long-term analyst forecast errors.

The F-O model and its inessential transformation have been active for a long time around the forecast. All improvements contribute to the earning forecast so as to estimate the relatively accurate parameters for the use of firm valuation. As many adherents such as Bernard (1995) acknowledged, the F-O framework “leads us away from an emphasis on explaining stock price behavior and towards a focus on predicting future earnings and growth in book value… How observable data are used to form expectations about future abnormal earnings becomes a key step in the research design and, ultimately, the step that distinguishes one study from another.”

6.1.2 Application of the F-O Framework to the Value Frontier Model

To apply (6.5) to the value frontier model, we need to take into account the excess value that results from the irrationality and over-optimistic or irregular expectation of future returns by abstracting a third term of bubbles from the second term in the equation, which makes (6.5) become:

$$P_t = K_t + \sum_{\tau=1}^{\infty} \frac{\hat{\pi}_{t+\tau}}{(1+i)^{\tau}} + B_t = K_t + \sum_{\tau=1}^{\infty} \frac{\left[\Pi_{t+\tau} - rK_{t+\tau-1}\right]}{(1+i)^{\tau}} + B_t \tag{6.8}$$

where B, the so-called “bubble”, captures the excess value to reflect the irrationality, speculation and optimistic responses to the fundamental information K and Π. To make (6.8) estimable, we need to transform the term of abnormal returns to a current value by assuming that the abnormal earnings follow a growth rate g, i.e. $\hat{\pi}_t = (1+g)\hat{\pi}_{t-1}$. Hence, (6.8) becomes:

$$P_t = K_t + (\frac{1+g}{i-g})\Pi_t + r(\frac{1+g}{g-i})K_{t-1} + B_t \qquad \textbf{(6.9)}$$

Set $\lambda = r(\frac{1+g}{g-i})$, (6.9) becomes:

$$\begin{aligned} P_t &= K_t + (\frac{1+g}{i-g})\Pi_t + \lambda K_{t-1} + B_t \\ &= (\frac{1+g}{i-g})\Pi_t + (1+\lambda)K_t - \lambda(K_t - K_{t-1}) + B_t \\ &= (\frac{1+g}{i-g})\Pi_t + (1+\lambda)K_t - \lambda\Delta K_t + B_t \end{aligned} \qquad \textbf{(6.10)}$$

where $\Delta K_t = K_t - K_{t-1}$, the whole term of $[(\frac{1+g}{i-g})\Pi_t + (1+\lambda)K_t - \lambda\Delta K_t]$ represents the fundamental value in (6.10), and any excess value that cannot be explained by the fundamental variables are kept in B which is interpreted as bubbles.

Furthermore, if the risk premium r is considered, and r in (6.9) is replaced with $r_t = i + \beta_t \tilde{R}_t$, where β is a measure of a stock's volatility relative to the overall market and it reflects the risk of a stock, and $\tilde{R}$ is the market risk premium, it then has:

$$P_t = K_t + (\frac{1+g}{i-g})\Pi_t + i(\frac{1+g}{g-i})K_{t-1} + (\frac{1+g}{g-i})\tilde{R}_t\beta_t K_{t-1} + B_t \quad \textbf{(6.11)}$$

Set $\lambda' = i(\frac{1+g}{g-i})$ (6.11) becomes:

$$\begin{aligned} P_t &= K_t + (\frac{1+g}{i-g})\Pi_t + \lambda' K_{t-1} + \lambda' K_t - \lambda' K_t + (\frac{1+g}{g-i})\tilde{R}_t\beta_t K_{t-1} + B_t \\ &= (\frac{1+g}{i-g})\Pi_t + (1+\lambda')K_t - \lambda'(K_t - K_{t-1}) + (\frac{1+g}{g-i})\tilde{R}_t\beta_t K_{t-1} + B_t \\ &= (\frac{1+g}{i-g})\Pi_t + (1+\lambda')K_t - \lambda'\Delta K_t + (\frac{1+g}{g-i})\tilde{R}_t\beta_t K_{t-1} + B_t \end{aligned}$$

(6.12)

where i is the discount rate and it is supposed that the discount rate is a time-invariant non-risk interest rate.

Therefore, by taking into account the investment risk of a stock, we can have two versions of fundamental value P_{it}^f : one is the fundamental value with account of the full risk of investment on stock i at the time t:

$$P_{it}^f = (\frac{1+g}{i-g})\Pi_{it} + (1+\lambda')K_{it} - \lambda'\Delta K_{it} + (\frac{1+g}{g-i})\tilde{R}_t\beta_{it} K_{it-1} \quad \textbf{(6.13)}$$

And another is the fundamental value with only account of the market risk of investment on stock i at the time t, i.e. $\beta = 1$

$$P_{it}^f = (\frac{1+g}{i-g})\Pi_{it} + (1+\lambda')K_{it} - \lambda'\Delta K_{it} + (\frac{1+g}{g-i})\tilde{R}_t K_{it-1} \quad \textbf{(6.14)}$$

6.2 Estimation of Firm Level Bubbles for the United States and the United Kingdom

6.2.1 Models

In Section 6.1.2, the residual income valuation model is extended in the firm level value frontier model. However, it's still necessary to make some adjustments in order to make (6.12) empirically estimable.

First, due to the belief that the investors' expectation to the change in the book value is formed on the basis of information provided in the past, ΔK_{it} is substituted by the change made last year, denoted by ΔK_{it-1}, in the econometric version of the model (6.12) (see 6.16 below). Second, in order to capture the firm-specific characters in the information-revealing process and to ensure the process is identical among the companies in the sample, we introduce firm dummies to control specific effects on the revealing process of each stock. Moreover, we take two approaches to capture the effect of the term $\tilde{R}_t \beta_{it} K_{it-1}$ on the stock price. One is to assume that $\beta_{it} = 1$, so that the term can be simplified to $\tilde{R}_t K_{it-1}$. To avoid the multicollineary problem of K_{it-1} with K_{it} in the estimation, we drop K_{it-1} and further simplify the term of $\tilde{R}_t \beta_{it} K_{it-1}$ to $\tilde{R}_t$. Since $\tilde{R}_t$ is a premium rate at the market level, we can take time or year dummies to capture the market effect of $\tilde{R}_t$ which is common on all stocks at a point of time. Another approach is to control the term of $\tilde{R}_t \beta_{it} K_{it-1}$ in estimation by separating it into two components $\tilde{R}_t$ and $\beta_{it} K_{it-1}$ respectively. $\tilde{R}_t$ is estimated by the year dummies and $\beta_{it} K_{it-1}$ is estimated as a combined new variable. Thus (6.12) becomes model A with the assumption of $\beta_{it} = 1$ and model B with full account of risk effects on the price forming:

Model A:

$$P_{it} = \alpha + D_i + T_t + \gamma_1 K_{it} + \gamma_2 \Pi_{it} + \gamma_3 \Delta K_{it-1} + \varsigma_{it}$$

$$\text{with } \hat{P}_{it}^f = \gamma_1 K_{it} + \gamma_2 \Pi_{it} + \gamma_3 \Delta K_{it-1} \qquad \varsigma_{it} = B_{it} + \varepsilon_{it} \tag{6.15}$$

Model B:

$$P_{it} = \alpha + D_i + T_t + \gamma_1 K_{it} + \gamma_2 \Pi_{it} + \gamma_3 \Delta K_{it-1} + \gamma_4 \beta_{it} K_{it-1} + \varsigma_{it}$$

$$\text{with } \hat{P}_{it}^f = \gamma_1 K_{it} + \gamma_2 \Pi_{it} + \gamma_3 \Delta K_{it-1} + \gamma_4 \beta_{it} K_{it-1} \qquad \varsigma_{it} = B_{it} + \varepsilon_{it} \tag{6.16}$$

where $\hat{P}_{it}^f$ is the proxy of the fundamental value, ε_{it} is the statistical disturbance term with normal distribution of $N \sim (0, \sigma^2)$, D_i is a firm dummy variable capturing the company-specific characters, and T_t represents the time dummy variable to capture all market-specific risks and shocks on all stocks at a particular time.

In order to take a robust check for the model B, the beta value is separated from $\beta_{it} K_{it-1}$ of model B and K_{it-1} is dropped to avoid the collinearity with ΔK_{it-1} and K_{it}. Model C is also achieved:

Model C:

$$P_{it} = \alpha + D_i + T_t + \gamma_1 K_{it} + \gamma_2 \Pi_{it} + \gamma_3 \Delta K_{it-1} + \gamma_4 \beta_{it} + \varsigma_{it}$$

$$\hat{P}_{it}^f = \gamma_1 K_{it} + \gamma_2 \Pi_{it} + \gamma_3 \Delta K_{it-1} + \gamma_4 \beta_{it} \qquad \varsigma_{it} = B_{it} + \varepsilon_{it} \tag{6.17}$$

In (6.15), (1.16) and (6.17), the bubble term is denoted by variable B_{it} with $B_{it} > 0$.

In the estimation, using the cost frontier technique, BI_{it} is estimated on the basis of:

$$BI_{it} = \exp(b_{it}) = \frac{P_{it}}{P_{it}^{f} \cdot \exp(\nu_{it})} \geq 1 \qquad \text{with } b \geq 0 \tag{6.18}$$

P_{it} is defined as $P_{it} = P_{it}^{f} \times \exp(\nu_{it} + b)$ by the frontier technique. Where ν is the random disturbance which is assumed to be independently and identically distributed as N (0, σ^2), empirically, BI_{it} is a bubble index to measure bubbles B_{it} relative to the proxy of fundamental value P^{f} in a sample.

By taking into account both firm and time dummies, (6.18) can be written into a logarithmic form that is:

$$\ln P_{it} = \alpha + A_{i} + Y_{t} + \beta_{1} \ln P_{it}^{f} + b_{it} + \nu_{it} \tag{6.19}$$

6.2.2 Data

In the ongoing studies of companies' valuation, such as Penman (1996), Dechow et al (1998), Frankle and Lee (1998), Dechow et al (1999a,b) and Francis et al (2000), the data utilised includes the CRSP dataset (Center for Research in Security Prices), Compustat and I/B/E/S consensus forecasts. The stock price or return are normally acquired from CRSP, and the historical accounting data, such as annual data of book value of an owner's equity, earnings and dividends are obtained from the Compustat Annual File and Research File. The I/B/E/S database provides the forecast data over a long horizon, such as future earnings or future returns on average equity (ROEs). However, the datasets of Compustat confine the research within North America.

Moreover, it produces more work to match stock market data and accounting data from separate sources. To overcome these problems, the whole dataset applied to our empirical estimation is obtained from Datastream Global Indices List data. The U.S. and U.K. markets are processed respectively. Under the U.S. Datastream Index, 950 domestic listed companies are pooled from 1991 to 2003, and the U.K. sample is composed of 461 British listed companies under the Datastream Index of U.K. from 1995 to 2003. The annual data of prices (P), the book value per share (K) and earnings per share (Π) are employed in the unbalanced panel (see Appendix 6.1 for the definition of variables).

In addition, in order to highlight that the bubble index estimated from our estimation is not identical to the price earning ratio (*PE*) and the price dividend ratio (*PD*), the annual data of *PE* and *PD* of each individual share over the period of 1995 to 2003 are employed to draw the graph together with the estimated bubbles.[46]

For analytical convenience, all the companies in the sample are classified into several sectors. In the U.S. sample, the companies are grouped according to the Dow Jones Global Classification Standard.[47] The U.K. company classification follows the London Stock Exchange sector division.[48]

The beta value is cited from the Datastream monthly data of beta value. The monthly data are transformed into annual data by averaging them year by year, and the

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[46] PE data are provided by Datastream directly, but Datastream doesn't provide the PD data directly. Thus, PD data are calculated from the data of the price and the dividend per share.

[47] There is a four-level classification under Dow Jones Global Classification Standard. The first level is the Economic Sector, the second level is the Market Sector, the third is the Industry Group and the sub-group of the Industry Group is the lowest level (http://www.nyse.com/listed/industry.shtml). Only the first and third levels are listed in Appendix 6.3.

[48] 31 sectors are included in our U.K. sample. Because of the limitation of the sample, some sector samples are too small to reflect the character of their group. I sum up the 31 sectors into 12 which are listed in Appendix 6.3.

average yearly data are applied.

The data applied in this chapter are the firm level sample, so that bubbles of each stock or firm will be estimated using the cost-frontier estimation technique. Therefore, the estimated firm level bubbles will enable us to draw the trend of bubble movement over time in terms of an industry or even a particular company.

6.2.3 A Two-Stage Estimation

In order to be consistent with the non-linear Cobb-Douglas function, which is applied in the empirical estimation, the cost-frontier model used in technical efficiency estimation is a logarithmic linear model. One problem in using (6.19) to estimate b_{it} is that the value frontier function P^f is linearly defined in (6.15), (6.16) and (6.17), which makes it inapplicable to estimate (6.19) directly. In order to solve this problem, this study sets two stages of estimation. At the first stage, the proxy of fundamental value $\hat{P}^f$ is estimated by running a panel regression on the basis of models A, B and C respectively. The second stage is to replace P^f with the proxy of fundamental value $\widehat{P}^f$ which is predicted from models A, B or C.

The crux of the two-stage method is that the value of $\widehat{P}^f$ is composed of estimated parameters of independent variables, which are estimated from the first stage regressions. The relatively big difference between the observed price and the proxy of fundamental value $\widehat{P}^f$ allows us to detect the bubbles at the second stage of estimation.

Based on the two-stage value frontier estimation method above, at the first stage, the basic tests for panel data are employed to acquire the unbiased coefficients from the prediction. Since firm dummies in models have their meaning with the descriptions of firm-specific characters, it must exist in each regression. Consequently, to some extent, the choice between the fixed and random effect loses its function, as each regression with firm dummies can be treated as fixed effects. However, the significant result from the hausman test is still expected to validate the fixed effect model. The effort is mainly put on the test and correction of the group-wise heteroskedasticity and the autocorrelation within the panel. The final decision is located on the GLS with the assumption of AR (1) error.

6.2.4 Results of Estimation

At the first stage, the significant results of the Breusch-Pagan test and the Modified DW test show the problems of heteroskedasticity and autocorrelation (see tables 6.1-A and 6.2-A). In order to get unbiased coefficients, a GLS regression with the assumption of AR (1), which controls heteroskedasticity, and autocorrelation, is pursued. It is easy to see from the results shown in Table 6.1-A and 6.2-A, that the coefficients and standard errors do not change significantly among the three models after correcting the two problems of the error.

[Table 6.1-A and 6.2-A are about here]

In the U.K., the marginal effect of earnings on a stock price is around 0.7429, which is less than 1.1366 of the U.S. However, the marginal effect of the book value of equity on the price is similar between the U.S. and the U.K and is 0.7459 and 0.7256 respectively. In addition, the coefficient of earnings in the U.S. is 1.1366, which is far bigger than 0.7459 of the book value variable. Therefore, loosely speaking, in the U.S. market, the stock price is less sensitive in response to the book value and keener to react to the information of earnings than in the U.K. market. This finding is consistent with the result of Dechow et al (1998), in which the asymmetric effect of the book value and earnings on the stock price is 0.4 and 3.88 respectively in the US market.

In our first stage of the estimation, attention is drawn to the risk premium variable. In Table 6.1-A and 6.2-A, the coefficients of beta value are negatively associated with stock prices, which can be explained from the standpoints of fundamental values and bubbles. First, from the viewpoint of bubbles, the negative effect of risk on stock prices can be explained by Easton and Zmijewski's (1989) opinion. They addressed the fact that greater risk implies a larger discount rate which reduces the discounted present value of the revisions in expected future earnings. To the extent of stock bubbles, the reduced expectation on the fundamental element, earnings, will shrink bubbles. Second, the risk can influence fundamental values by changing the cost of capital. A higher risk means more capital cost, which reduces the abnormal earnings of a company so as to diminish the fundamental value. Therefore, the risk can negatively influence stock prices by restoring fundamental values and bubbles.

The first stage estimation is just a half of the estimation, and the frontier technique is then employed to complete the final estimation. Tables 6.1.-B and 6.2.-B list the second stage results of the U.K. and the U.S. respectively. The frontier technique intriguingly measures the relative values of the estimated bubbles that enable us to pursue through further analysis.

[Table 6.1-B and 6.2-B are about here]

Before analyzing the bubble movement, one question appearing is that between model A and model B, which one will bring us a more robust result? The original residual income valuation model is introduced with an assumption of risk neutral investors, and therefore, the risk premium is ignored in the model. However, in the value frontier model, the risk-neutral assumption for investors is relaxed. Moreover, the fact that risk premiums that compensate for risk is a core concern. However, graphs exhibited in Figure 6.1 imply no significant distinction between models A and B, though there is a short inconsistency in the U.K. graph in 2000. The support also comes from the sector figures. In the graphs under Figure 6.4, the bubble movements estimated from models A, B and C are highly consistent. This means that taking into account the risk in the modelling does not substantially affect the result of bubble movement.

[Figure 6.1 and 6.4 are about here]

One robust check is made by employing the results of the market level bubble. Certainly, due to the statistical bias, the inconsistency is acceptable when the averaged firm level results are compared with the market level ones. However, the deviation between them is still expected to be minor. Comparing Figure 6.1 with 6.3, our confidence is located on model A, since the moving path of the firm level bubble from model A is most similar to the market level figures in both of the U.K. and the U.S. market. Thus, the estimated bubbles from model A are employed to show bubble movements over time across industrial sectors.

[Figure 6.3 is about here]

In addition, it's possible to make a further comparison between the bubble path and the price tendency so as to enforce the argument that the estimated values of bubbles are different from stock prices in terms of their moving trends. The comparison of the estimated bubbles with actual prices is presented in Figure 6.5 for every industrial sector. It is easy to see that bubble figures may move with the price sometimes, but appear independent movements often, which proves that estimated values of bubbles are not identical to stock prices.[49]

[49] The estimated values of bubbles used are from model B.

[Figure 6.5 is about here]

In order to highlight the fact that the estimated bubble is not identical to the price/earnings ratio and the price/dividend ratio which have been marking the stock overpricing, these two groups of values are concerned jointly with the estimated bubble on the graph. In Figure 6.2, obviously, the estimated bubbles are independent of the PE and PD. It is worth noting that the same sample is used for all three variables in the plots to ensure a uniform comparison. In pursuit of this aim, this study suffers the loss of all observations with a zero-dividend value which in turn causes a bias in bubble graph plots. However, it is important to note that the aim of this comparison is to investigate the co-movement of bubbles with either the PE or PD and not the movements of the bubble itself.

[Figure 6.2 is about here]

6.3 Interpretation of the Bubble Movement in the U.S. and the U.K. Markets

Our examination of bubbles starts from plotting the bubble index over time for the U.S. and the U.K. markets. However, it is too cumbersome to do graph plots for every single company in these two markets. Instead, all the sample companies have been grouped in their corresponding industrial sectors. In Figure 6.6, the level of bubbles in each industrial sector is plotted against the mean of estimated bubbles of all sample companies.

[Figure 6.6 is about here]

6.3.1 The U.K. Market

In Figure 6.6 and Table 6.3-A, the average bubble of the U.K. market is quite stable over time which is almost 30% above the fundamental value. We are concerned that the light fluctuation of average bubbles in the UK market attributes to a stable economic growth, a relative high inflation and a large number of institutional investors.

[Table 6.3-A is about here]

Through the second half of the 1990s, the UK economy (as measured by GDP) has grown at around 2.5% per annum, and over the half century from 1949 to 1999, income per capita rose by approximately 2% per annum. Compared with the "boom-recession-boom" between the end of the 1980s and the beginning of the 1990s, the UK economy over the period of 1995 to 2003 was relatively steady, while during this period, most other developed countries were achieving faster growth than the UK (Sawyer, 2001). This stable and sustainable macro economy supports a lesser variation in expectation of the stock value, which gives rise to a stable bubble path.

Meanwhile, the relative high inflation rate is another reason for the low level of bubbles. Over the period of 1989 to 1999, the average annual inflation rate in UK is 4.1% which is higher than 3.2% of the US and around 2% of most other developed markets. As demonstrated in Chapter 5, inflation negatively affects stock bubbles by reducing the investors' expectation of the economic fundamental value and raising the risk aversion of investors. The high inflation in the UK economy helped to form a relatively low level of bubbles. After 1999, the inflation rates are often under 3%,[50] and a slight increase of bubbles can be accordingly observed in Figure 6.1.

In addition, the institutional investors, such as pension funds, life insurance companies and mutual funds, dominate the UK stock market. In the UK, the institutional intermediation ratio reached 0.40 in 1998, i.e. the institutional investors'

[50] Source: Sawyer (2001)

share of intermediation is 40%. The value of institutional assets (life insurance, pension funds and mutual funds) in 1998 is indicated to be 2,742 billion US dollars which is 197% of GDP.[51] Davis and Steil (2001) mentioned that institutional investors have a major influence on the behaviour of capital markets, because institutional investors may be more diversified and have a lower risk aversion in their investment than households would. Also, according to Merton and Bodie (1995), one of the key functions of institutional investors is to manage uncertainty and control risk. Thus, by setting up a portfolio to diversify risk, a large number of institutional investors keep the average bubble fluctuating lightly in the UK market.

In contrast to the market average bubble, sector bubbles have shown their fluctuation around the market average line (Figure 6.6). Our attention will mainly focus on the sectors of manufacturing, financial services, telecommunication and energy, since the structure of the British economy has been changing over time and the changes of these sectors are most apparent.

Sawyer (2001) reported that the share of manufacturing in total output in the UK is declining, though the absolute amount of it continues to rise. The British economy has a more pronounced decline in the relative importance of manufacturing than many other industrialised economies.[52] The decline of manufacturing occurs with an increase of services, especially financial services which have increased substantially from 1.69% of total consumers' expenditure in 1970 to 4.09% in 1998. This rapid growth was more apparent during the 1990s. Thus, Sawyer (2001) concluded that the British economy is now largely a service economy. In Figure 6.6, bubbles in the sectors of engineering and electronics show the declining trends, and, in contrast, the bubble in the financial sector keeps going upward most years and remains higher

[51] Source: Davis and Steil (2001)

[52] 'Manufacturing' is a broad category of output covering production of textiles, wood and metal products, paper, plastics, rubber, electricals, vehicles, machinery and equipment, and a host of other produced goods (Sawyer, 2001).

than the average level of bubbles since 2000. Obviously, these findings are consistent with the common argument that investors' expectation will be variable according to the changes in fundamental values.

In Figure 6.6, there is an extraordinary bubble movement in telecommunication and technology, which climbed sharply over the period of 1997 to 2000, and dropped afterwards. In 2002, the bubble of this sector was shown to be lower than the average level of the market. Obviously, this trend followed the dot-com fad in the US market. The technology, media and telecoms were three magic words to excite every investor's heart before the end of the 1990s.[53] However, with the crash of NASDAQ, the UK stock market was turned from a boom to a tremendous decline after 2000.

Bubbles of the energy sector have been shown with a growing tendency since 1999 and a more rapid increase occurs in 2002. Indeed, in 1999 and 2000 with rising world demand and some restriction of OPEC output, oil prices rose sharply. The bubble graph of the energy sector appropriately reflects a higher expectation of a rise in world demand, particularly by Asian economies, such as China, for the international supply of energies, such as oil.

6.3.2 The U.S. Market

In Figure 6.6 and Table 6.3-B, bubbles in the US market fluctuate periodically before 1997 and a constant increase of bubbles is shown between 1997 and 2000. The bubble burst at 2000 and keep at a low level afterwards. The market average line of bubbles reflects the American economic changes in the whole 1990s and the early 2000s. As a result of successive interest reduction, the American economy turned up a slow recovery in the early 1990s, and after 1993, the economy began to experience robust growth. However, after 1997, the gain of dramatically increased productivity

[53] Source: 'Is the dot.com bubble bursting? (a report of BBC News , 11 April, 2000)

caused by the improved technology was offset by the reduced profitability due to the excess supply. The “New Economy” built on a technology-boost productivity revolution stirred up the optimistic expectation of the economy. However, “…productivity can have very little to do with profits…”[54] Therefore, bubbles were inflated by the high expectation of the “productivity miracle” with a descending profitability. The final crash of TMTs (Technology, Media and Telecommunication companies) happened in 2000. Mahar (2003) name 1997 the year of the turning point for profits. From Figure 6.1, bubbles started to increase in 1997, which perfectly reflected the reduction of profits in the real world; i.e. the profit of companies fell which led to a shrinking of the fundamental value to inflate bubbles.

The changes in the American economy are achieved by the common development in its industrial sectors, such as the manufacturing sector (such as the industrial sector, consumer, and telecommunication and technology), service sectors (such as the financial sector and investment products) and other non-manufacturing industrial sectors (such as utilities and energy etc.). Bubble movements in sectors can also be detected in Figure 6.6.

The American economy was mainly driven by the performance of the manufacturing sector in the 1990s. Brenner (2002) reported that, in the early 1990s, a major increase in US international competitiveness and a dramatically increased orientation of the US manufacturing sector toward exports was thereby facilitated, which enabled US manufacturers to launch an extended and decisive process of profitability recovery and the economy as a whole expanded with it. From the fourth quarter of 1993 through 1997, the investment jumped ahead at an average annual pace of 9.5 per cent, which opened the way to the growth in manufacturing output and productivity, averaging 5.7 and 4.4 per cent per annum respectively, and an average of 33 per cent increase of manufacturing profit rate. However, profit rates of manufacturers

[54] Said by Jeremy Grantham, the Boston-based money manager. Source: Mahar, 2003

remained flat in both 1996 and 1997 due to their reduced export prices caused by the ascending dollar. In addition, over-capacity in international manufacturing at that time worsened the profitability further. In terms of manufacturing profitability, Brenner (2002) define 1997 as a peak year for the 1990s' economic recovery in US. After that, the real increase in the manufacturing profit rate was replaced by the "miracle" of productivity achieved by the huge investment in technology. The bubble in the sector of high-tech manufacturing, such as the internet and computers, dramatically ran up, since the excess capacity made supply swamp demand which in turn devastated profits. The dramatic performance of the American manufacturing sector is reflected in the sector-level graphs of the estimated bubble. In Figure 6.6, the sector of consumer (cyclical and non-cyclical) and industry perform in the low-bubble position. Their bubbles are moving on or below the average line in the most of the observed years. Before 1997, bubbles in these three sectors all kept moving downwards, but experienced sharp increases in 1997, which reflects the manufacturing recovery in the first half of the 1990s and the decreasing profitability after the profit turning point of 1997. The sector of high-tech manufacture (the telecommunication and technology) shows a sharp increase over the period of 1997 to 2000, which perfectly reflects the delusive boom in the era of the "New Economy".

Unlike the manufacturing sector, the non-manufacturing sector had been undergoing a steady increase in productivity and profitability since 1970s. However, the rapid growth occurred after 1995 with a further 17.5 per cent increase of profits during the next two years.[55] The steadily ascending profits gave rise to a sound explanation of the constant declining bubbles in the sector of utilities and energy in Figure 6.6: fattened fundamental values swamped the price increase so shrinking the level of bubbles.

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[55] Source: Brenner (2002)

The financial sector had a parallel growth with the real economy. The reduction in the short-term interest rate at the beginning of the 1990s enabled banks to win an extra gain from the gap between the short-term borrowing and the long-term lending. Consequently, during the 1990s, US commercial banks achieved their highest rates of return on equity and assets in the post-war era, and the financial sector profits were higher than at any pervious time in post-war history (Brenner, 2002). In Figure 6.5, the bubble in the financial sector reached its peak in 1998 and dropped back to a low in 2000. This tendency was obviously achieved by the faster increase of fundamental values relative to the stock price in the financial sector during the period of "bull".

6.3.3 Summary

Table 6.3 and Figure 6.6 show that the market average bubble remains about 30% and 40% above the fundamental value in the UK and the US market during the period of observation. This reveals a movement of bubbles that is more stable at the market level than the industry level.

Since the industry-level graphs of estimated bubbles (Figure 6.6) exhibit higher volatility than market average plots (Figure 6.1), this enables us to further examine the origin of bubbles in link with the performance of individual economic sectors during a certain period of time. In this section, bubbles in two developed markets, the US and the UK markets, are interpreted at the industry-level by their respective economic activities, since the economic performance is the trigger to stir up (or break down) investors' expectation and fundamental values so as to drive the movement of stock bubbles. This close relationship between stock bubbles and economic performances is soundly summarised by Brenner (2002): "the boom thus opens the way to the bubble; the bubble blows up the boom a good deal further; and the explosion of the bubble under its own pressure ultimately put an end to the boom."

6.4 Summary and Conclusion

Based on the value frontier theory, the study makes a breakthrough by identifying bubbles at the firm level at a point in time. Moreover, it is concerned that the lesser volatility of market level bubbles may be a reason of the failure in testing the existence of bubbles in current researches. To this extent, a deeper level study of stock bubbles at the firm level is in a priority which can bring more evidence in support of the argument that bubbles persist in stock markets. Thus, compared with the market level study in a previous chapter, the firm level estimation is much more comprehensive and interesting.

This chapter identified bubbles of every single sample company over the period of 1991 to 2003 in the U.S. market, and 1995 to 2003 in the U.K. market, which enables us to draw a movement of bubbles over time in terms of each industrial sector or a company. There are two progresses obtained in the estimation of this chapter. Firstly, in the value frontier modeling, a well-acknowledged accounting model, F-O model, is utilised to construct the fundamental valuation model. It is concerned that the F-O model is superior to other fundamental valuation models in the value frontier modeling in that its starting point is the dividend discount model which is exactly the valuation model used in our market level modeling. This guarantees a consistency for the value frontier modeling between the market level and the firm level estimation. Furthermore, in the F-O model, several accounting variables rather than a single fundamental variable of dividends are employed, which enables us to give a more comprehensive and in-depth view on the fundamental valuation at the firm level. Secondly, to make the value frontier model of (6.19) applicable for the estimation of bubbles, we design a two-stage procedure for the value frontier estimation. This trial provides us with more degrees of freedom to build the fundamental valuation structure in the future, i.e. the fundamental valuation structure is not necessarily a non-linear function, instead it is allowed to be a linear approach. In summary, the important contribution of this chapter not only relies on its empirical findings, but also on its innovative estimation method to identify firm level bubbles, which is a significant breakthrough for the methodology of bubble studies.

However, it is worth highlighting a significant limitation in the newly developed two-stage estimation procedure, which is that any biases in parameters estimated from the first stage estimation will affect the frontier value and so the bubble results. Thus, an extra effort should be put on the justification for the first step estimation. The veracity of the estimated parameters is a weak part which is most likely to be challenged.

In the next chapter, we will extend our new approach to estimate bubbles of China's listed companies, which operate in a closed emerging market when compared with the U.K. and U.S. market that are open and mature.

Appendices

Appendix 6.1 Definition of Datastream Global Indices List Data

Book Value Per Share (K) represents the book value of equity (proportioned common equity divided by outstanding shares) at the company's fiscal year end for non-U.S. corporations and at the end of the last calendar quarter for U.S. corporations.

Preference stock has been included in equity and the calculation of book value per share where it participates with common/ordinary shares in the profits of the company. It is excluded in all other cases, deducted at liquidation value for U.S. companies and at par value for all others. For U.S. corporations, common and common equivalent and fully diluted book values are shown, when available.

For companies with more than one type of common/ordinary share, the book value is based on combined shares adjusted for the par value of the share type identified in field 06005-Type of Share (Datastream).

Earnings Per Share (*V*) represents the earnings for the 12months ended the last calendar quarter of the year for U.S. corporations and the fiscal year for non-U.S. corporations. It is as reported by the company.

Preference stock has been included in the share base where it participates with the common/ordinary shares in the profits of the company.

United Kingdom represents profit after tax, minority interest, and preferred dividends (except where preferred is included in share base), generally including pretax extraordinary items. United Kingdom earnings per share exclude extraordinary items prior to 1993. However with the adoption of FRS3 they are now included.Where corporation tax is not reported it has been estimated. U.S. bases earning per share on profit after tax, minority interest and preferred dividends, but before extraordinary items.

For companies with more than one type of common/ordinary share, earnings per share are based on combined shares adjusted to reflect the par value of the share type identified in field 06005-Type of Share (Datastream).

Prices (*P*) are generally based on 'last trade' or an official price fix from the main exchange.

U.K.**:** For shares traded on the London Stock Exchange's electronic trading system

(SETS), the default price, as of the introduction of SETS on 20/10/97, is the last automated trade generated from the order book. From 31/12/98 the closing price generated by SETS is a volume-weighted average derived from all automated trades in the 10 minutes before market close. For shares not traded on the electronic trading system, the default price continues to be the mid of the closing bid and ask prices generated from the exchange's automatic quotation system.

U.S.: For listed US shares prices are "composite" in that they reflect the last trade on either the New York or American exchanges or one of five other main regional exchanges. The average of closing bid and ask quotations is used when a stock does not trade.

Price/earnings ratio (*P/E*) is the price divided by the earnings rate per share at the required date.

Price/dividend ratio (*P/D*) is the price divided by the dividend per share at the required date. Dividend per share is rolling 12 month dividend per share.

Datastream beta calculations (β) The derivation of Datastream betas is based on the method described in 'Predictability of British Stock Market prices' by S. Cunningham, Journal of Royal Statistical Society Series C (1973).

Note

For the purpose of this explanation, exceptional conditions (such as stocks traded for less than 2½, large price changes and so on) are ignored.

This method assumes that movements in the market and in an individual equity are inter-related and that the relationship is of the form:

$y = \alpha x^{\beta}$

Where y = movement in equity (price)

x = movement in market (index)

The calculation can be broken up into three stages:

Step1

The four-weekly prices for the past 58 months are converted to a series of logarithmic

index changes, using the following formula for each stock:

$$[\log \frac{price_{(i+1)}}{price_i}]$$

Similarly, the four-weekly price indices are converted for each market. These values are used in the calculations described in Step 2.

Step 2

For each equity, the alpha and beta coefficients α and β are calculated as follows:

$$\beta_E = \frac{(N\sum EM - \sum E \sum M)}{N\sum M^2 - (\sum M)^2}$$

$$\alpha_E = \frac{(\sum E - \beta_E \sum M)}{N}$$

Variance of $\alpha_E = \frac{1}{N-1}[\sum E^2 - \frac{(\sum E)^2}{N}]$

Variance of $\beta_E = \frac{[\sum (E - \alpha_E - M\beta_E)]^2}{(N-1)\sum M^2 - (\sum M)^2}$

The average alpha and beta for the markets are derived as the sum of equity values over the number of equities, and the variance of the market beta can then be calculated thus:

Variance of $\beta_M = \frac{\sum \beta_E^2}{N-1} - (\sum \beta_E)^2 - \frac{\sum Var.\beta_E}{N}$

Where E = logarithmic index change for a stock

M = logarithmic index change for a market

N = number of periods -1

Step 3

Finally, the estimator, forecast beta and correlation are calculated for each stock:

$$\beta_{est} = \beta_M + \frac{[\sum M(\alpha_E - \alpha_M) + \sum M^2(\beta_E - \beta_M)][(N-2)Var.\beta_M + \sum M^2]}{Var.\alpha_E[(N-1)\sum M^2 - (\sum M)^2]}$$

Appendix 6.2 The Cross-section Frontier Technique- Normal-Truncated Normal Distribution [56]

The normal-truncated normal formulation was introduced by Stevenson (1980). Under the assumption of normal-truncated normal distribution, the stochastic production frontier model can be describe

$$y = \alpha + \beta x + v - u \qquad u > 0 \qquad (1)$$

(i) v ~ iid $N(0, \sigma_v^2)$

(ii) u ~ iid $N^+(\mu, \sigma_\mu^2)$

(iii) u and v are distributed independently of each other, and of the regressors.

[56] Appendix 6.2 is abstracted from “Stochastic Frontier Analysis” by Kumbhakar and Lovell, 2000

where v is the two-sided "noise" component, and u is the nonnegative technical inefficiency component of the error term.

A maximum likelihood method is used to estimate three parameters: σ_u, σ_v and μ. There is a two-step procedure, in which the first step involves the use of OLS to estimate the slope parameters, and the second step involves the use of maximum likelihood to estimate the intercept parameters and the variances of the two error components. The distributional assumption is used in the maximum likelihood estimation, which is the second step of the two-step procedure.

The truncated normal distribution assumed for u generalizes the one-parameter half normal distribution, by allowing the normal distribution, which is truncated below at zero, to have a non zero mode.

The density function of v is

$$f(v) = \frac{1}{\sqrt{2\pi}\sigma_v} \cdot \exp\left\{-\frac{v^2}{2\sigma_v^2}\right\} \tag{2}$$

The truncated normal density function for $u \geq 0$ is given by

$$f(u) = \frac{1}{\sqrt{2\pi}\sigma_u \Phi(\mu/\sigma_u)} \cdot \exp\left\{-\frac{(u-\mu)^2}{2\sigma_u^2}\right\} \tag{3}$$

where μ is the mode of the normal distribution, which is truncated below at zero, and $\Phi(\cdot)$ is the standard normal cumulative distribution function. Thus $f(u)$ is the density of a normally distributed variable with possibly non zero mean μ, truncated below at zero.

The joint density function of u and v is the product of their individual density functions, and can be written

$$f(u,v)=\frac{1}{2\pi\sigma_u\sigma_v\Phi(\mu/\sigma_u)}\cdot\exp\left\{-\frac{(u-\mu)^2}{2\sigma_u^2}-\frac{v^2}{2\sigma_v^2}\right\} \tag{4}$$

The joint density of u and ε is

$$f(u,\varepsilon)=\frac{1}{2\pi\sigma_u\sigma_v\Phi(\mu/\sigma_u)}\cdot\exp\left\{-\frac{(u-\mu)^2}{2\sigma_u^2}-\frac{(\varepsilon+u)^2}{2\sigma_v^2}\right\} \tag{5}$$

where ε is the composed error, which is $v+u$

The marginal density of ε is

$$\begin{aligned} f(\varepsilon)&=\int_0^\infty f(u,\varepsilon)du \\ &=\frac{1}{\sqrt{2\pi}\sigma\Phi(\mu/\sigma_u)}\cdot\Phi\left(\frac{\mu}{\sigma\lambda}-\frac{\varepsilon\lambda}{\sigma}\right)\cdot\exp\left\{-\frac{(\varepsilon+\mu)^2}{2\sigma^2}\right\} \\ &=\frac{1}{\sigma}\cdot\phi\left(\frac{\varepsilon+\mu}{\sigma}\right)\cdot\Phi\left(\frac{\mu}{\sigma\lambda}-\frac{\varepsilon\lambda}{\sigma}\right)\cdot\left[\Phi\left(\frac{\mu}{\sigma_u}\right)\right]^{-1} \end{aligned} \tag{6}$$

where $\sigma=(\sigma_u^2+\sigma_v^2)^{1/2}$, $\lambda=\sigma_u/\sigma_v$, and $\phi(\cdot)$ is the standard normal density function.

$f(\varepsilon)$ is asymmetrically distributed, with mean and variance

$$\mathrm{E}(\varepsilon)=-\mathrm{E}(u)=-\frac{\mu a}{2}-\frac{\sigma_u a}{\sqrt{2\pi}}\cdot\exp\left\{-\frac{1}{2}\left(\frac{\mu}{\sigma_u}\right)^2\right\} \tag{7}$$

$$V(\varepsilon)=\mu^2\frac{a}{2}\left(1-\frac{a}{2}\right)+\frac{a}{2}\left(\frac{\pi-a}{\pi}\right)\sigma_u^2+\sigma_v^2 \tag{8}$$

respectively, where $a=[\Phi(\mu/\sigma_u)]^{-1}$

The log likelihood function for a sample of I is

$$\ln L = \text{constant} - I\ln\sigma - I\ln\Phi\left(\frac{\mu}{\sigma_u}\right) + \sum_i \ln\Phi\left(\frac{\mu}{\sigma\lambda} - \frac{\varepsilon_i\lambda}{\sigma}\right) - \frac{1}{2}\sum_i\left(\frac{\varepsilon_i + \mu}{\sigma}\right)^2 \quad (9)$$

where $\sigma_u = \lambda\sigma/\sqrt{1+\lambda^2}$. The log likelihood function can be maximized with respect to the parameters to obtain maximum likelihood estimates of all of the parameters.

The conditional distribution $f(u|\varepsilon)$ is given by

$$f(u|\varepsilon) = \frac{f(u,\varepsilon)}{f(\varepsilon)} = \frac{1}{\sqrt{2\pi}\sigma_*[1-\Phi(-\tilde{\mu}/\sigma_*)]}\cdot\exp\left\{-\frac{(u-\tilde{\mu})^2}{2\sigma_*^2}\right\} \quad (10)$$

$f(u|\varepsilon)$ is distributed as $N^+(\tilde{\mu}_i, \sigma_*^2)$, where $\tilde{\mu}_i = (-\sigma_u^2\varepsilon_i + \mu\sigma_v^2)/\sigma^2$ and $\sigma_*^2 = \sigma_u^2\sigma_v^2/\sigma^2$. Thus either the mean or the mode of $f(u|\varepsilon)$ can be used to estimate the technical efficiency, and we have

$$E(u_i|\varepsilon_i) = \sigma_*\left[\frac{\tilde{\mu}_i}{\sigma_*} + \frac{\phi(\tilde{\mu}_i/\sigma_*)}{1-\Phi(-\tilde{\mu}_i/\sigma_*)}\right] \quad (11)$$

and

$$M(u_i|\varepsilon_i) = \begin{cases} \tilde{\mu}_i & \textit{if} \quad \tilde{\mu}_i \geq 0 \\ 0 & \textit{otherwise} \end{cases} \quad (12)$$

Point estimates of the technical efficiency of each producer can be obtained by substituting either $E(u_i|\varepsilon_i)$ or $M(u_i|\varepsilon_i)$ into following Eq.

$$\begin{aligned} TE &= E(\exp\{-u_i\}|\varepsilon_i) \\ &= \frac{1-\Phi[\sigma_* - (\tilde{\mu}_i/\sigma_*)]}{1-\Phi(-\tilde{\mu}_i/\sigma_*)}\cdot\exp\left\{-\tilde{\mu}_i + \frac{1}{2}\sigma_*^2\right\} \end{aligned} \quad (13)$$

Appendix 6.3 Sector Code

The U.K. Market

1	Financial	Banks	5	Entertainment	Leisure Entertainment & Hotel
		Life Assurance			Media & Photography
		Insurance	6	Construction	Real Estate
		Investment Companies			Construction & Building Materials
		Specialty & Other Finance	7	Electronics	Electronic & Electrical Equipment
2	Engineering	Aerospace & Defense			Household Goods and Textile-Consumer Electronics
		Automobiles & Parts	8	Healthcare	Health
		Engineering			Pharmaceuticals
3	Food and Tobacco	Beverages			Chemicals
		Food & Drug Retailers	9	Support Service	Support Service
		Food Producers & Processors	10	General Retailer	General Retailer
		Tobacco	11	Transport	Transport
4	Energy	Electricity	12	Telecommunication	Information Technology Hardware
		Mining			Software & Computer Service
		Oil & Gas			Telecommunication Services
		Utilities Others			

The U.S. Market

1	Basic Materials	Forest Products&Paper			Aerospace
		Mining&Metals			Containers&Packaging
		Chemicals			Electric Components&Equipment
2	Consumer, Cyclical	Auto Parts&Tires			Industrial,Diversified
		Automobile Manufacturers			Industrial Equipment
		Airlines			Advanced Industrial Equipment
		Leisure Goods &Services			General Industrial Services
		Home Construction &Furnishings			Industrial Transportation
		Textiles&Apparel	7	Investment Products	Investment Products
		Advertising	8	Consumer, Non-Cyclical	Beverage
		Broadcasting			Consumer Services
		Entertainment			Food Retailers&Wholesalers
		Publishing			Household Products
		Retail			Tabacco
3	Energy	Energy			Food
4	Financial	Banks			Cosmetics
		Diversified Financial	9	Technology	Software
		Real Estate			Technology Services
		Securities Brokers			Communications Technology
		Insurance			Semiconductors
5	Healthcare	Biotechnology			Technology Hardware&Equipment
		Pharmaceuticals	10	Telecommunications	Wireless Communications
		Healthcare Providers			Fixed-Line Communications
		Medical Products	11	Utilities	Electric Utilities
6	Industrial	Building Materials			Gas Utilities
		Heavy Construction			Water Utilities

Tables and Figures

Table 6.1 Firm-level Estimation of Bubbles: the U.K. Market

A. The First Stage Estimation: Estimating Fundamental Values

Dependent Var. P	**Model A**	**Model B**	**Model C**
Independent Var.			
Intercept	1.2418 (1.37)	1.4231 (1.56)	1.5797 (1.73)
Π_{it}	0.7429 (5.85)	0.7043 (5.50)	0.6779 (5.32)
K_{it}	0.7256 (16.77)	0.7544 (16.74)	0.7312 (16.41)
ΔK_{it-1}	0.2237 (5.33)	0.2514 (5.76)	0.2138 (5.01)
$\beta_{it}K_{it-1}$	-	-0.0867 (-2.28)	-
β_{it}	-		-0.4609 (-4.55)
Statistics of Estimations			
Numbers of Obv.	3162	3162	3047
R^2 within between	0.3120 0.9965	0.3118 0.9965	0.3025 0.9963

overall	0.8147	0.8147	0.8122
$F_{0.05}$ statistics H_0: non of T_t influence P	33.8865 c.v.1.94	34.0656 c.v.1.94	32.5336 c.v.1.94
Wald Test χ^2	5501.02 [0.0000]	5491.80 [0.0000]	5233.82 [0.0000]
AR1	0.4457	0.4473	0.4513
σ_e	1.2261	1.2250	1.2211
Statistical Tests			
Hausman Test χ^2 H0: Random Effects	184.77 [0.0000]	233.73 [0.0000]	240.02 [0.0000]
Breusch-Pagan/Cook-Weisberg Test for Heteroskedasticity χ^2 H0: Constant Variance	14558.54 [0.0000]	14425.94 [0.0000]	13989.16 [0.0000]
Modified Bhargava DW	1.1591	1.1575	1.1550
Baltagi-Wu LBI	1.4892	1.4871	1.4780

Note: 1. t ratios are in parentheses, and p values are in square brackets;
2. R^2 values reported in the table are correlations squared which are from the second –round regression $p_{it} = \gamma \hat{p}_{it}$;
3. Firm and time dummies are not reported in the table;
4. All the statistical tests proceed from the estimation before controlling autocorrelation and heteroskedasticity.

B. Second Stage Estimation of Rational Bubbles Using the Frontier Model

Dependent Var. $p = \ln P$	**Predicted Fundamental Value from Model A**	**Predicted Fundamental Value from Model B**	**Predicted Fundamental Value from Model C**
Independent Var.			
Intercept	0.3681 (2.43)	0.5791 (4.19)	0.8823 (7.89)
$\hat{p} = \ln \hat{P}^{\mathbf{f}}$	0.5672 (18.96)	0.4105 (30.74)	0.3325 (23.52)
T_{1996}	0.0754 (2.63)	0.2468 (9.67)	0.1644 (6.65)
T_{1997}	0.1161 (3.90)	0.3156 (12.10)	0.1892 (7.60)
T_{1998}	0.1391 (4.26)	0.4693 (18.14)	0.3402 (13.63)
T_{1999}	0.1426 (4.43)	0.3847 (14.78)	0.2435 (9.69)
T_{2000}	0.1130 (3.57)	0.3101 (11.98)	0.1211 (4.81)
T_{2001}	0.1613 (4.82)	0.4453 (17.22)	0.2827 (11.09)
T_{2002}	0.1697 (5.10)	0.4591 (17.82)	0.3581 (14.19)
T_{2003}	0.0748 (2.46)	0.0910 (3.21)	0.0362 (1.32)

Statistics of Estimations			
Number of Obsv.	3019	3071	2275
Wald Test χ^2	13091.13 [0.0000]	18628.43 [0.0000]	13878.5 [0.0000]
$\lambda = \sigma_b / \sigma_v$	1.3662	1.5870	1.5756
σ_b	0.3370	0.3587	0.2821
σ_v	0.2467	0.2261	0.1791
σ^2	0.1745	0.1798	0.1117
Log Likelihood	-822.3433	-758.1663	-25.3866
Likelihood Ratio Test H0: $\sigma_b = 0$	9.62 [0.001]	20.79 [0.000]	6.95 [0.004]

Note: t ratios are in parentheses, and p values are in square brackets;
Firm dummies are not reported in the table.

Table 6.2 Firm-level Estimation of Bubbles: the U.S. Market

A. The First Stage Estimation: Estimating Fundamental Values

Dependent Var. *P*	**Model A**	**Model B**	**Model C**
Independent Var.			
Intercept	-7.9904 (-1.75)	-7.5650 (-1.65)	-5.1129 (-1.11)
Π_{it}	1.1366 (13.94)	1.1045 (13.51)	1.1233 (13.82)
K_{it}	0.7459 (22.25)	0.7647 (22.59)	0.7427 (22.20)
ΔK_{it-1}	0.3024 (9.04)	0.3314 (9.71)	0.3017 (9.05)
$\beta_{it} K_{it-1}$	-	-0.0722 (-4.13)	-
β_{it}	-		-1.5477 (-6.96)
Statistics of Estimations			
Numbers of Obv.	9237	9237	9237
R^2 within between overall	0.5279 0.9942 0.7435	0.5273 0.9941 0.7432	0.5292 0.9941 0.7442
$F_{0.05}$ statistics H_0: non of T_t influence *P*	1.5605 c.v.1.75	1.0420 c.v.1.75	1.5641 c.v.1.75
Wald Test χ^2	10017.54	9984.59	10065.23

	[0.0000]	[0.0000]	[0.0000]
AR1	0.4994	0.5018	0.5014
σ_e	8.5135	8.5049	8.4888
Statistical Tests			
Hausman Test χ^2 H0: Random Effects	272.15 [0.0000]	72.74 [0.0000]	61.23 [0.0000]
Breusch-Pagan/Cook-Weisberg Test for Heteroskedasticity χ^2 H0: Constant Variance	18499.52 [0.0000]	18451.19 [0.0000]	18454.79 [0.0000]
Modified Bhargava DW	1.0656	1.0642	1.0615
Baltagi-Wu LBI	1.2785	1.2772	1.2739

Note: 1. t ratios are in parentheses, and p values are in square brackets;

2. R^2 values reported in the table are correlations squared which are from the second –round regression $p_{it} = \gamma \hat{p}_{it}$;

3. Firm and time dummies are not reported in the table;

4. All the statistical tests proceed from the estimation before controlling autocorrelation and heteroskedasticity.

B. Second Stage Estimation of Bubbles Using the Frontier Model

Dependent Var. $p = \ln P$	**Predicted Fundamental Value from Model A**	**Predicted Fundamental Value from Model B**	**Predicted Fundamental Value from Model C**
Independent Var.			
Intercept	-0.2862 (-1.86)	-0.4072 (-4.17)	0.7459 (4.70)
$\hat{p} = \ln \hat{P}$	0.6070 (32.85)	0.6497 (70.79)	0.2905 (44.13)
T_{1995}	0.2225 (8.76)	0.3330 (17.01)	0.3204 (15.62)
T_{1996}	0.2848 (10.28)	0.4819 (23.42)	0.4212 (19.78)
T_{1997}	0.3546 (12.03)	0.6325 (30.44)	0.6065 (28.89)
T_{1998}	0.3886 (12.78)	0.7526 (38.04)	0.7745 (38.42)
T_{1999}	0.4369 (13.98)	0.7451 (37.14)	0.7811 (38.66)
T_{2000}	0.3867 (11.79)	0.6018 (29.62)	0.7059 (34.40)
T_{2001}	0.4936 (15.20)	0.7508 (36.60)	0.8200 (39.94)

T_{2002}	0.4783 (14.84)	0.7308 (35.13)	0.8420 (41.11)
T_{2003}	0.4899 (15.27)	0.6307 (29.79)	0.7864 (37.76)
Statistics of Estimations			
Number of Obsv.	9052	9061	8154
Wald Test χ^2	23277.84 [0.0000]	54129.37 [0.0000]	28169.46 [0.0000]
$\lambda = \sigma_b / \sigma_v$	1.3914	2.5805	1.1270
σ_b	0.4190	0.4771	0.2916
σ_v	0.3011	0.1849	0.2587
σ^2	0.2662	0.2619	0.1520
Log Likelihood	-4332.6221	-2823.4942	-2069.2838
Likelihood Ratio Test H0: $\sigma_b = 0$	24.69 [0.000]	310 [0.000]	22.68 [0.000]

Note: t ratios are in parentheses, and p values are in square brackets;
Firm dummies are not reported in the table.

Table 6.3 Market Average Values of Stock Prices, Fundamental Values and Bubbles: the UK and the US Markets[57]

A. The U.K. Market

Year	Price	Proxy of Fundamental Value	Bubble Index
1995	1.037835	0.544911632	1.360866044
1996	1.136793	0.657233751	1.341041537
1997	1.138179	0.702280268	1.326281876
1998	1.254638	0.798345685	1.328384246
1999	1.198094	0.784448299	1.308135246
2000	1.106582	0.748843872	1.307144462
2001	1.212835	0.816582371	1.320528061
2002	1.24546	0.810808063	1.334464409
2003	1.02646	0.654498788	1.368532431

B. The U.S. Market

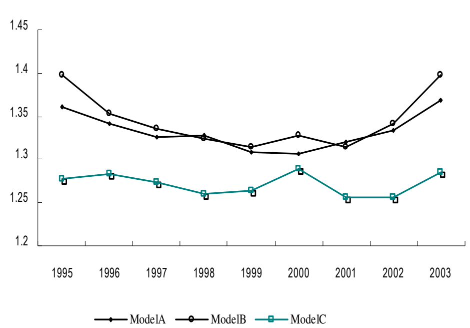
Year	Price	Proxy of Fundamental Value	Bubble Index

57 The values of price in the table are logarithmic values. The proxy of fundamental values is the predicted value of the second stage value-frontier estimation. The proxy of fundamental values and bubble index is estimated by model A.

1991	2.516521	1.988029	1.487703
1992	2.611425	2.028376	1.483356
1993	2.674678	2.123587	1.472957
1994	2.732661	2.176645	1.438828
1995	2.807588	2.303548	1.414799
1996	2.990235	2.479942	1.407286
1997	3.203464	2.697999	1.399125
1998	3.453962	2.836239	1.428523
1999	3.545988	2.926835	1.426242
2000	3.398568	2.90131	1.543488
2001	3.147952	3.007444	1.442585
2002	3.074297	2.992566	1.443197
2003	3.098344	2.995737	1.452446

Figure 6.1 Comparisions among Three Models in the Firm-level Estimation: Market Average Values of Bubbles

The U.K. Market



The U.S. Market

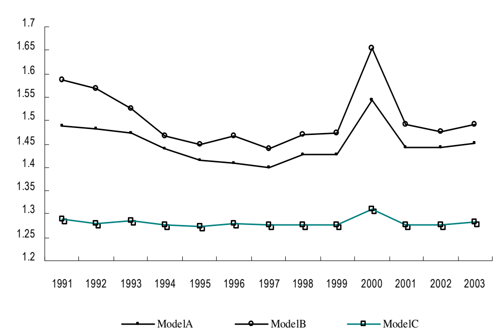
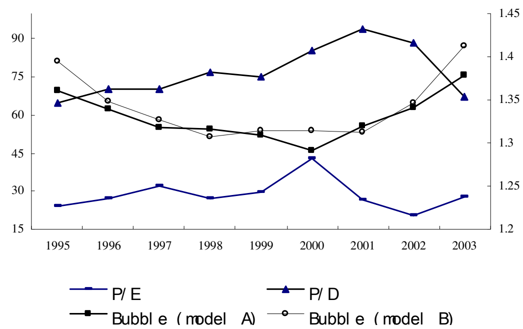


Figure 6.2 Comparisons between Bubble Index and PE, PD

The U.K. Market



The U.S. Market

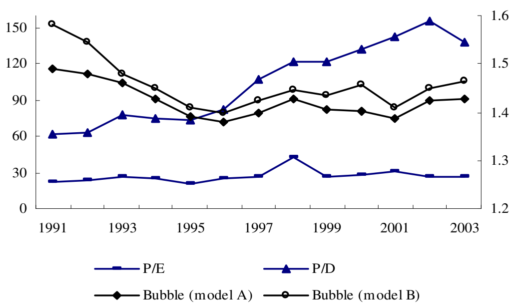


Figure 6.3 Estimated Market Level Bubbles

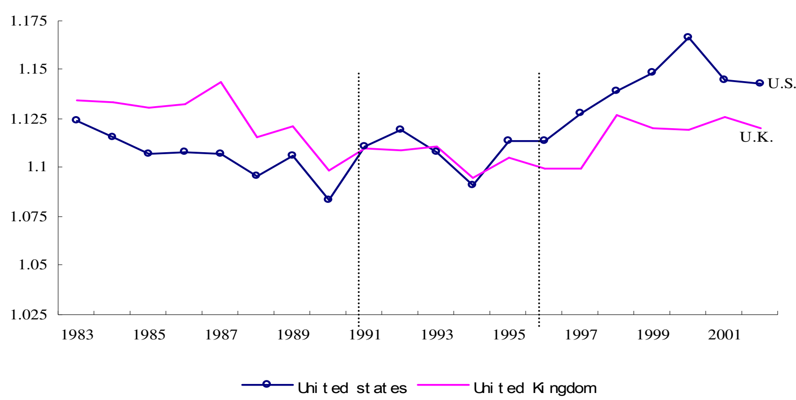
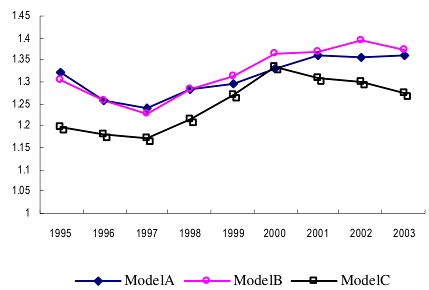


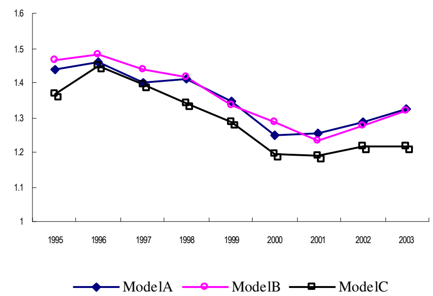
Figure 6.4 Comparisons among Three Models in the Firm Level Estimation: Average Values of Bubbles in A Sector

The U.K. Market

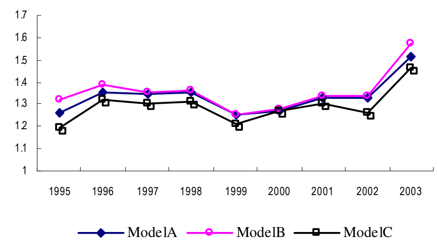
Financial



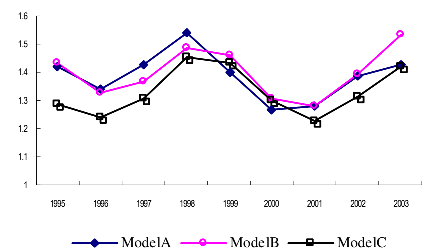
Egineering



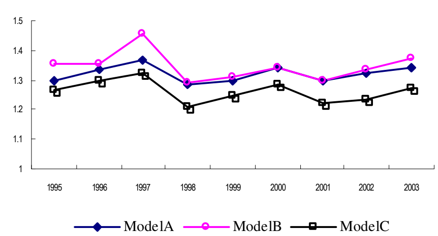
Energy



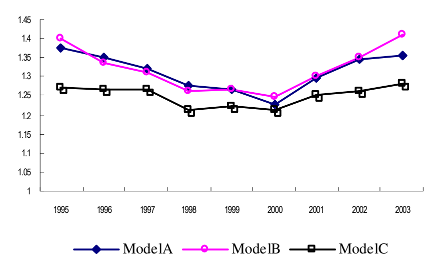
Food and Tobacco



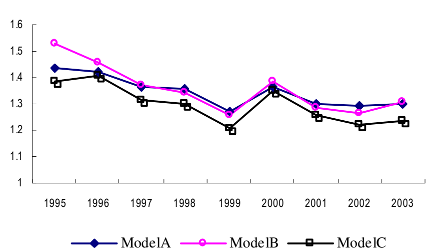
Entertainment



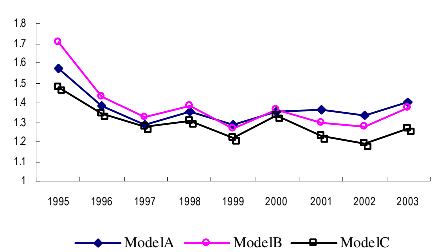
Construction and Real estate



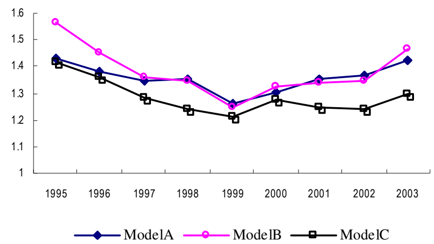
Electronics



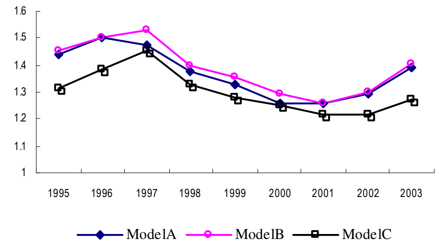
Health



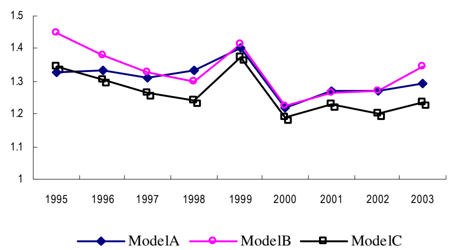
Surport Service



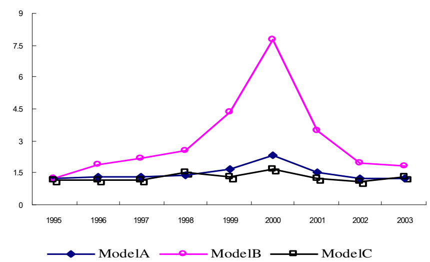
General Retailer



Transport

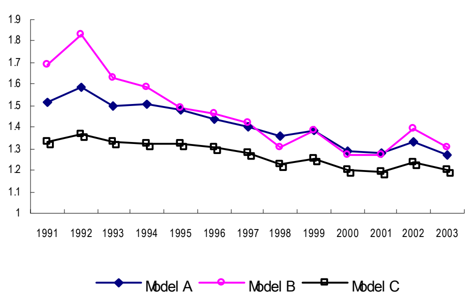


Computer and Telecommunication

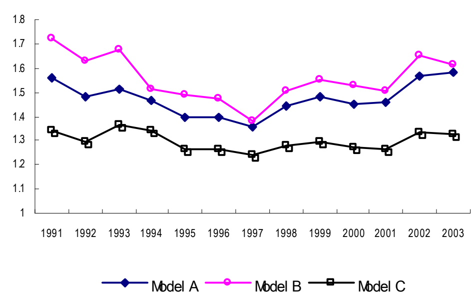


The U.S. Market

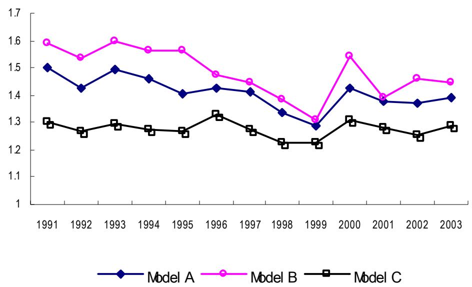
Basic Materials



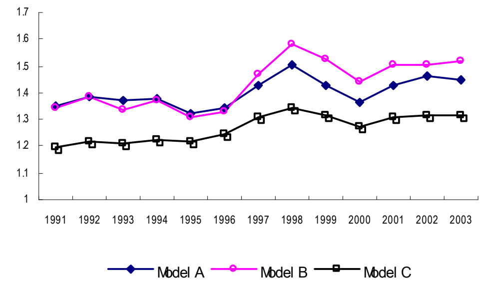
Consumer, Cyclical



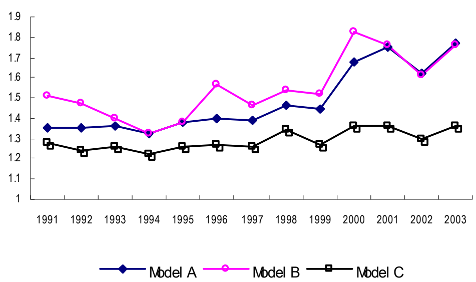
Energy



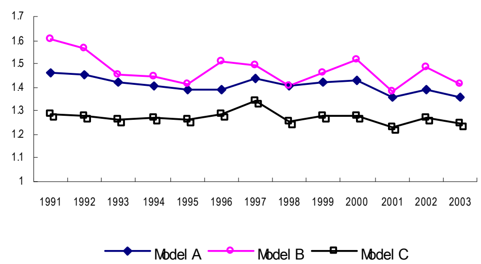
Financial



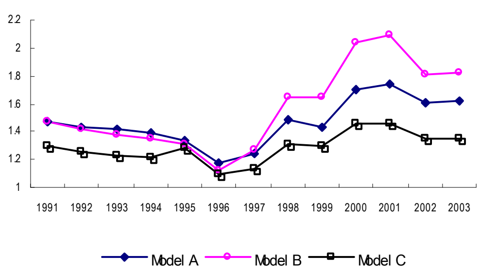
Healthcare



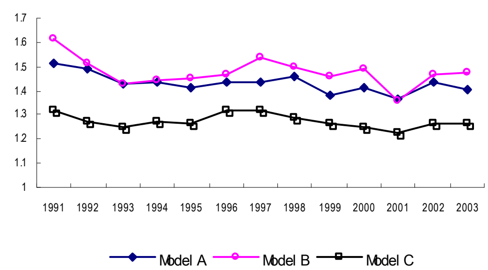
Industrial

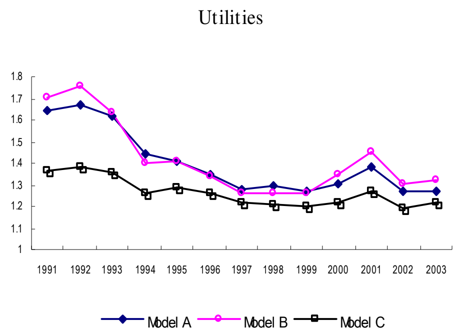


Investment Products



Consumer, Non-Cyclical





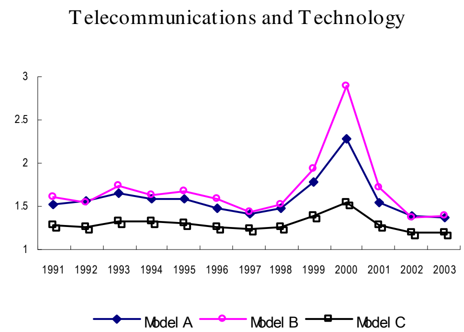
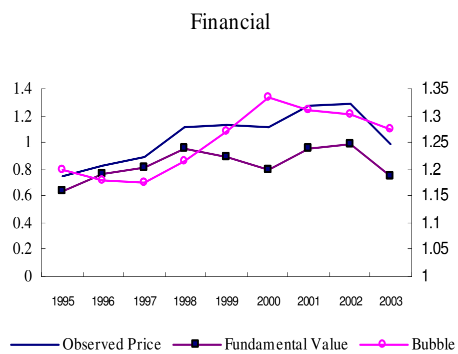
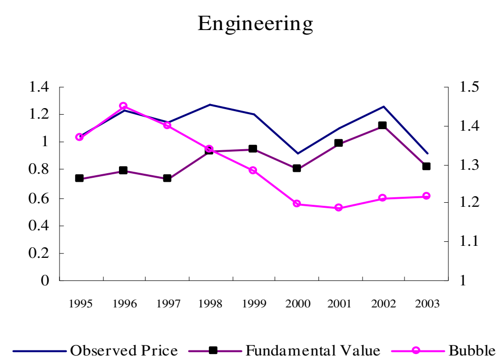
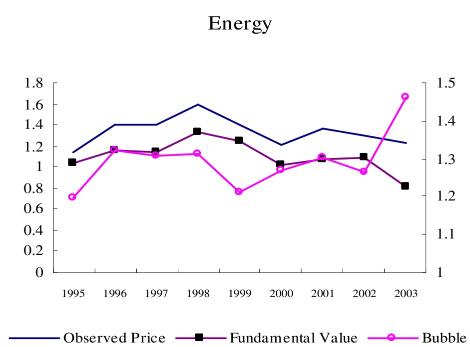


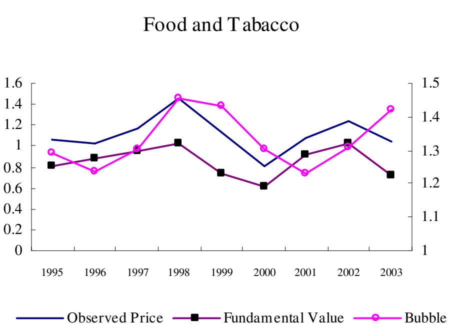
Figure 6.5 Stock Prices, Fundamental Values and Bubbles: Average Values in A Sector[58]

The U.K. Market



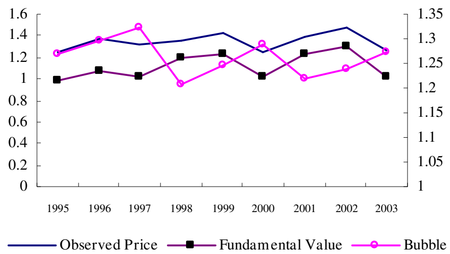




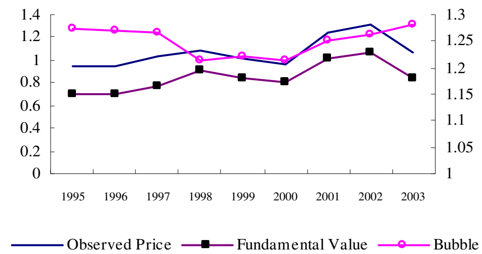


[58] The estimated bubble used for the comparison among observed prices, fundamental values and bubbles is estimated from model C except for the sector of telecommunication in UK (since the estimation of model C gives rise to a large number of missing data in this sector, in stead, the estimated bubble calculated from model A is used in this sector).

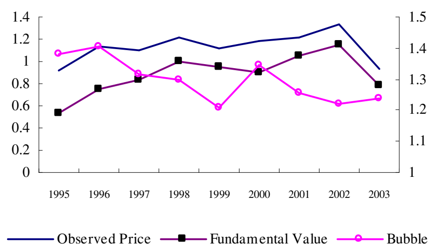
Entertainment



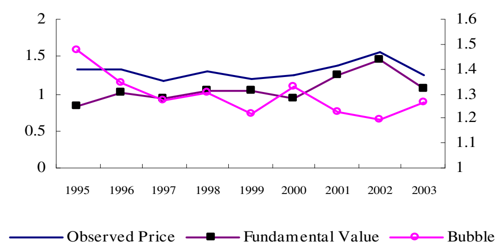
Construction and Real estate



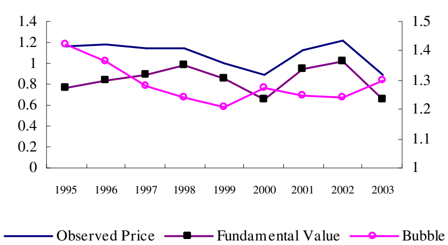
Electronics



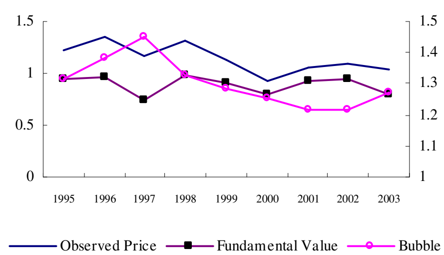
Health



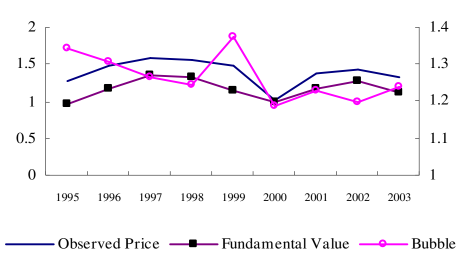
Surport Service



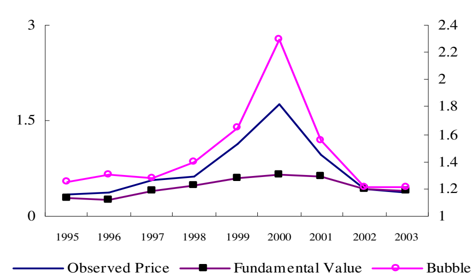
General Retailer



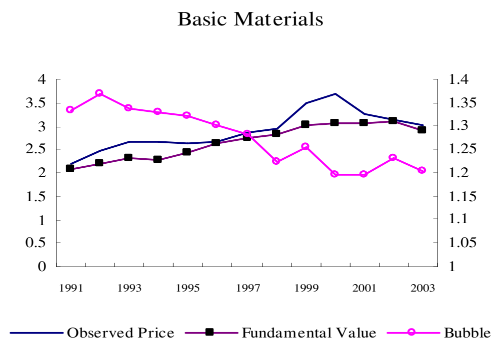
Transport

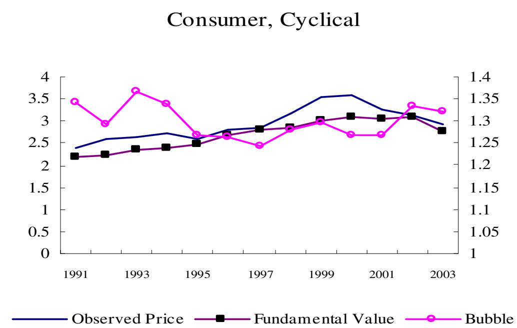


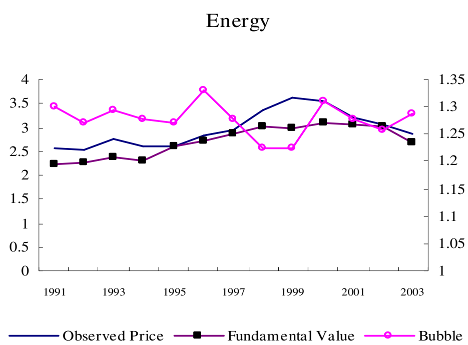
Computer and Telecommunication

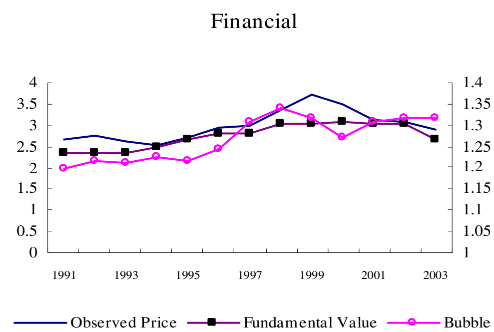


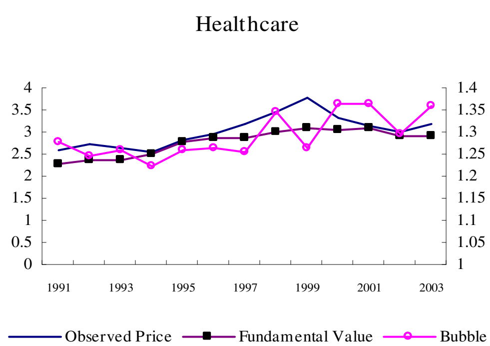
The U.S. Market

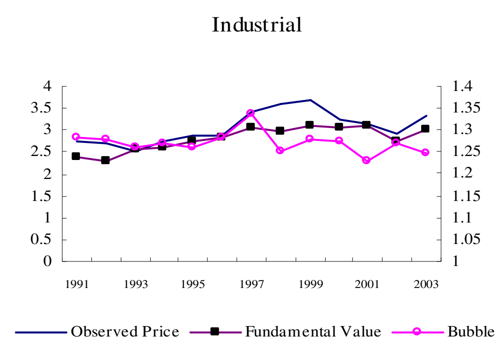












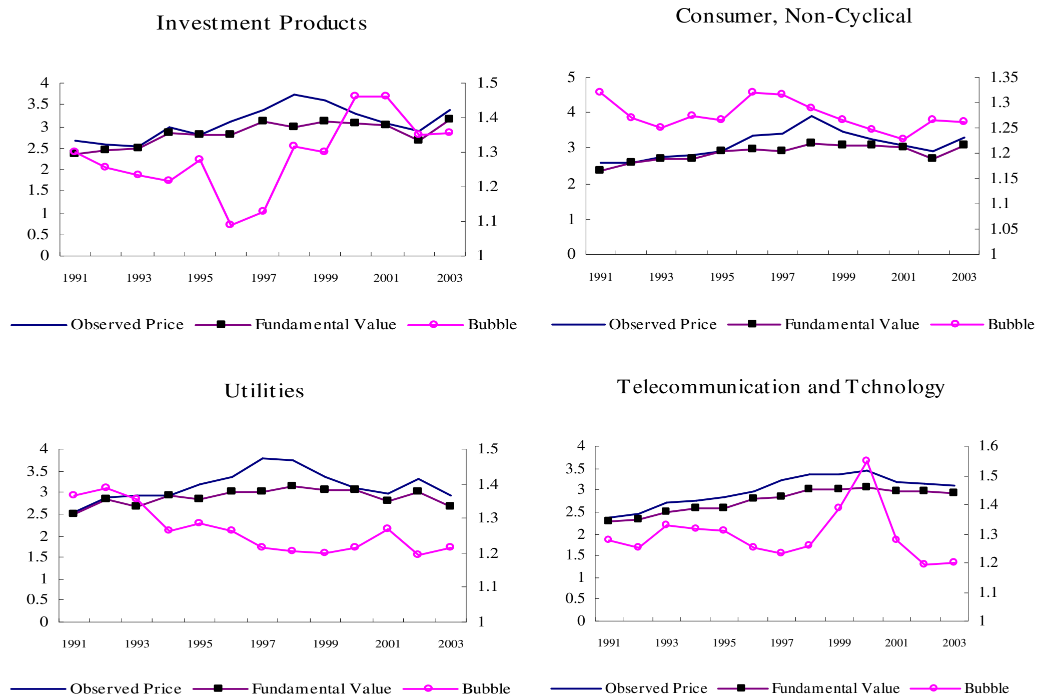
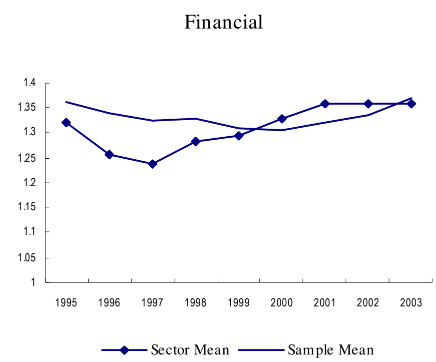
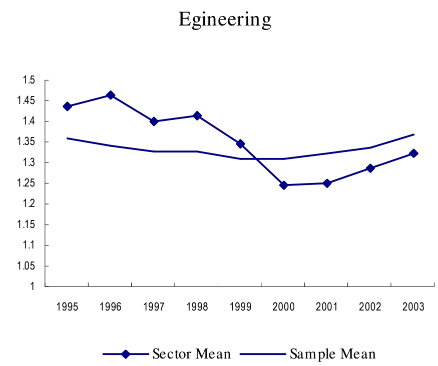


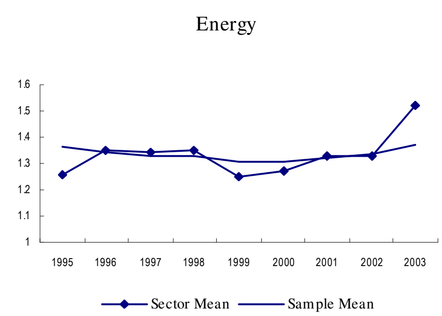
Figure 6.6 Bubbles in A Sector and Their Market Average Value: the UK and the US Markets[59]

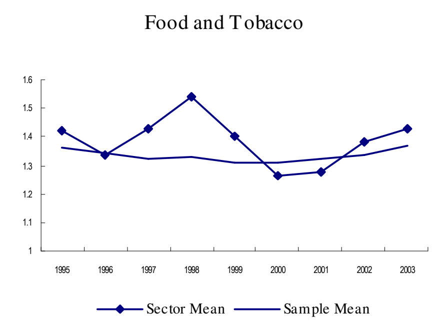
The U.K. Market

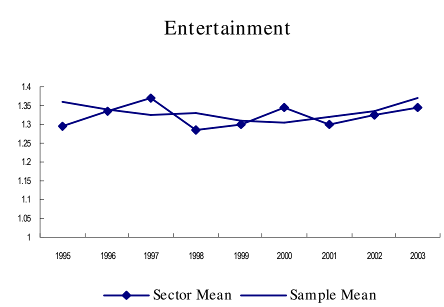
[59] The estimated bubble used is estimated from model A.

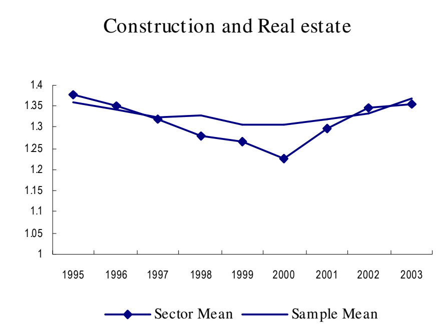

Financial
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
1995 1996 1997 1998 1999 2000 2001 2002 2003
Sector Mean
Sample Mean

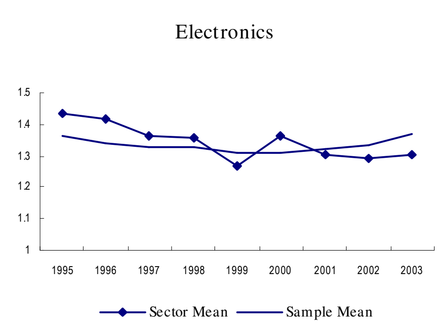

Egineering
1.5
1.45
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
1995 1996 1997 1998 1999 2000 2001 2002 2003
Sector Mean
Sample Mean

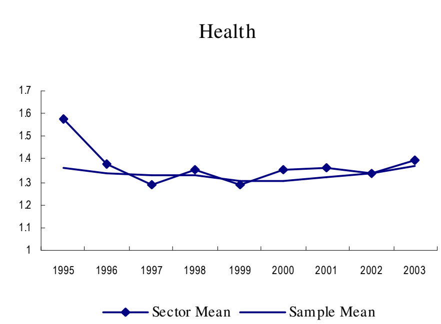

Energy
1.6
1.5
1.4
1.3
1.2
1.1
1
1995 1996 1997 1998 1999 2000 2001 2002 2003
Sector Mean
Sample Mean

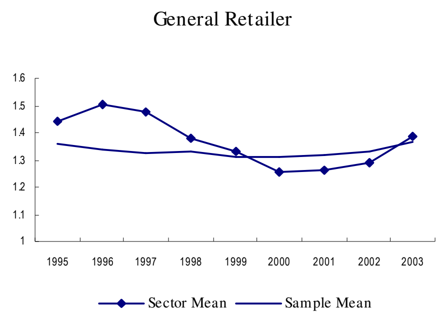

Food and Tobacco
1.6
1.5
1.4
1.3
1.2
1.1
1
1995 1996 1997 1998 1999 2000 2001 2002 2003
Sector Mean
Sample Mean

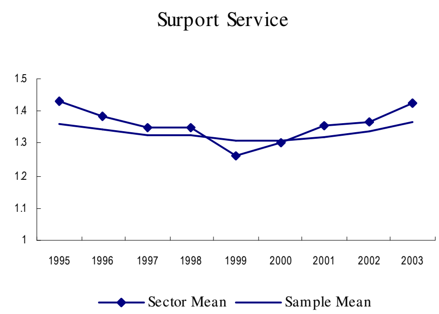

Entertainment
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
1995 1996 1997 1998 1999 2000 2001 2002 2003
Sector Mean
Sample Mean

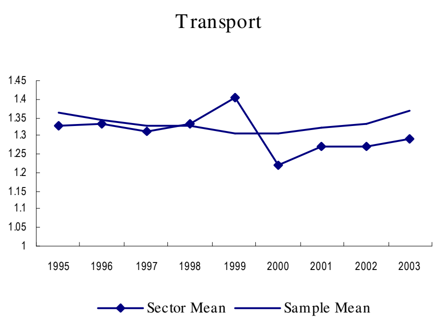

Construction and Real estate
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
1995 1996 1997 1998 1999 2000 2001 2002 2003
Sector Mean
Sample Mean

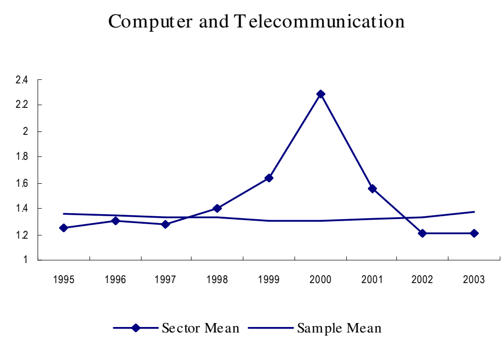

Electronics
1.5
1.4
1.3
1.2
1.1
1
1995 1996 1997 1998 1999 2000 2001 2002 2003
Sector Mean
Sample Mean


Health
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
1995 1996 1997 1998 1999 2000 2001 2002 2003
Sector Mean
Sample Mean



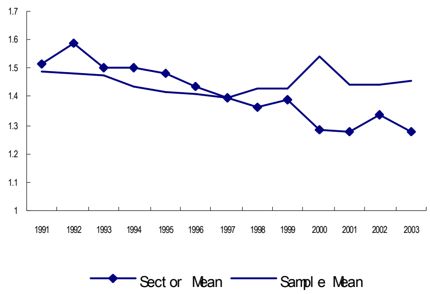




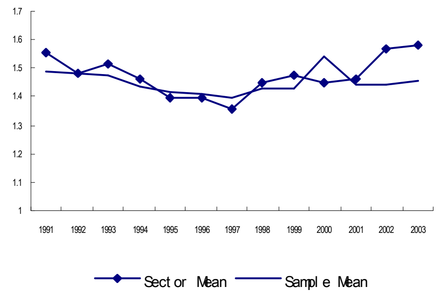


The U.S. Market

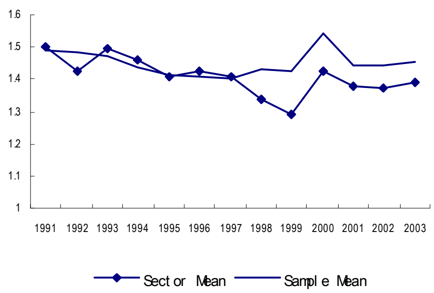
Basic Materials



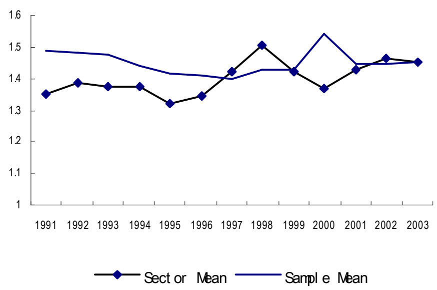
Consumer, Cyclical



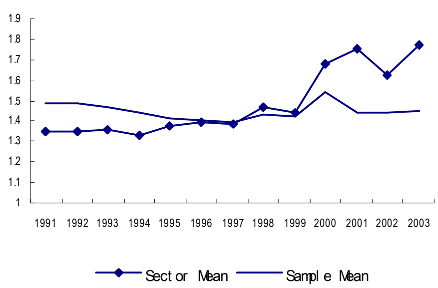
Energy



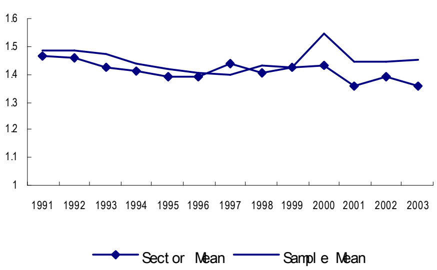
Financial



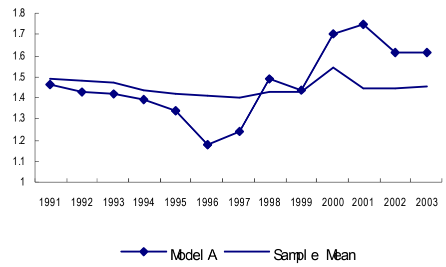
Healthcare



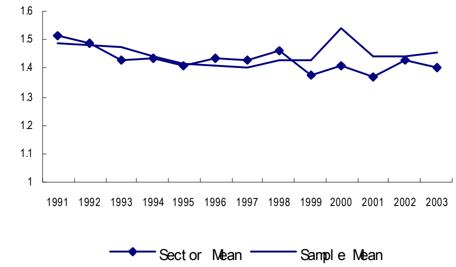
Industrial



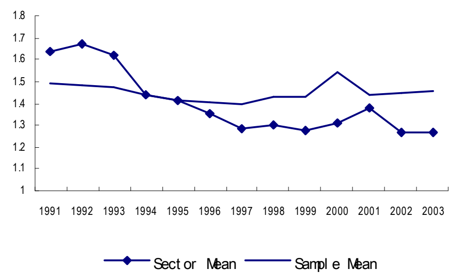
Investment Products



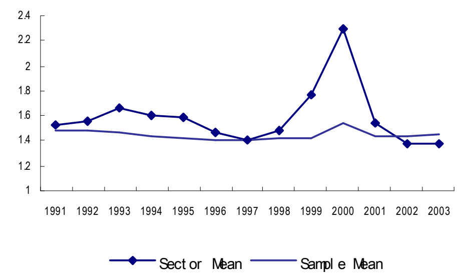
Consumer, Non-Cyclical



Utilities



Telecommunications and Technology



Chapter 7 Application of the Value Frontier Methodology III: Estimation of Firm Level Bubbles in an Emerging Market (China)

In the last chapter, our estimation is made on the basis of developed markets. Thus, one may raise a question that the estimation for developed markets may not be applicable for emerging markets. In order to address this concern, in this chapter, the value frontier model is applied to a typical emerging market - the Chinese stock market. Moreover, another motive to study the bubbles of China is to discover how bubbles behave in this closed market. When compared with open markets, such as the U.K. and the U.S, are bubbles higher or lower in this closed emerging market? Some studies, such as Su and Fleisher (1998), Zhang and Zhao (2004), Green (2003), Xu and Wang (1999) and Zhou and Sornette (2006), demonstrate that, in the Chinese stock market, there is an excessive volatility caused by the political risk, a high PE ratio resulted from an extensive speculation, and an earning-insensitive anticipation made by investors' short-term investment horizon. These findings imply a high level of bubbles in the Chinese stock market since irrationalities and government shocks are expected to be more serious in the Chinese stock market than a developed market. But an opposite argument for lower bubbles in the Chinese stock market can also be made with the following two reasons.

First, we are concerned that bubbles in a less mature market are not necessarily higher than the ones in a mature market. The less orderly market doesn't mean that the investors acting in it are naïve. Bubbles in emerging markets may be moving below the level of mature markets due to the lesser fundamental value of their economies as long as their investors are prudent enough. The evidence for this argument can be found by jointly observing the average return on equity (ROE) of sample companies in three countries – the U.S., the U.K. and China. In Table 7.1, Chinese listed companies are obviously weaker than U.S. companies in terms of profitability. If the accounting manipulation is taken into account, the Chinese numbers in Table 7.1 may be further lower than the U.K. Certainly, the poor profitability can hardly sustain a high level of the stock market boom.

[Table 7.1 is about here]

Secondly, in the Chinese stock market, investors show a higher risk aversion when compared with developed open markets, which restrains the growth of bubbles. This negative attitude towards risk is caused by two reasons. First, the Chinese stock market is a "policy-driven market" (Heilmann, 2002).[60] There are so many unstable elements coming from government reforms in this developing market, which increases its uncertainty. If the game of stock investment is not one short, these elements can make investors learn from the past, which eventually results in lower confidence on future returns and so have higher risk aversion. Second, since the less international investors there are, the less risk can be diversified, investors in a closed stock market feel less secure than in a completely opened market which means that they bear a relatively more conservative expectation to this market. Therefore, bubbles in the Chinese stock market should be expected at a lower level than developed markets such as the U.S. or the U.K. market.

With the motive to verify the arguments above, in the study of this chapter, we will estimate stock bubbles in the Chinese stock market by applying the value frontier estimation to this market with some further extension to take into account the particular conditions of the market. Thus, this chapter is structured as follows: Section 7.1 focuses on the background of the Chinese stock market which has only 15 years' history; Section 7.2 is devoted to the empirical work in which some new elements are added into the firm level model concerning the special pattern in this

[60] Heilmann (2002) gave rise to three characters for the policy-driven market of China: 1. political calculations, policy missions and administrative interference are more important than the dynamics of market competition for determining price fluctuations; 2. State-owned shares and legal person shares are excluded from trading so as to perpetuate state control; 3. the most powerful political and economic actors try to benefit from their control over state assets.

market; Section 7.3 is designed to examine the econometric and analysis results, in which several findings are addressed. Section 7.4 deals with the summary and conclusion of this chapter.

7.1 Background of the Chinese Stock Market

7.1.1 Characteristics of the Chinese Stock Market - A Closed Emerging Market

With the progress of an opening-up policy in the Chinese economy, the Chinese stock market has been also rapidly developed since the beginning of the 1990s. Since then, it has attracted considerable interest from foreign investors (Green, 2003). Ma (2003) summarised the development of the Chinese stock market into three stages.

The first stage is over the period of 1978 to 1990, the so-called "infancy stage". In this stage, although stocks were issued to the public, there was no formal public trading market. Therefore, the liquidity of stocks in this stage was very poor.

The second stage is from 1991 to 1996, which is the "growing stage". During this period of time, two stock exchanges - the Shanghai stock exchange and the Shenzhen stock exchange - were established in 1990 and 1991 respectively. Since then, significant growth has been achieved both for the size of the market and the number of shareholders. The value of equities issued increased from RMB 3 billion (0.8 billion US dollar) in 1989 to RMB 30 billion (5.2 billion US dollar) in 1993. The number of stocks listed on both exchanges increased from 15 in 1991 to 381 by the end of 1995. By the end of 1994, the number of shareholders in both exchanges is 15 million with an estimated growth of 10,000 new shareholders a day (Mookerjee and Yu, 1999). However, during this period of time, the Chinese stock market was highly protected and disorganised, in that the government restricted the quantum of the stock issue, and controlled the issuing price. In fact, there were no systematic stock market regulations restricting investors' behaviours at that time. Thus, this environment provided a huge chance of manipulation (Ma, 2003).

It is commonly acknowledged that the Chinese stock market reached a milestone in its development in 1996 when many regulations were implemented by the government, clearly marking the transition of the market from its "growing stage" to the "stage of approaching maturity". After 1996, although the government still plays a big role in this immature market, with the establishment of relevant regulations, the market manipulation has been reduced and the listed companies lose the chance to deceptively report their performances (Ma, 2003). Since 2000, China has been rapidly progressing in terms of improving its capital market (Jingu, 2002). Green (2004) demonstrated that the Chinese state appeared to be significantly better coordinated in 2003 in financial policy than at any time since 1986.

However, behind the rapid growth, the Chinese stock market is suffering several fatal problems: low regulatory quality, frequent shocks from the government reform, the poor performance of listed companies caused by the structure of ownership, and the limitations of foreign ownership on stocks. These four issues have been broadly documented by existing studies on the Chinese stock market.

First, Pistor and Xu (2004) concluded that the Chinese stock market under-performed with regards to the quality of the law on the books and actual law enforcement. Although major efforts have been made by the Chinese government to develop a formal legal framework over the past twenty five years, the regulatory quality is still poor since it started from a very low level. According to the World Bank database, the average number of "regulatory quality" for all transition economics is 62.13 and China's score is only 57.

Secondly, since China has been undergoing economic reforms since the 1980s, the uncertainty of government policy is another problem affecting the stock market. Government shocks drive the stock market fluctuating from the bull to the bear. Su and Fleisher (1998) found that the government's market intervention policies have affected stock market volatility in China. Zhang and Zhao (2004) also demonstrated that the political risk of China is an important component of the country-specific risk in the Chinese stock market so as to play a critical role in the stock valuation. The political risk was mainly caused by the stock market governance reform and the reform of releasing the state ownership of listed companies. Green (2004) identified the development of the stock market governance structure with three periods between 1984 and 2003. With the push-forward stock market policy of the first period (1990-1992), the stock market was accordingly feverish. However, the restructure of the governance scheme caused several crises in the second period of 1992-1996. Hence, after a set of sound coordinated financial policies took effect in the third period, this gave rise to a "worthwhile cost" to produce a more rational stock market afterwards. Another significant shock to the stock market was privatisation. The Chinese government has been concerned with selling part of its state ownership in the stock market since 1999, and officially implemented this reform in 2001. This new policy was soon suspended due to the big crash caused in the stock market. However, the government's intention of proceeding this reform wasn't reduced by the chaos. Thus, since then, this issue has become the major concern influencing the investors' attitude towards the risk.

The poor performance of listed companies and their structure of ownership is the third concern. According to the result reported by Jefferson et al (2000) while SOEs performed badly, shareholding firms (all listed firms fall into this category) did even worse, suffering an annual 8% decline in their total factor productivity (TFP). Green (2003) concluded that the listed companies in the Chinese stock market became progressively less efficient in using resources, which is a signal that they were wasting the resources available to them. The poor performance of Chinese listed companies has been commonly considered as a result of the weakness of corporate governance, which is in turn caused by the problems of the share ownership (Bajona and Chu, 2004). In the Chinese stock market, the listed companies are mostly originated from state-owned enterprises, and their shares are only partially put into public and most of them are non-tradable which are owned by the state, the so-called state shares, or other SOEs, the so-called legal person (LP) shares.[61] These two types of non-tradable shares cannot be listed and traded on the stock exchanges, though they can be exchanged at auction or by one-to-one deals (Green, 2003). In September 2005, among 757.4 billion total shares, only 280 billion shares are traded in public, and over half the amount of shares are not tradable in the stock exchanges.[62] This ownership structure protects the listed companies from exposing themselves to the discipline of the market, since the major share ownership is not liquid in the public market and controlled by the government. Chen et al (2002b) found that the profitability and efficiency in Chinese listed companies declined over the period of 1991 to 1997 and attributed this to the ownership structure. They addressed the fact that the government influences management in order to achieve political and social objectives through its majority share ownership that may be detrimental to corporate profitability.

Finally, compared with the opening speed of the real economy, the Chinese stock market seems to be a specially protected corner preventing foreign investors to participate in this market. Since China currently maintains total control over its monetary policy in a closed capital market, the Chinese stock market is a closed market and the majorities of participators in this market are Chinese citizens. Like many other emerging stock markets, such as Brazil, Indian, Mexico and Philippines,

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[61] Chen et al (2002b) named them as legal entities shares.
[62] Source: statistic data of Shanghai and Shenzhen Stock Exchange www..sse.com.cn, www.szse.cn.

the Chinese government imposes restrictions on the foreign ownership of domestic equity to ensure domestic control of local firms (Ma, 1996). The stocks traded in the Chinese stock market are classified into two parts, namely A- and B-share.[63] The trading of A-share had been localised only on Chinese citizens until July 2004 when the QFII (qualified foreign institutional investor) implemented by the Chinese government. Before that, the foreign investors were only allowed to hold B-shares. B-share exists with the purpose of raising foreign capitals, which is denominated with the U.S. dollar in the Shanghai stock exchange and with the Hong Kong dollar in the Shenzhen stock exchange respectively, [64] while A-share is priced with local currency - RMB Yuan. The market segmentation contributes to the highly speculative tenor of the market and needs to be corrected (Jingu, 2002). Meanwhile, limitations on foreign ownership of domestic equity show that the Chinese stock market is still a closed market, at least for the time being.

Due to the four problems discussed above, it is easy to see that although an opening-up policy contributes to China’s economic boom, the Chinese stock market is still far from maturity and complete opening.

7.1.2 Performances of the Chinese Stock Market

Having examined the characteristics of the Chinese stock market, we turn to study the stock price performance in this market. Existing investigations in the Chinese stock market are diversified and the results are not clear-cut. Some of the studies tried to verify the heavy speculation and irregularity of the Chinese stock market, while others raised the opposite opinions by showing the sound development in this young market.

[63] Stocks issued by Chinese listed companies are normally classified into three parts: A, B and H share. However, H-shares are listed in Hong Kong market not in the mainland of China.
[64] There are two stock exchanges in China located in Shanghai and Shenzhen respectively.

The Chinese stock market is generally considered as a market with extensive speculation which marks the share prices at high levels. Green (2003) concluded that, when compared with Western markets, the share prices in the Chinese stock market are at high levels since the *PE* ratios for much of the 1990s in this market are double that of the Western markets. Ma and Barnes (2001), Darrat and Zhong (2000) and Seddighi and Nian (2004) failed to prove the efficient hypothesis in the case of the Chinese stock market. Su (2003) found that A-share prices do not react to changes in earnings per share, i.e. investors do not correctly anticipate the changes in earnings so as to fail to make adjustment in accordance with the new earnings information, since most of A-share holders are individuals with short-term investment horizon. The average period for which individual investors hold shares is just one to two months in the Chinese stock market, which shows the speculative nature when compared with 18 months in the U.S. (Xu and Wang, 1999). Zhou and Sornette (2006) described the Chinese stock market as immature, which seems to attract short-term investors more interested in fast gains than in long-term investments, thus promoting speculative herding. Under this circumstance, the expectation distortion is formed by the heavy speculation and meanwhile it is also likely to cause the positive feedback trading, so as to inflate the stock bubble.[65] This positive feedback trading behaviour in the Chinese stock market is ascertained by Yeh et al (2002) who documented that in emerging markets, such as the Chinese stock market, stock prices may be generally affected by the positive feedback trading. The speculative activities in the Chinese stock market were also pointed out by the central bank of China in 1995, which viewed stock prices as being excessively volatile in the sense that they do not reflect the economic fundamentals of listed firms (Laurenceson, 2002). However, in the meantime, Laurenceson (2002) also shows a declined trend of share volatility in the Chinese stock market in the most recent years by examining the

[65] When rational speculators receive good (bad) news, they will buy (sell) more shares today than the fundamental news warrants, in anticipating buying (selling) behaviours by the positive feedback traders tomorrow. The buying (selling) of positive feedback traders will help push prices above (below) fundamentals even as rational speculators are selling out (purchasing) and stabilising prices (De Long, Shleifer, Summers and Waldmann,1990).

standard deviation of the price index between the period of 1994 and 1998.

Like Laurenceson (2002)'s argument, many researchers have raised a positive outlook on the stock market performance of China. Los and Yu (2005) reported that, although the Chinese stock market was infamous for its high turnover rate, the volatility levels in this market have been gradually declining and it has become more efficient since 2003. They attribute this improvement of the Chinese stock market to the initial government interventions and the increased participation of many hedging noise traders who trade around the market mean but fewer powerful institutional investors who are used to take a few large "speculative buy-and-hold positions away from the market mean". Fernald and Rogers (1998) found that investors in the Chinese stock market are very well-informed about the price differences and so could each take a tiny position against mispricing. By studying stock returns and accounting data of Chinese listed companies between 1994 and 1997, Chen et al (2002a) and Haw et al (1999) also verified that although the Chinese stock market is very young and investors have limited knowledge and experience, the stock market does appear to incorporate earnings information in share prices, which means that the information of earnings influences investors in valuation decisions. Moreover, Wu (1996) and Laurence et al (1997) verified that the Chinese stock market is "weak-form efficient". They also found a strong causal effect from the U.S. stock market to the Chinese stock market and concluded that the Chinese stock market is becoming more integrated to the global economy.

Obviously, research in the area of the Chinese stock market is still in a rudimentary stage, since this market only has 15 years' history and its speciality gives rise to several difficulties in the study. Given the characteristics of the Chinese stock market which has been under rapid development, it is expected that the market would behave very differently at different stages of development. It is inappropriate to conclude on the market on the basis of a phenomenon that appeared in a particular stage of development, since it changes over time. This further implies that stock bubbles in China cannot simply be expected to be at a similar level to the US and the UK markets, since the effect of development plays a more important role in forming bubbles in emerging markets than in a developed market. This argument will be shown by our following analysis.

7.2 Estimation of Firm Level Bubbles in the Chinese Stock Market

7.2.1 Models

Since the stock bubble is a phenomenon of stocks traded in stock markets, the focus of our bubble study should be stocks traded in the stock exchange. Thus, non-tradable shares shall be in theory excluded from the bubble estimation. However, in the stock market, the fundamental value of a share determined by fundamental variables, such as the book value of equity and earnings, is related to the value of all shares including the non-tradable part. Existing studies on the Chinese stock market, such as those by Spencer (1995), Yao (1998) and Laurenceson (2002), documented that when only a small proportion of a company's total shares are available for trading, share prices cannot reflect the market's view of the fundamental value of a listed firm. Therefore, the existence of non-tradable shares is the major concern in the bubble modelling for the Chinese stock market. To take into account this concern, following Chen et al (2005), a variable, tradable ratio (*LR*), is added into the model, which may be defined as the ratio of tradable shares to total shares:[66]

$$LR = \frac{N_l}{N} \quad \textbf{(7.1)}$$

[66] Chen *et al* (2005) utilised a variable *TrdSha* to measure the effect of non-tradable shares on price limits. *TrdSha* is defined as the ratio of the number of tradable shares to the total number of shares outstanding.

where N_l is the amount of tradable shares, and N represents the total number of shares composed of tradable and non-tradable ones.

The fundamental value p^f of a tradable share is accordingly adjusted by a tradable ratio as the market price only demonstrates the price of tradable shares, not total shares. The function of the fundamental value can then be rewritten as:

$$P_{it}^f = f(x) \cdot LR \quad \textbf{(7.2)}$$

where x is the set of fundamental variables.

Thus, the transformed firm level value frontier model can be structured as:

$$P_{it} = P_{it}^f \times \exp(v_{it}) \times BI_{it} = f(x) \cdot LR^{\beta} \cdot BI_{it} \cdot \exp(v_{it}) \quad \textbf{(7.3)}$$

with $BI_{it} = \exp(b_{it})$

The estimation model is specified in a logarithmic form with the time (*Y*) and firm dummies (*A*):

Model I.

$$\ln P_{it} = \alpha + A_i + Y_t + \ln f(x) + \beta \ln LR_{it} + b_{it} + v_{it} \quad \textbf{(7.4)}$$

with $b_{it} = \ln(BI_{it})$

One might ask: does the adjustment achieved by the tradable ratio really affect the final bubble results? To answer this question, the estimation without the variable *LR* is also considered in Model II.

Model II.

$$\ln P_{it} = \alpha + A_t + Y_t + \ln f(x) + b'_{it} + \nu'_{it} \qquad \textbf{(7.5)}$$

with $b'_{it} = \ln(BI'_{it})$

where BI is named the adjusted bubble index, and accordingly BI' is called the non-adjusted bubble index.

To calculate the proxy of $f(x)$, three models, which are deliberated in Chapter 6, are once again employed as follows:[67]

Model A:

$$P_{it} = \alpha + D_i + T_t + \gamma_1 K_{it} + \gamma_2 \Pi_{it} + \gamma_3 \Delta K_{it-1} + \varsigma_{it}$$

with $f'(x)_{it} = \gamma_1 K_{it} + \gamma_2 \Pi_{it} + \gamma_3 \Delta K_{it-1} \qquad \varsigma_{it} = B_{it} + \varepsilon_{it}$ **(7.6)**

Model B:

$$P_{it} = \alpha + D_i + T_t + \gamma_1 K_{it} + \gamma_2 \Pi_{it} + \gamma_3 \Delta K_{it-1} + \gamma_4 \beta_{it} K_{it-1} + \varsigma_{it}$$

with $f'(x)_{it} = \gamma_1 K_{it} + \gamma_2 \Pi_{it} + \gamma_3 \Delta K_{it-1} + \gamma_4 \beta_{it} K_{it-1} \qquad \varsigma_{it} = B_{it} + \varepsilon_{it}$ **(7.7)**

Model C:

$$P_{it} = \alpha + D_i + T_t + \gamma_1 K_{it} + \gamma_2 \Pi_{it} + \gamma_3 \Delta K_{it-1} + \gamma_4 \beta_{it} + \varsigma_{it}$$

with $f'(x)_{it} = \gamma_1 K_{it} + \gamma_2 \Pi_{it} + \gamma_3 \Delta K_{it-1} + \gamma_4 \beta_{it} \qquad \varsigma_{it} = B_{it} + \varepsilon_{it}$ **(7.8)**

where K is book value of equity per share, Π is earnings per share and β is beta value. D and T represent firm and time dummies. ς_{it} contains both bubbles B_{it} and the statistic noise ε_{it}. We don't break down ς_{it} into two components at stage one of estimations.

[67] The detailed derivation of models can be found in Chapter 6.

7.2.2 Data and Estimations

The data source in this chapter is from the SINOFIN China stock data produced by China Centre for Economic Research (CCER).[68] We employ the data with two considerations. One is about the two classes of shares- A and B share. As already mentioned in Section 7.1, the trading of these two kinds of shares are running in two separate markets. Thus, it seems that giving rise to their respective concerns should proceed in the study of Chinese stock bubbles. However, at the present research, we assuredly concentrate the estimation particularly on A-shares as it is the main body of the Chinese stock market with the market value of 1,006.8 billion Yuan which is more than 94% of the total market value. Until September 2005, there are 1,381 listed companies in the Chinese stock market, but only 109 of them are listed with B-shares. B-shares floating in this stock market are merely around 10% of A-shares.[69] Table 7.2 also shows that A-share companies dominate the Chinese stock market. Another consideration is that, as introduced in Section 7.1, the market was highly disorganised during the time of its infancy. Thus, the attention in this chapter is only placed on data after 1996.

[Table 7.2 is about here]

Therefore, the dataset employed in this chapter is an unbalanced panel pooled by all A-share listed companies in both Shanghai and Shenzhen stock exchanges from 1996 to 2003. Annual data of book value of equity per share (K), earnings per share (Π) and beta value (β) are provided by the data, in which the beta value is calculated based on Scholes and Williams (1977), and K and Π are computed by accounting numbers of equity and net profit over the total number of shares respectively. In

[68] China Centre for Economic Research (CCER) is a leading research institution of economics and finance in China.
[69] Source: statistic data of Shanghai and Shenzhen Stock Exchange www.sse.com.cn and www.szse.cn.

addition, following the study by Chen et al (2001) in which the percentage of public holdings are defined by the percentage of public share holdings over total shares outstanding, the tradable ratio (*LR*), which is computed by the number of tradable shares (N_l) and the number of total shares (*N*) is used for the purpose of controlling the non-tradable element in the estimation (the definition of data can be found in Appendix 7.1.).

The two-stage estimation introduced in Chapter 6 is again employed in this chapter. Three models, models A, B and C (7.6, 7.7 and 7.8) are applied in the first stage of estimations respectively, and accordingly values of $f'(x)$ are generated. The first stage statistics (Table 7.3) show that the fixed effect panel regression conduces to the problems of autocorrelation and heteroskedasticity, which could result in biased estimation. As explained in Chapter 6, the accuracy of the prediction in the first stage estimation is the key concern. Therefore, AR(1) and heteroskedasticity are controlled by running the GLS regressions with the assumption of AR(1) and the estimated results are shown in Table 7.3.

[Table 7.3 is about here]

In the second stage, similar to Chapter 6, in order to control firm-specific effects and the market impact, a frontier estimation program is applied with inclusion of time and firm dummies. Three groups of values of $f'(x)$ acquired respectively in the first stage are applied to models I and II (Eq.7.4 and Eq.7.5) which gives rise to six estimations. For convenience of explanation, these six estimations are labeled as I-A, I-B, I-C, and II-A, II-B, II-C, as shown in Table 7.4.

[Table 7.4 is about here]

After the two-stage estimation, the analysis based on the estimated bubbles is provided. The plot of bubble movements is conducted by averaging the values of the estimated bubble (*BI*) year by year. First of all, a robust bubble path is expected by jointly plotting the values of the adjusted bubble from three estimations (I-A, I-B and I-C). Thereafter, the adjusted bubble index and the unadjusted bubble index are examined together in order to check the influences of non-tradable shares on the investors' decision.

7.3 Results and Interpretations

Table 7.3 and Table 7.4 show that the results are intriguing. First, the likelihood ratio test significantly rejects the null hypothesis of zero standard deviation of *b*, which means that bubbles (*b*) do exist over the time period of our study. This provides further evidence for Ahmed, Li and Jr.'s (2000) argument for the possible existence of bubbles during the 1990s. Second, the statistics of λ in Table 7.4 look extremely high when compared with the U.K. and the U.S., which coincides with an intuition of relatively stronger bubble volatility in the emerging market. Finally, the coefficients of variables in six estimations appear to be robust. In Table 7.3, the coefficient of earnings Π is higher than the book value of equity *K*, which is consistent with Chen et al (2002a)'s conclusion that the earning signal has a stronger impact on stock prices than other accounting information in the Chinese stock market. This result is similar with the U.S. market where the coefficient of earnings appears higher than the book value, and is different from the U.K. market with the almost equivalent influence of earnings and book values on prices. Moreover, compared with the estimations in the U.K. and the U.S. market, lower coefficients of $\ln P^f$ for China in Table 7.4 imply a relatively weak effect of fundamental values on China's stock market. In other words, in the Chinese stock market overall, investors are less responsive to fundamental values than those investing in more developed markets. This finding is consistent with the short-term behaviour of investors who hold shares just one to two months on average in the Chinese stock market, which is far shorter than 18 months in the US market (Xu and Wang, 1999).

In addition, the significant coefficients and the negative sign of $\ln LR$ demonstrate a negative relationship between the market value and the tradable ratio of A-shares, which implies that investors prefer the firms with high proportion of non-tradable shares. This conclusion is coincident with Qi et al's (2000) report that shares have higher returns on equity if the non-tradable share ownership is high. Fernald and Rogers (1998) also verified that investors tend to pay higher prices for small firms with larger state ownership which is not tradable in stock exchanges. Meanwhile, to some extent, the significant effect of tradable ratio on the price verifies Chen et al's (2005) finding that stocks with a high ratio of tradable shares tend to hit their price limits more frequently,[70] i.e. stocks with a high ratio of non-tradable shares appear less volatile, which means the issue of tradable ratio does affect investors' decision and so in turn do influence stock prices.

Having discussed estimated results, our attention turns to three major issues. The first issue is the average bubble movement in the Chinese stock market over the sample period of 1996 to 2003. This bubble movement will be explained based on the Chinese economic and financial reform implemented during this period. Investors' behaviours in the Chinese stock market are our second issue, since stock bubbles are formed by investors' decisions. We will discuss the question "Are investors in the Chinese stock market as naïve as this market is?" This in turn gives a fresh look to the question raised at the beginning of this chapter: "Are bubbles higher or lower in the Chinese stock market than the U.K. and U.S. markets?" A comparison between opened markets (the U.K. and the U.S.) and a closed market (China) is conducted. The firm level estimation also provides us with an opportunity to see this market in

[70] On December, 1996, the Chinese government restored the price limit policy in order to reduce the effects of speculative activities. Before, the price limit was withdrawn between 1992 and 1996 with the purpose of stimulating the trading in the Chinese stock market.

detail, which enriches the stock performance profile when the stock market is analysed. Thus, our final issue is how to show bubbles in individual industrial sectors. Nine industrial sectors are studied respectively by comparing their bubble levels with the mean of the market.[71]

7.3.1 A Descending Path of Bubbles in the Chinese Stock Market

The bubble movement in the Chinese stock market over the period of 1996 to 2003 is demonstrated in figures 7.1, 7.2 and 7.3. Figure 7.2 presents three similar paths which eventually reveal the robust results, though there is a slight inconsistency shown between the results of estimation I-B and I-C over the period of 2001 to 2002.[72] In addition, Figure 7.3 shows that bubbles do not follow the trend of stock prices. Between 1996 and 2000, the ascending price accompanies the downward bubble movement, which was caused by the significant improvement of fundamental values of Chinese listed companies during this period. Ahmed, Li and Jr. (2000) verified that the considerable volatility in the Chinese stock market represents the persistence of bubbles during the 1990s. They predicted, however, that bubbles in this market will not exhibit quite as much volatility as they did in the 1990s with a further development of the Chinese stock market.

[Figure 7.1, 7.2 and 7.3 are about here]

In addition, despite a co-moving tendency indicated in figure 7.1, the non-adjusted bubbles move above the adjusted ones only before year 2001, cross through in 2001 and are slightly lower afterwards, which reveals that before 2001, the stock price can be explained more with the consideration of the tradable ratio. This finding implies that the concern of the tradable ratio governs investors inconsistently, i.e. before 2001, investors gave stronger concerns about the tradable ratio than after 2001. The

[71] The sector classification is cited from the SINOFIN database.
[72] The inconsistency is considered as the result of losing observations in model C.

explanation is obvious if one attends to Chinese government policies. Since the non-tradable shares are mostly dominated by the government, the partial liquidity was beneficial to the stability of the stock market from the viewpoint of investors. However, in 1999, the Chinese government promoted a reform aiming to sell a part of the non-tradable shares and formally implemented it in 2001, which caused a big loss to investors because the market was not grand enough to contain a sudden bulk buy. Even though the reform paused at the end of 2001 so as to relieve the chaos, since then the attention of investors to the tradable ratio has eased in valuating stocks, with the Chinese government having shown a clear sign of relaxing non-tradable shares to the stock trading market. No doubt, this event has been the major issue significantly driving the Chinese stock market between 1999 and 2001, which is considered as a reason that the bubble dropped sharply between 1999 and 2001, lowered its speed in 2002 and gradually recovered afterwards.

It is worth mentioning that, in this firm level study of the Chinese stock market, the market average movement of bubbles is slightly different from the figure in the market level estimation (figure 4.2-1). From figure 7.1 and 7.2, the average bubble movement of the A-share market shows a downward tendency over the period of 1996 and 2001; however, in the market level result (figure 4.2-1), bubbles of the A-share market move up between 1996 and 1997 as well as between 1999 and 2000, while they decline most of the time over the period of observation. The slight divergence between figure 7.1 and 4.2-1 may be explained as a result of model transformation and the different size of samples. First, the fundamental valuation structure in the firm level estimation embraces several accounting variables and a risk element while the only fundamental variable, dividend, is used in the market level estimation. The model transformation from a single fundamental variable to a set of accounting variables may lead to the results being partly divergent. Second, in the firm level estimation, more than one thousand Chinese listed companies are employed in the sample; however, there are only four hundred sample companies chosen to constitute the Datastream Chinese A-share market index. It is highly possible that the results from a smaller sample exhibit a bias from the larger sample estimates. It is thought that the firm level bubble estimation may produce more precise results than the market level estimation because of its more detailed fundamental structure and the larger sample size.

7.3.2 Immature Market and Mature Investors

The primary discovery in the last section is a tremendous change in the Chinese stock market from the mania of the 1990s to a reasonably low bubble position. This downward movement can be interpreted as a result of changes in investors' expectations of stock values.

In Figure 7.4, according to the movement of estimated bubbles, we divide the period between 1996 and 2003 into three parts (1996-1999, 1999-2001 and 2001-2003), and then two different bubble trends appear respectively before and after the shadow period (1999-2001). These three periods are named as: adjustment, government shock and the recovery period.

[Figure 7.4 is about here]

It is no more than a repetition if the attention is focused on explaining why the level of bubbles is far higher than the other two mature markets in the adjustment period. As documented in Section 7.1, before 1996 the weak governance and the thin capitalisation of the Chinese stock market provided a huge chance of manipulation (Ma, 2003). In addition, as is commonly recognised, a newly-born market is most likely to stimulate investors' fantasies.

However, after 1996, bubbles appear in a significant downward tendency. Three implications of this declining movement are argued. First, the period of adjustment has its name due to an apparent downward tendency which reveals that investors in this developing market had been already conscious of the fictitious exuberance in that period. Secondly, the open economy brings along the consideration of worldwide shocks, which, between 1998 and 1999, posits the bubble just below the level of the U.S. after a strong reaction to the global financial crisis of 1997 to 1998. Third, the decline of bubbles can be also interpreted as a result of the information flowing from the B-share market where foreign institutional investors make their decision using the valuation technique applied simultaneously in developed stock markets. Sjoo and Zhang (2000) raised an idea that the presence of foreign investors can be a buying signal for the relatively uninformed domestic investors, since the major participants of the B-share market, foreign institutional investors, excel domestic investors in terms of three points: being more experienced, having better means of obtaining information, and having access to more advanced technology to analyse data. Similar opinions are also documented by Chui and Kwok (1998), Lin and Wu (2003), and Yang (2003).

The sharp drop between 1999 and 2001 is attributed to the government reform of the dual-class share system. This was also demonstrated by Zhou and Sornette (2006) who identified an anti-bubble in the Chinese stock market which started in 2001. Jingu (2002) documented that the plan to reduce the quantity of state-owned shares caused a sharp decline in stock prices in the Chinese stock market. This reform has been regarded as a bomb by both investors and researchers that blew down the market expectation of future values. However, our argument for the effect of this government shock on bubbles is that it truly forces investors to change their investment behaviours from over-speculative to less speculative; by which, Chinese stock bubbles are dragged to a low level. The proposed reform created a high risk aversion which resulted in a lower bubble level at the beginning of the 2000s. Being aware of the uncertainty with the higher risk aversion, investors produced a lower level of bubbles in China than in both the U.S. and the U.K. market, which shows evidence that more rationalities have been taken by Chinese investors in their decision-making. This is consistent with the findings of Ahmed, Li and Jr. (2000) who verified that the considerable volatility in the Chinese stock market represents the persistence of bubbles during the 1990s, and further predicted that bubbles in this market will not exhibit quite as much volatility as they did in the 1990s, with a further development of the Chinese stock market.

The last sample period called recovery time is undoubtedly more proof to our argument for rational investors. In these three years, Chinese stock bubbles move below but consistently with the ones in the U.S. and the U.K. market, which shows clear evidence for Laurence et al's (1997) argument that the Chinese stock market is becoming more integrated into the global economy. This implies that investors in the Chinese stock market have already taken global information into account and kept bubbles at a healthy state between 2001 and 2003. The similar finding was also documented by Copeland and Zhang (2003). They detected spectacularly absolute returns characterising the early post-deregulation period, but showing the familiar properties with typical western stock markets in recent years.

Evidence also can be found in the sector study. Figure 7.5 shows the bubble levels of nine sectors respectively.[73] Over the adjustment period of 1996 to 1999, the bubble figure declines in every sector except the sector of telecommunication. The unique rise in the telecommunication sector over the adjustment period is commonly understood as a result of the influence of the American dot-com fad. This phenomenon becomes the first sign of touching the outside world. This finding indicates that international shocks can still affect Chinese investors' decision even in a stock market that is closed to the West. Undoubtedly, an open economy can bring

[73] Since the bubbles calculated from three models are identically moving, it would be nothing more than a repetition if all of these three groups of results were plotted. Thus, only the result from model A is examined.

the “infection” from the international market to its own protected stock market.

[Figure 7.5 is about here]

A more striking finding is that, after 1998, Chinese stock bubbles in all sectors have moved synchronously with bubbles in the U.S. market. In particular, some sectors, such as energy and utility, technology and telecommunication and industry, have already shown this trend earlier than that (see Table 7.5 and Figure 7.5 B). This implies that the integration of China’s economy with the US has been shown by co-movement of Chinese and US investors in response to the industrial performance and shocks since the late 1990s.

[Table 7.5 is about here]

In summary, although China is still struggling to pave a shortcut to catch up with the developed markets, investors in this closed emerging market have learnt from their experience in the past. As a result, when the game is repeated, Chinese investors become more rational than before, which is reflected by a declining trend in the bubble movement.

7.3.3 Chinese Stock Performances at the Industry Level: the Domestic and the International Analysis

In this section, an industry level study of bubbles is carried out. Since diversified classifications for sub-sectors are respectively used in the U.S., the U.K. and the Chinese markets, all firms are reorganised into six sectors so as to make the industry level comparison feasible.

Figure 7.5-A shows the bubble movement of each industry in comparison with the

domestic average. It shows that the average level of bubbles reveals the average expectation of investors for the overall economy, which is called the "moderate bubble". Bubbles of a sector in excess of the average level represent an excessive expectation of this sector, the so-called "excess bubble". In contrast, bubbles of a sector below the average level which signal an under-expectation of this sector, is called the "under-average bubble". Thus, in the 1990s, there were excess bubbles in the area of finance, consumer staples and information technology. However, their bubbles were moderate and were falling below the average at the beginning of the 2000s. In contrast, bubbles in the sectors of energy and utility became higher after 2002. In fact, the bubbles in the energy sector reached an even higher level than the level of bubbles in the telecommunication sector in 1999. To some extent, this figure rings a bubble alarm to the energy share fanatics. The figures also draw one's attention to three sectors: industrials, consumer discretionary product and materials, which are currently important for the Chinese economy. However, one striking issue appears in Figure 7.5-A that bubble levels in these three sectors are not obviously higher than the domestic average level in recent years.

In Figure 7.5-B, if the U.S. market is treated as a benchmark (in fact, it is the benchmark of the Chinese stock market, which can be easily revealed from the figures), it shows that, after two years' descending of bubbles, most sectors started to show their rational patterns. As mentioned above, the reasonable bubble level in the Chinese market is deemed to be lower than the U.S. and the U.K. market due to its lesser fundamental value of the economy and the heavy political risk. Bearing in mind this principle to observe the recent bubble trends, one may easily notice a "red light" in the sector of energy and utility, where the bubble level is far beyond the ones in the U.S. and the U.K. markets in 2003. The dangerous signal is also thrown to the sector of industry, where bubbles almost move to the same level with the other two markets. In contrast, there is a big distance between the U.S. and the Chinese bubble lines in the healthcare sector. It seems too early to draw a conclusion that there is an opportunity to invest healthcare in the Chinese stock market, because one may be suspicious of a healthcare fad in the U.S. market as it also runs too far from the U.K. market.

Combining the domestic and international analyses together, one may draw a conclusion that bubbles in the sector of energy and utility is extremely active in the Chinese stock market, and the new investment to this sector risks a large probability of a bubble burst. The industry sector is the second danger. Despite an optimistic result for this sector shown in the domestic analysis figure, the international comparison brings the reconsideration to this positive opinion.

It is easy to see that the estimated bubbles can provide us with a quantitative signal to detect if the price is overheated for a particular company or sector. Given the estimated bubbles, a careful comparison of bubbles between the domestic and the international market is still required for assessing the extent of any overheated investment on stocks.

7.4 Summary and Conclusion

By applying the firm level value frontier model to Chinese listed companies, we can estimate Chinese bubbles at the firm level or the industrial level and compare them with bubbles in other stock markets. The comparison of estimated bubbles between different markets reveals that first, over the period of 1996 to 2003, bubbles in the Chinese stock market performed a decreasing tendency, and with the result of the great deal of uncertainty in the Chinese market and the expectation for lower profitability of listed companies, Chinese stock bubbles are conceived to move below the U.S. and U.K. bubble levels, particularly after year 2000; second, in recent years, among the Chinese, the U.S. and the U.K. markets, it shows a clear tendency for

Chinese stock bubbles to co-move with the bubble paths in the other two open markets, especially the U.S. market; third, the Chinese stock market is still under-developed and closed with continuous reforms, but Chinese investors seem to behave more rationally in recent times than we expect. Finally, estimated bubbles in the Chinese stock market offer us evidence in support of an argument that even in a closed stock market in terms of capital flow, its investors can still improve their investment behaviours towards rationality by learning not only from the experience in the past but also from other opened markets. Indeed, the significant decreasing trend of Chinese bubbles shows that behaviours of Chinese investors have been converging to those in opened markets.

Withstanding the above significant findings, however, the bubble study for the Chinese stock market is not completed, since the B-share and the H-share markets are not taken into account in this chapter. The anticipated bubble comparisons between the A-share market and the B-share (or H-share) market may enable us to gain an insight into the discrepant behaviours of the Chinese investors in the segmented markets. This in turn brings us an interesting question: Are the fundamental values the same for a dully listed company in the A-share market and the B-share (or H-share) market? This question is acute in the bubble study for the Chinese stock market, since there is an identical payoff structure but there are also divergent price movements in these two markets. Explicitly, from the supply perspective, the fundamental values of a dully listed stock in A and B (or H) share markets should be the same, since we define the fundamental value as the present value of future dividends stream. However, in our firm level model, we have introduced a risk element into the model. Therefore, from the demand perspective, the fundamental value could be perceived differently since investors' opinions on the market risk could be regarded differently for different markets. This expectation needs to be tested against observations of the real world. As a result, this raises an interesting question for future research: how are risks perceived differently in different markets?

Apparently, the market segmentation in the Chinese stock market brings us a very interesting picture that if the fundamental value of A and B (or H) share is justified to be the same, the divergent prices in these two markets can be solely explained as a result of different levels of optimism effects and speculative effect. Implicitly, this may also solve a question: Why does segmented trading cause segmented markets?[74] The answer would not only be the asymmetric information but could also be found in the further study of bubble formation or investors' behaviours.

[74] Segmented trading does not always result in segmented markets because cross-market informational links or arbitrage can work. (Yang, 2003)

Appendices

Appendix 7.1 Data Definition

Book Value Per Share represents the book value of equity (total ownership divided by total number of shares) at the end of calendar year.

Earnings Per Share represents the earnings for the 12months ended at the calendar year. It is the net profit divided by the total number of ordinary shares.

Annual Share Prices represents share prices at the end of the calendar year. It is the last trading day's total market value of a company's tradable A-shares divided by its quantity.

Tradable Ratio represents the ratio of the amount of tradable A-shares to the number of total shares excluding B-shares and H-shares. The total shares include both preference and ordinary shares.

Beta Value represents the relative risk of every individual share to the total market risk. The calculation formula is based on Myron Scholes and Joseph Williams (1977)[75].

$$\beta_i = \frac{\sum_t (R_{it} \cdot \tilde{R}_t^m) - \frac{1}{n}\sum_t R_{it} \cdot \sum_t \tilde{R}_t^m}{\sum_t (R_t^m \cdot \tilde{R}_t^m) - \frac{1}{n}\sum_t R_t^m \cdot \sum_t \tilde{R}_t^m}$$

$$R_{it} = \ln(1 + daily \quad resturn \quad of\ share \quad i) \quad R_t^m = \ln(1 + market \quad resturn)$$

$$\tilde{R}_t^m = R_{t-1}^m + R_t^m + R_{t+1}^m$$

n is the number of observations

[75] 'Earnings Betas from Nonsynchronous Data' Journal of Financial Economics, Vol 5, 1977, 309-327. The beta value data is directly downloaded from SINOFIN Database.

Tables and Figures

Table 7.1 Average Return On Equity (ROE) of Sample Firms

Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
China	0.09096	0.09198	0.08656	0.09045	0.07852	0.06183	0.05379	0.05845
U.K.	0.10635	0.11752	0.09213	0.08686	0.06295	0.03810	0.05026	0.06954
U.S.	0.12529	0.12310	0.11519	0.12537	0.12857	0.08716	0.09752	0.11808

ROE=Earning÷Shareholder's Equity; Data sources: Datastream and SINOFIN Data Service China

Table 7.2 Statistics of the Chinese Stock Market (1996-2003)

	1996	1997	1998	1999	2000	2001	2002	2003
Total No. of A-share Firms	514	720	825	923	1060	1133	1201	1262
Total No. of A and B-share Firms	530	745	851	949	1088	1160	1224	1287
No. of A-shares (Million shares)	26732	44268	60803	81318	107816	132387	150908	171460
Total No. of Tradable Shares	42985	67144	86194	107964	135426	183047	204160	226758
Total No. of Shares	121954	194267	252679	308895	379171	525106	587546	642846

Data sources: Chen *et al.* (2005)

Table 7.3 the First Stage Estimation of Bubbles in the Chinese Market

Dependent Var. P	**Model A**	**Model B**	**Model C**
Independent Var.			
Intercept	10.9485 (6.20)	11.4967 (6.68)	12.7364 (24.65)
V_{it}	2.3912 (14.12)	2.1400 (12.42)	2.2952 (13.51)
K_{it}	0.4725 (5.88)	0.5920 (7.29)	0.4792 (6.00)
ΔK_{it-1}	2.57 (2.57)	1.1847 (6.18)	0.4474 (2.57)
$\beta_{it}\ K_{it-1}$	-	-0.5530 (-9.16)	-
β_{it}	-		-1.7043 (-9.28)
Statistics of Estimations			
Numbers of Obv.	5331	5310	5309
R^2 within between overall	0.4945 0.9937 0.7022	0.5087 0.9944 0.7109	0.5087 0.9944 0.7109
Wald Test χ^2	6710.77 [0.0000]	7006.03 [0.0000]	7002.78 [0.0000]
AR1	0.4087	0.3948	0.3956
σ_e	3.1047	3.0763	3.0759
Hausman Test χ^2 H0: Random Effects	152.17 [0.0000]	88.79 [0.0000]	75.03 [0.0000]
Breusch-Pagan/Cook-Weisberg Test for Heteroskedasticity χ^2 H0: Constant Variance	9400.78 [0.0000]	9503.00 [0.0000]	9180.05 [0.0000]
Modified Bhargava DW	1.2531	1.2755	1.2926
Baltagi-Wu LBI	1.6970	1.7096	1.7236

Note: 1. t ratios are in parentheses, and p values are in square brackets;

2. R^2 values reported in the table are correlations squared which are from the second –round regression $p_{it} = \gamma\ \hat{p}_{it}$;

3. All the statistical tests proceed from the estimation before controlling autocorrelation and heteroskedasticity.;

4. Time and firm dummies are included.

Table 7.4 the Second Stage Estimation of Bubbles in the Chinese Market

Dependent Var. $p_{it} = \ln P_{it}$	**Estimation I-A**	**Estimation II-A**	**Estimation I-B**	**Estimation II-B**	**Estimation I-C**	**Estimation II-C**
Independent Var.						
Intercept	1.6645 (73.64)	1.8340 (97.30)	1.6912 (67.77)	1.8242 (85.04)	2.1093 (65.66)	2.2881 (107.68)

$\hat{p}_{it} = \ln \hat{P}_{it}$	0.2214 (21.91)	0.2083 (20.46)	0.2112 (131.83)	0.2092 (20.67)	0.1180 (17.79)	0.1173 (23.79)
$lr_{it} = \ln LR_{it}$	-0.2991 (-15.95)	-	-0.3152 (-9.53)	-	-0.3392 (-7.87)	-
T_{1997}	0.1190 (72.98)	0.1087 (4.89)	0.0949 (3.70)	0.1124 (4.39)	0.0402 (65.66)	0.0401 (55.96)
T_{1998}	0.2319 (15.12)	0.2097 (10.00)	0.2223 (10.58)	0.2343 (11.13)	0.1146 (5.49)	0.0984 (4.45)
T_{1999}	0.3354 (20.48)	0.3013 (16.60)	0.2905 (13.85)	0.2881 (13.72)	0.1052 (5.05)	0.0815 (3.88)
T_{2000}	0.8093 (45.28)	0.7457 (41.34)	0.7643 (36.33)	0.7376 (34.92)	0.5572 (23.76)	0.4911 (24.29)
T_{2001}	0.5100 (28.46)	0.4509 (25.01)	0.4732 (22.42)	0.4354 (19.39)	0.2878 (11.51)	0.2043 (9.87)
T_{2002}	0.2390 (15.46)	0.1769 (9.78)	0.2139 (9.21)	0.1584 (7.09)	0.0346 (1.35)	-0.0655 (-3.19)
T_{2003}	-0.0296 (-1.77)	-0.0903 (-4.58)	-0.0530 (-2.40)	-0.1071 (-5.08)	-0.1522 (-5.92)	-0.2518 (-11.98)
Statistics						
Number of Obsv.	4416	5018	4202	4202	2748	2748
$\lambda = \sigma_b / \sigma_v$	4.37×10^{8}	3.95×10^{8}	4.06×10^{8}	5.99×10^{8}	2.61×10^{8}	2.36×10^{8}
σ_b	0.3541	0.3646	0.3513	0.3557	0.3195	0.3240
σ_v	8.1×10^{-10}	9.22×10^{-10}	8.66×10^{-10}	5.93×10^{-10}	1.23×10^{-10}	1.37×10^{-9}
σ^2	0.1254	0.1329	0.1234	0.1265	0.1021	0.1050
Log Likelihood	1379.2381	1421.0224	1345.7846	1294.1648	1140.965	1102.9585
Likelihood Ratio Test H0: $\sigma_b = 0$	1900 [0.000]	2100 [0.000]	1700 [0.000]	1700 [0.000]	1200 [0.000]	1200 [0.000]

Note: t ratios are in parentheses, and p values are in square brackets.
Time and firm dummies are included.

Table 7.5 Integration of Bubbles in Three Sectors between US and China

year	Technology and Telecommunication		Energy and Utility		Industry	
	US	China	US	China	US	China
1996	1.472508	1.320992	1.38724	1.53855	1.392403	1.56355
1997	1.411178	1.44514	1.34616	1.60273	1.441377	1.40764
1998	1.483556	1.516349	1.31951	1.40251	1.405751	1.25772
1999	1.773224	1.667804	1.28079	1.25962	1.422747	1.40553
2000	2.29298	1.521345	1.36456	1.18104	1.432372	1.26018
2001	1.536797	1.27684	1.37947	1.2207	1.359915	1.25007
2002	1.380606	1.238778	1.32091	1.28003	1.39269	1.23841
2003	1.371009	1.238048	1.32979	1.69774	1.360339	1.31026

Figure 7.1 Comparison of Adjusted and Unadjusted Bubbles (From Estimation I-A and II-A)

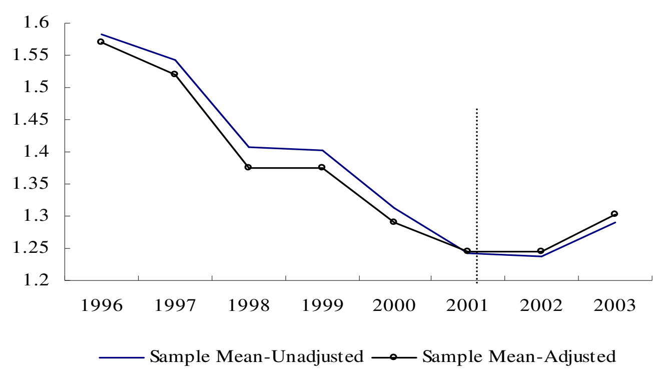


Figure 7.2 Comparisons of Bubbles among Estimation I-A, I-B and I-C

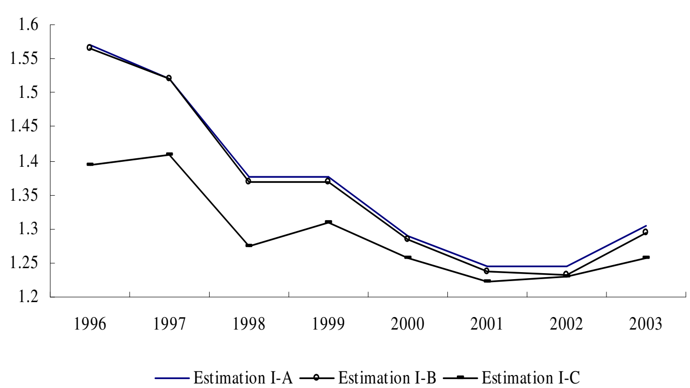


Figure 7.3 Stock Prices, Fundamental Values and Bubbles: Market Average Values (From Estimation II-A)

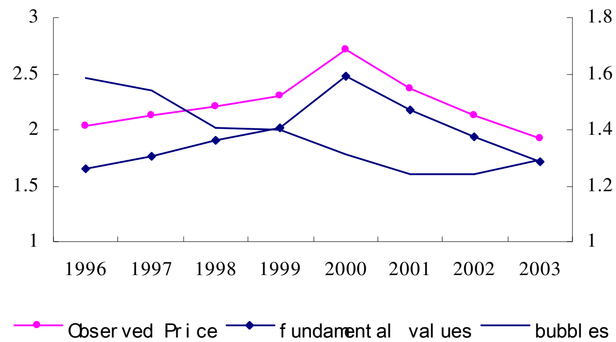


Figure 7.4 Comparisons of Bubbles among Three Markets[76]

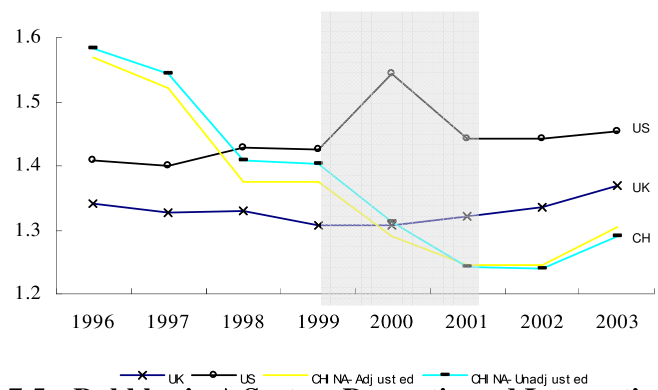
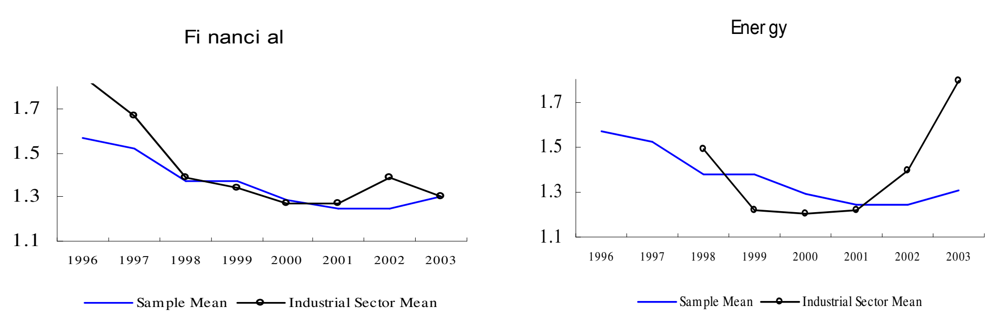


Figure 7.5 Bubbles in A Sector: Domestic and International Comparisons

A. Domestic Comparison



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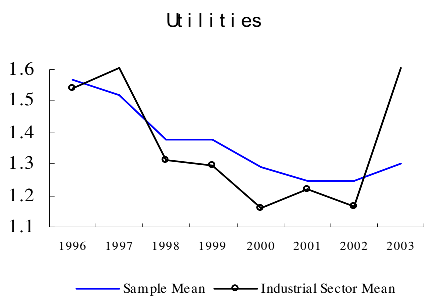
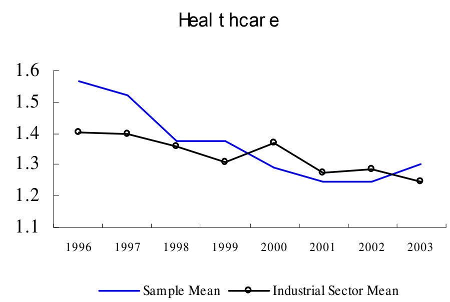
[76] Bubbles are estimated from Model A.


Utilities
1.6
1.5
1.4
1.3
1.2
1.1
1996 1997 1998 1999 2000 2001 2002 2003
Sample Mean
Industrial Sector Mean


Healthcare
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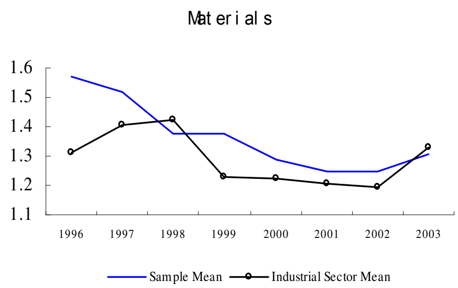
1.4
1.3
1.2
1.1
1996 1997 1998 1999 2000 2001 2002 2003
Sample Mean
Industrial Sector Mean


Materials
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1.3
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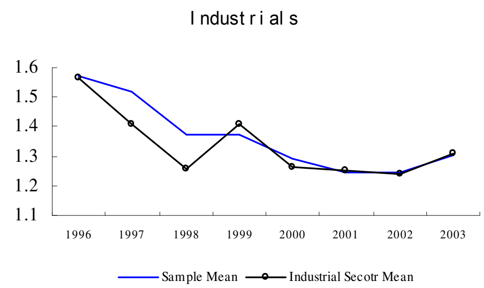
1.1
1996 1997 1998 1999 2000 2001 2002 2003
Sample Mean
Industrial Sector Mean


Industrials
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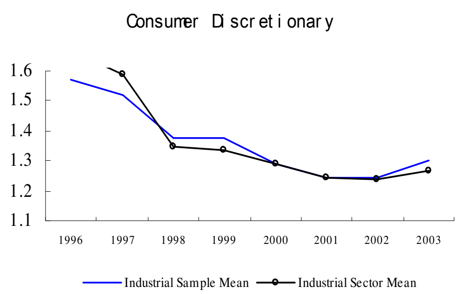
1996 1997 1998 1999 2000 2001 2002 2003
Sample Mean
Industrial Secotr Mean


Consumer Discretionary
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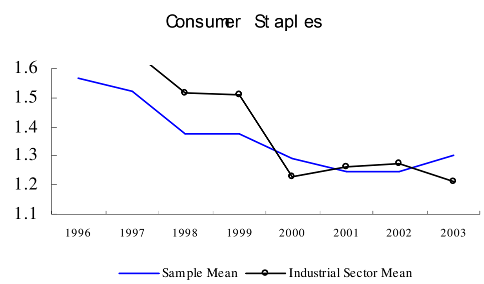
1.4
1.3
1.2
1.1
1996 1997 1998 1999 2000 2001 2002 2003
Industrial Sample Mean
Industrial Sector Mean


Consumer Staples
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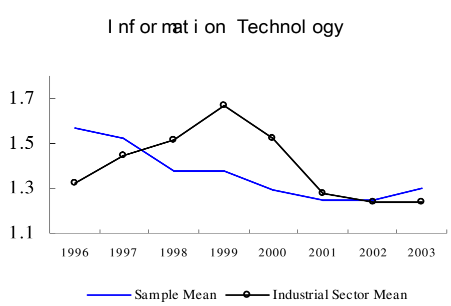
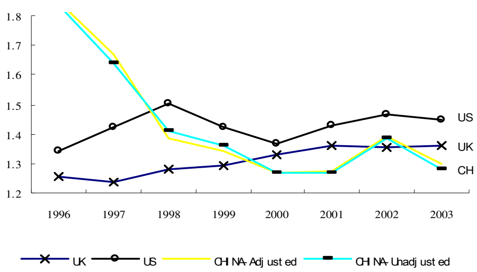
1.5
1.4
1.3
1.2
1.1
1996 1997 1998 1999 2000 2001 2002 2003
Sample Mean
Industrial Sector Mean

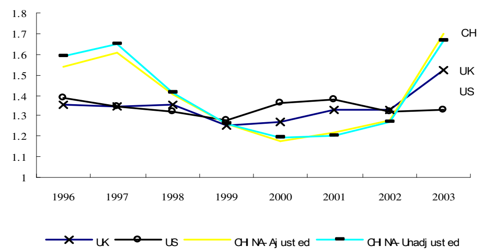

Information Technology
1.7
1.5
1.3
1.1
1996 1997 1998 1999 2000 2001 2002 2003
Sample Mean
Industrial Sector Mean

International Comparison

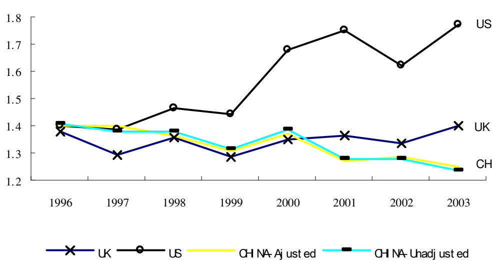
Financial



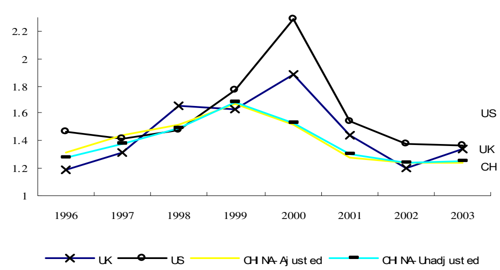
Energy and Utilities



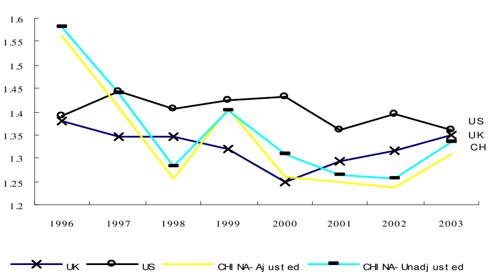
Healthcare



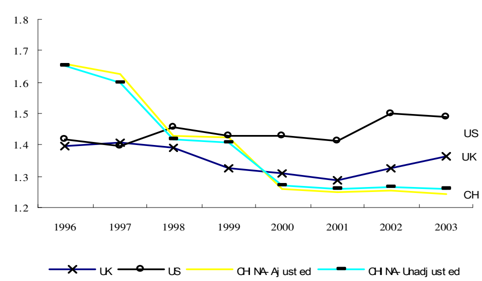
Technology and Telecommunication



Industrials



Consumer



Chapter 8 Conclusions and Further Research

The EMH, which was once at the forefront of financial economics, is now accepted as being outdated. More and more researchers, such as Shiller (1981), Campbell and Kyle (1993), Kahneman and Riepe (1998), Shleifer (2000), and Thaler (1999, 2005) believe that the intricate plot in capital markets can hardly be explained by the traditional paradigm of the efficient market. Instead, the new studies of security prices, such as rational bubbles and behavioral finance, theoretically and empirically lead us to consider the financial market to be inefficient. Furthermore, it is argued that systematic and significant deviations from efficiency in stock markets are expected to persist for long periods of time (Shleifer, 2000). With this in mind, it is considered that the ongoing new area of research in market inefficiency is a remarkable alternative to the EMH for providing fresh explanations to the progressively capricious behaviours of stock markets. Thus, the study of an inefficient market is expected to embrace three layers of topics relative to market inefficiency: how to verify it, how to measure it, and what causes it. Remarkably, the research for the first and the third topics have been broadly documented. In fact, the third question is the central topic of behavioural finance which has already set itself as "open-minded finance" combining twin disciplines of psychology and finance (Thaler, 1993; Belsky and Gilovich, 1999). However, the second question is still a blank area. Our study of stock market bubbles in this thesis aims to develop a new methodology, the value-frontier estimation method, to measure both market level and firm level stock bubbles which will facilitate the second layer of research to take off.

8.1 The Advantages of the Value Frontier Methodology

In our work, the value frontier methodology excels as a first attempt to measure stock bubbles. It is born with a belief that a stock market is inefficient due to the heterogeneity of investors. Especially, it is known that people in general and investors in particular, are not fully rational (Shleifer, 2000). The advantages of the value-frontier methodology can be summarized as follows.

First, it regards EMH as an idealistic situation of equilibrium, which is consistent with the discipline of rational bubbles (for example, Shiller, 1981; Blanchard and Watson, 1982) and behavioural finance (for example, Thaler, 2005). Moreover, unlike both the schools of rational bubbles confining bubbles in a rational framework, and behavioural researchers mainly focusing on the psychological evidence of irrationalities, the value-frontier theory gives rise to a new approach to estimating bubbles combining both the rationality and the irrationality together, which extends the concept of bubbles to a broader horizon.

Second, it is apparent that the magnitude of fundamental values are hardly ever calculated since they depend on the values produced in the future which cannot be truly perceived by people at present, as portrayed by a Greek poet (1863-1933)[77]: "men know what is happening now; the gods know the things of the future." To overcome this problem, a value frontier, which is modelled by several fundamental variables, acts as a proxy of fundamental values so that a bubble index defined by actual stock prices over the value frontier is estimated by applying the cost frontier estimation technique. For the model, it is unnecessary to devise a forecast procedure to calculate the fundamental values, and fundamental variables in the model can be adjusted according to any particularities.

Third, in the models of rational bubbles, various assumptions about the bubble moving path or the probability of collapsing have been applied (for example, Blanchard and Watson, 1982; West, 1987; Diba and Grossman, 1988b; and Fukuta, 1998 etc.). Compared to the various hypothesis tests in rational bubble research, value frontier modelling is more parsimonious in that no assumption about the

[77] Source: http://introduction.behaviouralfinance.net/Schm02.pdf

bubble moving path is required in the model.

Finally, the existing tests of bubbles are mostly done in time-series data and results are diversified. Summers (1986) attributes the failure of finding contradictory evidence of EMH to the low power tests of the time series. He illustrates that it takes a lot of data and perhaps a better theoretical idea of what to look for before researchers can find persuasive evidence. In the value frontier estimation of panel data, the likelihood ratio test on the existence of inefficiency is then applied to the sample. This test rejects consistently the non-existence of bubbles across different samples, which provides us with a legitimate condition to estimate bubbles. Thus, it is argued that using the panel-data approach to test bubbles is more powerful than using conventional time-series-data-based tests which could result in a failure in verifying bubbles.

In summary, due to the above advantages of the value frontier methodology, the innovative ideas of the value frontier estimation will create a new approach to the research of market inefficiency. Moreover, the estimated bubble will undoubtedly provide us with critical information for the future research of financial economics.

8.2 The Relevance of the Estimated Bubbles

The major contribution of this work is to produce an estimated bubble (or bubble index) which represents the magnitudes of stock bubbles. While manifesting the success of the measurement, it is also worth emphasising the roles of estimated bubbles in the fields of both the academia and the practice so as to highlight the significance of this research.

8.2.1 The Further Relevance of the Estimated Bubbles in Academia

Obviously, the academic and practical uses of the estimated bubble are extensive as it has been the only variable purely reflecting bubbles until now. The conventional variables representing stock market performances, such as the price index, stock returns, and the share price volatility, do not serve well to present bubbles as they all inextricably contain the fundamental factor of stocks. The doubts are also cast on some "market fever" variables, such as the price earning ratio, the price dividend ratio, and the price book value ratio, which are not able to embrace more than one fundamental variable at the same time. Instead, the estimated bubble is assigned to play a unique role superior to those conventional variables, in that it purely represents the bubble without commingling with any fundamental elements. Any "impurities" can be weeded out by improving the value frontier modelling.

In academia, the estimated bubble can potentially improve researches in two broad areas: research on stock market inefficiency; research on the relationship between a stock market and an economy.

The major contribution of this work is certainly to enhance the research of the inefficient market. As introduced at the beginning of this chapter, among three layers of research in the inefficient market (verification, measurement and explanation), the second layer of research which is "how to measure the market inefficiency" is still blank, while the other two are not sufficient to replace the efficient market theory due to the scanty evidence. As Shleifer (2000) mentioned, "although we may reject the null hypothesis of market efficiency with more confidence than before, we still know relatively little about such key determinants of prices as expectations about fundamentals, discount rates and simple movements of demand." To some extent, the crux of understanding the determinants of stock prices is to explain bubbles. If the variable of estimated bubbles takes a proxy of stock bubbles, the effect of explanatory factors on stock bubbles can be revealed more easily. Obviously, the measurement of bubbles in our work will not only fulfil the gap of the second layer of research, but also empirically improve studies in the other two layers in obtaining more evidence in support of market inefficiency, especially the behavioural research which is the most potential area leading the future of the financial research.

This brings out another benefit of the estimated bubbles. With the variable of estimated bubbles, many topics about the interaction between the stock market exuberance and real economic behaviours can be further explored (for example, the topic of share price-inflation relationship which is studied in Chapter 5). Moreover, while believing the real economy is the cause to soar or suppress stock bubbles through investors' perception, the reverse investigations, for example, how the stock market bubble gives rise to the instability of an economy, is also liable to be obtained using the estimated bubbles. In this case, the value frontier estimation explores a path leading to the future research on the effects of bubbles on the real world economic performance. For example, Binswanger (1999) argues that stock bubbles persist since they are not reproducible assets and their fundamental values are obscure. He also highlights remarkable roles of a sustainable bubble in the interaction between a stock market and a real economy. In this view, the extraordinary exuberance is not the only sign of bubbles. Instead, bubbles persist in stock markets due to the expectation distortion in existence commonly, and a sustainable bubble is expected to facilitate real economic activities. Our work is in support of Binswanger's (1999) argument of persistent bubbles by developing a new methodology to estimate the magnitude of persistent bubbles. This new development helps to verify and improve the argument of Binswanger (1999).

8.2.2 The Relevance of the Estimated Bubbles in the Real World

The academic use of the estimated bubbles is remarkable, and the applications of it in practice are also highly valuable. The estimated bubbles (or the "bubble index") are like a thermometer persistently inspecting the "fever" of a stock market. The bubble is no longer invisible and stealthily inflated until a crash. It can always be detected even when there are no any signs of heavy irrationalities and a collapse. This can be achieved from both macro and micro horizons. The macro bubble index represents market level bubbles which measure the overpricing level for a stock market at a point of time. A stock market can get self-supervised by checking its bubble movements in time or comparing its bubbles with other stock markets around the world at a point in time. The firm level bubble index can reveal the degree of overvaluation for each single stock, which is expected to reduce the mania and irrationalities in a stock market. Being aware of the bubble accumulation of a particular stock, the confidence in this stock may be diminished with the bubble inflating. This will help to reduce both the irrationality and the expectation distortion in stock markets tremendously, since investors can be conscious of the mania by checking the bubble index of a stock or an industrial sector. In addition, a domestic and international analysis of stock bubbles obtained by the firm level bubble index will be extremely helpful in enhancing the professional’s horizon in stock analysis.

8.3 Is the Market Efficient?

In EMH, the efficiency of a stock market is concerned in accordance with the disclosure of information. Fama (1970, 1991) defined that a market in which prices always fully reflect available information is called “efficient”. Jensen (1978) further stated that a market is efficient with respect to an information set if it is impossible to make economic profits by trading on the basis of the information set. The degree of efficiency is then classified into three categories with respect to information revealed to all participants: the weak form efficiency (the information set includes only the history of prices), semi-strong form efficiency (the publicly available information is known to all market participants), and strong form efficiency (all information including private information is known to any market participants). A crucial assumption of this argument is that all investors act according to the rational expectation model (Shiller, 1989).

The challenge can be raised to the EMH from two perspectives. First, the rational expectation of investors doesn't mean that investors must locate stock prices on their fundamental values. There could be a rational deviation from the fundamental value which is called "rational bubbles" (Blanchard and Watson, 1982 etc.). Second, with development of an idea of heterogeneous expectations, the assumption of rational expectations has been called into question by many researchers (for example, Shiller 1989). In other words, investors are not homogeneous but heterogeneous and their expectations are not fully rational.

Therefore, the study of market efficiency should be extended from a test of information revealing efficiency to a broader horizon of investors' efficiency in responding to given information. In contrast with the EMH, our study tests and measures the information-responsive inefficiency with an assumption that information is identical to all market participants and stock valuation technique is a common knowledge in a market. The finding of this study is that stock bubbles caused by the information-responsive inefficiency persist in stock markets, in which this can be shown by the world-wide average market level bubbles remaining at 12% above the fundamental values. This finding brings us a further question: Is it right to call a stock market with a stable movement of bubbles inefficient? If not, how should one define the responsive efficiency or inefficiency? To answer these questions, the view of "sustainable bubbles" from Binswanger (1999) is employed in our argument. He argued that stock bubbles exist persistently since fundamental values of stocks are uncertain. A "sustainable bubble" can positively facilitate the growth of an economy, and a bubble is "sustainable" in the long run only if its movements are consistent with real economic activities.

Following the above argument of Binswanger (1999), we claim that a market without bubbles is completely efficient from the perspective of investors' responsiveness to given information; a market with "sustainable bubbles" (bubbles that co-move with the economy), which results from rational responses to economic conditions, is in the strong form of information-responsive efficiency; a market with "non-sustainable bubbles", i.e. the bubble changes are not linked closely with economic foundations, is in the weak form of information-responsive efficiency.

Thus, on the basis of the findings from our empirical work, we conclude that the world-wide stock market is the weak form of the information-responsive efficiency with a relatively stable bubble at 12% above the fundamental value. Out of the UK, the US and Chinese stock market, the UK market is weakly responsively efficient in reacting to information. The US has been in the weak form of the information-responsive efficiency most of the time but it appeared to be inefficient in terms of information responsiveness over the period of 1999 to 2000, due to an "irrational exuberance" that resulted in a collapse. The Chinese stock market was responsively inefficient in the 1990s, but has moved towards to the weak form of the information-responsive efficiency over the period of 2001 to 2003.

8.4 Discrepancies and Further Research

The value frontier methodology developed by this thesis creates a new approach in financial research. However, like any ideas in their infancy, the contributions of this work are more appreciated as its freshly invented concepts than the results obtained. Certainly, some discrepancies in this work leave a gap waiting to be filled in. More delicate work is expected to be conducted to overcome the current problems in the value frontier estimation.

First, the theoretical analysis on the value frontier framework is mostly based on the form-analogy between the cost frontier model and the stock price model (i.e. price equals fundamental value plus bubble). The arguments concerning fundamental valuation and bubble formation are brief and descriptive in this work, and there is no thorough mathematical modeling to further explain the causes of bubbles. Apparently, the major attention in the future work could be paid to enriching the theoretical bases so that the value frontier framework becomes not only a methodology but a work containing the full complex of both theory and empirical estimation.

Secondly, the model demonstrated in this work is merely at a conceptual phase. The model can be improved by further enriching the fundamental variables. In the market level estimation, only one fundamental variable, dividends, is in the model to capture fundamental values. In the firm level estimation, only the basic framework of the F-O model is utilized. No doubt, a more ample model, which embraces a more comprehensive account of fundamental valuation, can considerably improve the accuracy of the estimated bubble. In this case, it is expected that in future research, more detailed fundamental factors will be added to the market level model and some selective research contributions about companies' valuation, for example, the economic value-added (EVA) model, may be employed in the firm level model. In addition, the derivation from the theoretical model to the empirical model in the rational bubble study is borrowed to our work which shows a significant weakness in the empirical modeling, since the theoretical model is an ex ante framework but the empirical model becomes a deterministic structure. It is suggested that some proxies of uncertainty may be taken into account in the future research as long as this new model can be well justified.

Thirdly, a key assumption, that a negative bubble could exist in a spot price or a very short run price but not in the medium or the long run, is employed for the value frontier theory. However, the annual price data used in our estimation are the last trading prices of a year, in which we assume that it represents a long-run valuation of a stock. This assumption needs to be tested in using the long-run price of a stock, for example, an average price of a month or a year, since the spot price might be undervalued below the fundamental at a spot time. Thus, looking for more appropriate data to take a proxy of the long-run price movement is another further project in the future.

Finally, from an information perspective, bubbles specified by the value-frontier approach are more informative than rational bubbles, since the value-frontier-specified bubbles are caused by the interaction of rationality and irrationality. This obscurity may cause a problem for the behavioural analysis in that it explains the market by some psychological phenomena which are mainly within the irrational scope. The work of identifying rationality/irrationality is a challenging topic. A rough idea of setting up a basket of rational benchmark variables to test the rationality of bubbles will be further explored in our future research.

8.5 Summary

All the efforts on the bubble research are conducted with a promising goal that will eventually build up a comprehensive theory of inefficient markets. Clearly, this final goal cannot be achieved only with partial advancement. The theoretical and empirical endeavors must be made to embody three sub-research areas: the company performance valuation, the bubble measurement and the investors' behaviours, which are able to jointly explain the price fluctuation and the inefficiency of a stock market. Obviously, our work of measuring bubbles, the area of which is neglected at present, takes a big step forward to the final agenda of the research, which illuminates a very promising way of proving empirically the inefficiency of a stock market.

However, just like other studies in the stock market inefficiency, our work in this thesis is just a start in terms of measuring stock bubbles, and nothing have been concluded. This view can be better presented by the comment of Thaler (2005) on behavioural finance that “this is a lot of accomplishment in a short period of time, but we are still much closer to the beginning of the research agenda than we are to the end.” We all know that every good race begins with one step, and though this step may be shaky at the first, it is undoubtedly the foundation for greater things to come.

References

Abreu, Dilip and Brunnermeier, **Markus K.,** 2003, “Bubbles and Crashes,” Economerica, Vol.71, No.1, 173-204.

Ackert, Lucy F. and Hunter, **William C.,** 1999, “Intrinsic Bubbles: The Case of Stock Prices: Comment,” The American Economic Review, 89, 5, 1372-1376.

Ackert, Lucy F., Narat Charupat, Bryan K. Church, and Richard, **Deaves,** 2001, “Bubbles in Experimental Asset Markets: Irrational Exuberance No More, Federal Reserve Bank of Atlanta,” Working Paper, 2002-2024.

Adam, M. C. and Szafarz, A, 1992, “Speculative Bubbles and Financial Markets,” Oxford Economic Papers, 44, 626-640.

Aggarwal, Rajesh K. and Wu, Guojun, 2003, “Stock Market Manipulation-Theory and Evidence,” Working Paper.

Ahmed, Ehsan, Li, Honggang and Jr, J. Barkley Rosser, 2000, “Nonlinear Bubbles in Chinese Stock Markets in the 1990s” (First draft)

Ahmed, Ehsan, Li, Honggang and Jr, J. Barkley Rosser, 2003, “Nonlinear Bubbles in Chinese Stock Markets in the 1990s” (New)

Aigner, D., Lovell, C.A.K., and Schmidt, P., 1977, “Formulation and Estimation of Stochastic Frontier Production Function Models”, Journal of Econometrics, 6, 21-37.

Allen, Franklin and Gale, Douglas, 2002, “Asset Price Bubbles and Stock Market Interlinkages,” Working Paper.

Allen, Franklin and Gorton, Gary, 1991, “Rational Finite Bubbles,” Working Paper.

Alpert, Marc and Raiffa, Howard, 1982, “A Progress Report on the Training of Probability Assessors, ” Judgment under Uncertainty: Heuristics and Biases, Cambridge University

Press.

Arestis, Philip,Demetriades, Panicos O and Luintel, Kul B., 2001, **“**Financial Development and Economic Growth: The Role of Stock Markets,” Journal of Money, Credit and Banking.33, 1,16-41.

Ayat, L., and P. Burridge, 2000 “Unit root tests in the presence of uncertainty about the non-stochastic trend, ” Journal of Econometrics 95 (1): 71–96.

Bajona, C. and Chu, T., 2004, “China’s WTO Accession and Its Effects on Chinese State Owned Enterprises”, Working Paper.

Barsky, Robert B. and DeLong, J. Bradford, 1993, “Why Does the Stock Market Fluctuate?” Quarterly Journal of Economics, 108, 291311

Beck,Thorsten & Levine, Ross, 2004. "Stock Markets, Banks, and Growth: Panel Evidence," Journal of Banking and Finance, 28, 423-442.

Belsky, Gary and Gilovich, Thomas, 1999, “Why Smart People Make Big Money Mistakes-and How to Correct Them: Lessons from the New Science of Behavioral Economics,” Simon & Schuster.

Bernard, Victor L., 1995, “the Feltham-Ohlson Framework: Implications for Empiricists,” Comtemporary Accounting Research, Vol.11, No.2, 733-747.

Bhaopichitr, Kirida, 1997, “Thailand’s Road to Economic Crisis,”
http:// www.hartford-hwp.com/archives/54/113.html.

Binswanger, Mathias, 1999, “Stock Markets, Speculative Bubbles and Economic Growth,” Edward Elgar Pub.

Binswanger, Mathias, 2004, “How Important are Fundamentals?- Evidence from a

Structural VAR Model for the Stock Markets in the US, Japan and Europe," Journal of International Financial Markets, Institutions and Money, 14, 185-201.

Black, F., 1986, "Noise," Journal of Finance, 41, 529-43.

Blanchard, Olivier J., 1979, "Forward and Backward Solutions for Economies with Rational Expectations," A.E.R. Papers and Proc. 69 (May 1979), 114-18.

Blanchard, O.J. and D. Quah, 1989, "The Dynamic Effects of Aggregate Demand and Supply Disturbances," American Economic Review 79, 655-673.

Blanchard, Olivier J. and Watson, Mark W., 1982, "Bubbles, Rational Expectations, and Financial Markets," in Paul Wachtel (Ed.), Crises in the economic and financial structure. Lexington, Mass.:Lexington books.

Bohl, Martin T., 2003, "Periodically Collapsing Bubbles in the US Stock Market?" International Review of Economics and Finance, 12, 385-397.

Bosworth, B., 1975, "The stock market and the economy," Brookings Papers on Economic Activity, 257-300.

Boyd,John H., Hu, Jian and Jagannathan, Ravi, 2005, "The stock market's Reaction to Unemployment News: Why Bad News Is Usually Good for Stocks," The Journal of Finance, Vol. LX, No.2, 649-672.

Branch, Ben, 1974, "Common Stock Performance and Inflation: an International Comparison," The Journal of Business, Vol.47 No.1, 48-52.

Brandt, Michael W. and Wang, Kevin Q., 2003, "Time-Varying Risk Aversion and Unexpected Inflation," Journal of Monetary Economics, 50, 1457-1498.

Brenner, Robert, 2002, "The Boom and the Bubble: the US in the World Economy," Verso.

Buehler, R., Griffin, D., and Ross, M., 1994, “Exploring the Planning Fallacy:Why People Underestimate Their Task Completion Times,” Journality of Personality and Social Psychology 67,366-81.

Campbell, John Y. and Cochrane, J. H.,, 1999, “By Force of Habit: A Consumption-based Explanation of Aggregate Stock Market Behavior,” Journal of Political Economy, Vol.107, 205-251.

Campbell, John Y. and Kyle, A. 1993, “Smart Money, Noise Trading, and Stock Price Behavior,” Review of Economic Studies, 60, 1-34.

Campbell, John Y. and Shiller, Rober J., 1987, “Cointegration and Tests of Present Value Models,” Journal of Political Economy, Vol.95, No.5, 1062-1088.

Campbell, John Y. and Shiller, Rober J., 1988a, “Stock Prices, Earnings and Expected Dividends,” Journal of Finance, Vol.43, 661-676.

Campbell, John Y. and Shiller, Rober J., 1988b, “the Dividend Price Ratio and Expectations of Future Dividends and Discount Factors,” The Review of Financial Studies, Vol.1, No.3, 195-228.

Campbell, John Y. and Vuolteenaho, Tuomo, 2003, “Inflation Illusion and Stock Prices,” Working Paper.

Carmichael, Benoit, 1985, “Anticipated Inflation and the Stock Market,” The Canadian Journal of Economics, Vol. 18 No.2, 285-293.

Chan, Kalok, McQueen, Grant and Thorley, Steven, 1998, “Are There Rational Speculative Bubbles in Asian Stock Markets,” Pacific-Basin Finance Journal, 6, 125-151.

Chang, Eric C. and Pinegar, J. Michael, 1987, “Risk and Inflation,” The Journal of

Financial and Quantitative Analysis, Vol. 22 No.1, 89-99.

Charemza, Wojciech W. and Deadman, Derek F, 1995, "Speculative Bubbles with Stochastic Explosive Roots: The Failure of Unit Root Testing," Journal of Empirical Finance, 2, 153-163.

Chen, Charles J. P., Chen, Shimin and Su, Xijia, 2001, "Is Accounting Information Value-Relevant in the Emerging Chinese Stock Market?" Journal of International Accounting, Auditing & Taxation, 10, 1-22.

Chen, Gongmeng, Firth, Michal and Gao, Ning, 2002a, "The Information Content of Concurrently Announced Earnings, Cash Dividends, and Stock Dividends: An Investigation of the Chinese Stock Market," Journal of International Financial Management and Accounting, 13:2.

Chen, Gongmeng, Firth, Michal and Rui, Oliver, 2002b, "Have China's Enterprize Reforms Led to Improved Efficiency and Profitability?" Working Paper.

Chen, Joseph, Hong, Harrison, and Stein, Jeremy C., 2002, "Breadth of Ownership and Stock Returns," Journal of Financial Economics, 66, 171-205.

Chen, Gongmeng, Firth, Rui, Oliver and Wang, Steven Shuye, 2005, "The Effectiveness of Price Limits and Stock Characteristics: Evidence from the Shanghai and Shenzhen Stock Exchanges" Review of Quantitative Finance and Accounting, 25, 159-182.

Chui, A. C. W. and Kwok, C. C. Y., 1998, "Cross-Autocorrelation between A-shares and B-shares in the Chinese Stock Market," Journal of Financial Research, 21, 333-353.

Chung, H. and Lee, B. S., 1998, "Fundamental and Nonfundamental Components in Stock Prices of Pacific-Rim Countries," Pacific-Basin Journal of Finance, 6, 321-346.

Cochrane, John H., 1989, "Explaining the Variance of Price: Dividend Ratios," Working paper No. 3157.

Cochrane, John H., 1991, “Volatility Tests and Efficient Markets,” Journal of Monetary Economics, 27, 463-485.

Cohn, Richard A. and Lessard Donald R., 1981, “the Effect of Inflation on Stock Prices: International Evidence,” Journal of Finance, Vol. 36 No.2, 277-289.

Copeland, Laurence and Zhang, Biqiong, 2003, “Volatility and Volume in Chinese Stock Markets,” Journal of Chinese Economic and Business Studies, Vol. 1, No.3, 287-300.

Cornwell, C., P. Schmidt and R.C. Sickles, 1990, “Production Frontiers with cross-Sectional and Time-Series Variation in Efficiency Levels,” Journal of Econometrics, 46,185-200.

Corsetti, Giancarlo & Pesenti, Paolo & Roubini, Nouriel, 1999. "What Caused the Asian Currency and Financial Crisis?" Japan and the World Economy, Elsevier, vol. 11(3), 305-373.

Cozier, Barry V. and Rahman, Abdul H., 1988, “Stock Returns, Inflation, and Real Activity in Canada,” The Canadian Journal of Economics, Vol. 21 No. 4, 759-774.

Cunado, J., Gil-Alana, L. A. and Gracia, Perez De, 2005, “a Test for Rational Bubbles in the Nasdaq Stock Index: a Fractionally Integrated Approach,” Journal of Banking and Finance.

Cuthbertson, Keith, 1996, “Quantitative Financial Economics: Stocks, Bonds and Foreign Exchange”, Wiley.

Danthine, J. P. and J. Donaldson, 1986, “Inflation and Asset Prices in an Exchange Economy,” Econometrica, 54, 585-606.

Darrat, A.F. and Zhong, M., 2000, "On Testing the Random-Walk Hypothesis: A Model-Comparison Approach, " Financial Review, 35(3).

Davidson, R., and J. G. MacKinnon, 1993, "Estimation and inference in econometrics," Oxford: Oxford University Press.

Davis, E. Philip and Steil, Benn, 2001, "Institutional Investors, " The MIT Press.

Day, Theodore E., 1984, "Real Stock Returns and Inflation," The Journal of Finance, Vol.39 No.2, 493-502.

DeBondt, Werner F.M. and Thaler, Richard, 1985, "Does the Stock Market Overeact?," Journal of Finance, 40, 793-808.

Dechow, Patricia, Kothari, S, and Watts, R., 1998, "The Relation Between Earnings and Cash Flows," Journal of Accounting and Economics, 25, 133-168.

Dechow, Patricia M., Hutton, Amy P. and Sloan, Richard G., 1999a, "an Empirical Assessment of the Residual Income Valuation Model," Journal of Accounting and Economics, 26, 1-34.

Dechow, Patricia M., Hutton, Amy P. and Sloan, Richard G., 1999b, "the Relation between Analysts' Forecasts of Long-term Earnings Growth and Stock Price Performance Following Equity Offerings," Working Paper.

DeLong, J. B., Shleifer, A., Summers L. H. and Waldman, R.J., 1990, "Noise Trader Risk in Financial Markets," Journal of Political Economy, 98, 703-738.

Dezhbakhsh, Hashem and Demirguc-Kunt, Asli, 1990, "On the Presence of Speculative Bubbles in Stock Prices," Journal of Financial and Quantitative Analysis, Vol.25 No.1, 101-112.

Diba, Behzad T. and Grossman, Herschel I., 1987, "On the Inception of Rational Bubbles," The Quarterly Journal of Economics, Vol.102, Issue 3, 697-3,700.

Diba, Behzad T. and Grossman, Herschel I., 1988a, "the Theory of Rational Bubbles in Stock Prices," Economic Journal, 98, 746-754.

Diba, Behzad T. and Grossman, Herschel I., 1988b, "Explosive Rational Bubbles in Stock Prices," American Economic Review, 78, 520-530.

Dolado, J., T. Jenkinson, and S. Sosvilla-Rivero, 1990, "Cointegration and unit roots," Journal of Economic Surveys 4 (3): 249–73.

Donaldson, R. Glen and Kamstra, Mark, 1996, "a New Dividend Forecasting Procedure that Rejects Bubbles in Asset Prices: the Case of 1929's Stock Crash," Review of Financial Studies, 9, 333-383.

Driffill, John. and Sola, Martin, 1998, "Intrinsic Bubbles and Regime-Switching," Journal of Monetary Economics, 42, 357-373.

Dulan, Harold A., 1948, "Common-Stock Investment as an Inflation Hedge, 1939-46," The Journal of Business of the University of Chicago, Vol.21 No.4, 230-238.

Durham, J. Benson, 2002, "The Effects of Stock Market Development on Growth and Private Investment in Lower-Income Countries," Emerging Market Review, 3, 211-232.

Easton, P. and Zmijewski, M., 1989, "Cross-Sectional Variation in the Stock Market Response to Accounting Earnings Announcements" Journal of Accounting and Economics, 11, 117-141.

Edwards, W. , 1968, "Conservatism in Human Information Processing," In B.Kleinmuntz (Ed.), Formal Representation of Human Judgment (pp. 17–52). New York: Wiley.

Elder, John and Kennedy, E., 2001, “Testing for Unit Roots: What Should Students Be Taught?” Discussion Paper.

Enders, W. , 1995, “Applied econometric time series,” New York: Wiley.

Engle. Robert F. and Granger, C.W.J., 1987, “Cointegration and Error Correction: Representation, Estimation, and Testing,” Econometrica, Vol.55, No.2, 251-276.

Evans, George W., 1991, “Pitfalls in Testing for Explosive Bubbles in Asset Prices,” American Economic Review, 81, 4, 922-930.

Fama Eugene F., 1970, Efficient Capital Markets: A review of Theory and Empirical Work, Journal of Finance, 25, 383–417.

Fama, Eugene F., 1981, “Stock Returns, Real Activity, Inflation, and Money,” The American Economic Review, Vol.71 No.4, 545-565.

Fama, Eugene F., 1983, “Stock Returns, Real Activity, Inflation, and Money: Reply,” The American Economic Review, Vol.73 No.3, 471-472.

Fama Eugene F., 1991, “Efficient Capital Markets: II,” The Journal of Finance, 46(5), 1575–1617.

Fama, Eugene F. and Miller, M.,1972, “the Theory of Finance,” Dryden Press.

Fama, Eugene.F., and Schwert, G. W., 1977, "Asset Returns and Inflation." Journal of Financial Economics 5(2), 115-146.

Feldstein, Martin, 1980, “Inflation and the Stock Market,” The American Economic Review, Vol.70, No.5, 839-847.

Feldstein, Martin, 1982, “Inflation and the Stock Market: Reply,” The American Economic

Review, Vol.72, No.1, 243-246.

Feltham, G. and Ohlson, J., 1995, “Valuation and Clean Surplus Accounting for Operating and Financial Activities,” Contemporary Accounting Research 11, 689-731.

Fernald, Johm and Rogers, Johm, 1998, “Puzzles in the Chinese Stock Market,” International Finance Discussion Papers 619. Board of Governors of the Federal Reserve System.

Firth, Michael, 1979, “the Relationship Between Stock Market Returns and Rates of Inflation,” The Journal of Finance, Vol. 34 No.3, 743-749.

Fischer, Stanley, 1998, “The Asian Crisis: A View from the IMF,”
http://www.imf.org/external/np/speeches/1998/012298/htm

Fischhoff, B., Slovic P., and Lichtenstein S., 1977, “Knowing with Certainty: the Appropriateness of Extreme Confidence,” Journal of Experimental Psychology:Human Perception and Performance3,552-64.

Fisher, I. ,1930, “ The Theory of Interest,” Macmillan, New York.

Flavin, Marjorie A., 1983, “Excess Volatility in the Financial Markets: a Reassessment of Empirical Evidence,” Journal of Political Economy, 91, 745-70.

Flood, Robert P. and Garber, Peter M., 1980. “Market Fundamentals Versus Price Level Bubbles: the First Tests,” Journal of Political Economy 88, 745-776.

Flood, Robert P. and Marion, Nancy, 1999, “Perspectives on the Recent Currency Crisis Literature,” International Journal of Finance and Economics, John Wiley & Sons, Ltd., 4(1), 1-26.

Flood, Robert P. and Hodrick, Robert J., 1986, “Asset Price Volatility, Bubbles and

Process Switching," Journal of Finance, 41, 831-42.

Flood, Robert P. and Hodrick, Robert J., 1990, "On Testing for Speculative Bubbles," Journal of Economic Perspectives, 4, 85-101.

Flood, Robert P. and Hodrick, Robert J., and Kaplan, Paul, 1986, "an Evaluation of Recent Evidence on Stock Market Bubbles," Working paper No.1986.

Francis, Jennifer, Olsson, Per and Oswald, Dennis R., 2000, "Comparing the Accuracy and Explainability of Dividend, Free Cash Flow and Abnormal Earnings Equity Value Estimates," Journal of Accounting Research, Vol.38, No.1.

Frankel, Richard and Lee, Charles M.C., 1998, "Accounting Valuation, Market Expectation, and Cross-Sectional Stock Returns," Journal of Accounting and Economics, 25, 283-319.

Froot, Kenneth A., 1987, "Tests of Excess Forecast Volatility in the Foreign Exchange and Stock Markets," Working paper No.2362.

Froot, Kenneth A. and Obstfeld Maurice, 1991, "Intrinsic Bubbles: the Case of Stock Prices," American economic review, 1189-1215.

Fukuta, Yuichi, 1998, "a Simple Discrete-Time Approximation of Continuous-Time Bubbles," Journal of Economic Dynamics and Control, 22, 937-954.

Fung, Libon, 1999, "Time Series Analysis of Rational Speculative Bubbles: a Simulation Experiment," Working paper.

Gertler, Mark and Grinols, Earl L., 1982, "Unemployment, Inflation, and Common Stock Returns," Journal of Money, Credit and Banking, Vol.14, No.2, 216-233.

Gervais, Simon and Terrance Odean, 2001, "Learning to be Overconfident," Review of

Financial Studies, 14, 1-27.

Geske, Robert and Roll, Richard, 1983, "the Fiscal and Monetary Linkage between Stock Returns and Inflation," The Journal of Finance, Vol.38, No.1, 1-33.

Gordon, Myron J., 1983, "the Impact of Real Factors and Inflation on the Performance of the U.S. Stock Market From 1960 to 1980," The Journal of Finance, Vol.38, No.2, 553-563.

Green, Stephen, 2003, "China's Stock Market: Eight Myths and Some Reasons to Be Optimistic," Report of A Research Project (www.riia.org/asia)

Green, Stephen, 2004, "Equity Politics and Market Institutions: the Development of Stock Market Policy and Regulation in China, 1984-2003," Working Paper.

Greene, William H., 2001a, "New Developments in the Estimation of Stochastic Frontier Models with Panel Data," Working paper.

Greene, William H., 2001b, "Estimating Econometric Models with Fixed Effects," Working paper.

Greene, William H., 2002a, "Alternative Panel Data Estimators for Stochastic Frontier Models," Working paper.

Greene, William H., 2002b, "Fixed and Random Effects in Stochastic Frontier Models," Working paper.

Greene, William H., 2003, "Distinguishing between Heterogeneity and Inefficiency: Stochastic Frontier Analysis of the World Health Organization's Panel Data on National Health Care Systems," Working paper.

Greenbaum, Stuart I. and Thakor, Anjan V., 1995, "Contemporary Financial Intermediation," The Dryden Press, Page 13.

Gultekin, N. Bulent, 1983, "Stock Market Returns and Inflation: Evidence from Other Countries," The Journal of Finance, Vol.38, No.1, 49-65.

Hamilton, James and Whiteman, Charles, 1985, "The Observable Implications of Self-Fulfilling Expectations," Journal of Money Economics, 16, 353-73.

Hammond, Peter J., 1997, "Rationality in Economics," Working Paper.

Hansen, Lam Peter and Sargent, Thomas, 1980, "Formulating and estimating dynamic linear rational expectations models," Journal of Economic Dynamics and Control 2, 7-46; reprinted in: Lucas and Sargent, eds. (1981) 91-136.

Haruvy,Ernan and Noussair, Charles N., 2006, "The Effect of Short Selling on Bubbles and Crashes in Experimental Spot Asset Markets," The Journal of Finance Vol. LXI, No.3, 1119-1157.

Hasbrouck, Joel, 1984, "Stock Returns, Inflation, and Economic Activity: The Survey Evidence, Vol.39 No.5, 1293-1310.

Hassett, Kevin, 2002, "Bubbleology: the New Science of Stock Market Winners and Losers."

Haug, Alfred A., 1996, "Tests for Cointegration, a Monte Carlo Comparison," Journal of Econometrics, 71, 89-115.

Haw, In-Mu, Qi, Daqing and Wu, Woody, 1999, "Value Relevance of Earnings in an Emerging Capital Market: The Case of A-Shares in China," Pacific Economic Review, 4:3, 337-347.

Heilmann, Sebastian, 2002, "The Chinese Stock Market: The Pitfalls of A Policy-Driven Market," Essay.

Henry, P.H., 2000a, “Do Stock Market Liberalizations Cause Investment Booms?” Journal of Financial Economics, 58, 301-334.

Henry, P.H., 2000b, “Stock Market Liberalization, Economic Reform, and Emerging Market Equity Prices, ” Journal of Finance, 55, 529-564.

Hess, Patrick J. and Lee, Bong-Soo, 1999, “Stock Returns and Inflation with Supply and Demand Disturbances,” The Review of Financial Studies, Vol. 12, No.5, 1203-1218.

Hirshleifer, David, 2001, “Investor Psychology and Asset Pricing,” The Journal of Financial, Vol. LVI, No.4, 1533-1597.

Holden, D., and R. Perman, 1994, “Unit roots and cointegration for the economist,” In B. B. Rao, ed.,Cointegration for the applied economist, 47–112. New York: St. Martin’s.

Hong, H., Scheinkman J.and W. Xiong, 2006, “Asset Float and Speculative Bubbles,” Journal of Finance, Vol. LX1,3,1073-1117.

Jefferson, G., T., Li , Rawski, W. and Zheng, Y., 2000, “Ownership, Productivity Change, and Financial Performance in Chinese Industry”, Journal of Comparative Economics, 28, 86-813.

Jensen, M., 1978, “Some Anomalous Evidence Regarding Market Efficiency,” Journal of Financial Economics, 6, 95-101.

Jingu, Takeshi, 2002, “Moving Forward in Reforming China’s Capital Market,” NRI Papers No.40.

Jovanovic, Boyan and Ueda, Masako, 1998, “Stock-Returns and Inflation in a Principal-Agent Economy,” Journal of Economic Theory, 82, 223-247.

Kahneman, D. and Riepe, M., 1998, "Aspects of Investors Psychology," Journal of Portfolio Management, 24, 52-65.

Kahneman, D., and A. Tversky, 1974, "Judgment Under Uncertainty: Heuristics and Biases," Science 185, 1124-31.

Kaminsky, Graciela L. and Reinhart, Carmen M., 1999. "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems," American Economic Review, American Economic Association, 89(3), 473-500.

Keran, Michael W., 1976, "Inflation, Regulation, and Utility Stock Prices," The Bell Journal of Economics, Vol.7, No.1, 268-280.

Keynes, J. M. ,1936, "The general theory of employment, interest and money, "London: Macmillan, 1964.

Khatri, Yougesh, Leruth, Luc and Piesse, Jenifer, "Corporate Performance and Governance: a Stochastic Frontier Approach to Measuring and Explaining Inefficiency in the Malaysian Corporate Sector," Working paper.

King, Ronald, Vernon Smith, Arlington Williams, and Mark Van Boening, 1993 "The Robustness of Bubbles and Crashes in Experimental Stock Markets, in I. Prigogine, R. Day, and P. Chen, eds.: Nonlinear Dynamics and Evolutionary Economics," Oxford University Press.

Kirk, Don, 2000, "Uncertainties Cloud South Korea Recovery," International Herald Tribune, http://www.iht.com/articles/2000/01/27/rkor.t.php.

Kleidon, Allan W., 1986, "Variance Bounds Tests and Stock Price Valuation Models," The Journal of Political Economy, Vol.94, Issue 5, 953-1001.

Koo, Jahyeong and Kiser, Sherry L., 2001, "Recovery from a Financial Crisis: the Case of

South Korea," Economic and Financial Review Fourth Quarter.

Kothari, S.P., 2001, "Capital Markets Research In Accounting," Journal of Accounting and Economics, 31, 105-231.

Koustas, Zisimos and Serletis, Apostolos 2005, "Rational Bubbles or Persistent Deviations from Market Fundamentals?" Journal of Banking and Finance.

Kraus, Alan and Smith, **Maxwell** 1998, "Endogenous Sunspots, Pseudo-Bubbles, and Beliefs about Beliefs," Journal of Financial Markets, 1, 151-174.

Krugman, Paul, 1998, "What Happened to Asia?"
http://web.mit.edu/krugman/www/DISINTER.html

Kumbhakar, S. C., 1990, "Production Frontiers, Panel Data, and Time-Varying Technical Inefficiency." Journal of Econometrics 46, 201–212.

Kumbhakar, S.C. and Lovell, C.A., 2000, "Stochastic Frontier Analysis," Cambridge University Press.

Lai, Quan B., 2000, "Currency Crisis in Thailand: The Leading Indicators," The Park Place Economist, 7.

Laurence, M., Cai, F. and Qian, S., 1997, "Weak-form Efficiency and Causality Tests in Chinese Stock Markets," Multinational Finance Journal, 1, 291-307.

Laurenceson, James, 2002, "The Impact of Stock Markets on China's Economic Development: Some Preliminary Assessments," Working Paper.

Lee, Bong-Soo, 1992, "Causal Relations among Stock Returns, Interest Rates, Real Activity, and Inflation," The Journal of Finance, Vol. 47, No.4, 1591-1603.

Lee, Y. H. and P. Schmidt, 1993, “A Production Frontier Model with Flexible Temporal Variation in Technical Efficiency.” In H. Fried, C. A. K. Lovell and S. S. Schmidt (eds.), The Measurement of Productive Efficiency: Techniques and Applications. Oxford University Press.

Lee, B. S., 1998, “Permanent, Temporary and Nonfundamental Components of Stock Prices.” Journal of Finance and Quantitative Analysis, 33, 1-32.

Lei, Vivian, Charles N. Noussair and Charles R. Plott, 2001, “Non-speculative Bubbles in Experimental Asset Markets: Lack of Common Knowledge of Rationality vs. Actual Irrationality” Econometrica, 69, 830-859.

LeRoy,Stephen F. and Porter Richard D., 1981, “the Present Valuation Relation: Test Based on Implied Variance Bounds,” Econometrica, 49, 555-74.

Lev., Baruch and Ohlson, James A., 1982, “Market-Based Empirical Research in Accounting: A Review, Interpretation, and Extension, ” Journal of Accounting Research, Vol.20.

Levine, Ross, 1991, “Stock Markets, Growth, and Tax Policy,” Journal of Finance, 46(4), 1445-65.

Levine, R. and Zervos, S., 1998a, “Stock Markets, Banks, and Economic Growth,” American Economics, 88, 537-558.

Levine, R. and Zervos, S., 1998b, “Global Capital Liberalization and Stock Market Development,,” World Development, 26, 1169-1183.

Lichtenstein, Sarah, Fischhoff, Baruch and Phillips, Lawrence D, 1982, “Calibration of Probabilities: The State of the Art to 1980,” In Judgment under Uncertainty: Heuristics and Biases, Cambridge University Press.

Lin, Jin-Lung and Wu, Chung-Shu, 2003, “Modeling China Stock Markets and International linkages,” Working Paper.

Litzenberger, Robert H. and Rao, Cherukuri B., 1971, “Estimates of the Marginal Rate of Prime Preference and Average Risk Aversion of Investors in Electric Utility Shares: 1960-66,” Bell J. Econ. And Management, 2, 265-77.

Loewenstein, Mark and Willard, Gregory A., 2000, “Rational Equilibrium Asset-Pricing Bubbles in Continuous Trading Models,” Journal of Economic Theory, 91, 17-58.

Lord, C., Ross, L. and Lepper, M., 1979, “Biased Assimilation and Attitude Polarization: the Effects of Prior Theories on Subsequently Considered Evidence,” Journal of Personality and Social Psychology, 37, 2098-2109.

Los, A. and Yu, Bing, 2005, “Persistence Characteristics of the Chinese Stock Markets,” Working Paper.

Lovell, C. A. K., 1993, “Production Frontiers and Productive Efficiency,” in The Measurement of Productive Efficiency: Techniques and Applications, ed. by Hal Fried, C. A. Knox Lovell, and Shelton Schmidt, Oxford: Oxford University Press, Inc.

Luis Orea and Subal C. Kumbhakar, 2003 “Efficiency Measurement Using A Latent Class Stochastic Frontier Model,” Working Paper.

Ma, Qingquan, 2003, “The History of Chinese Security Markets,” (Chinese), CITIC Publishing House.

Ma, S. and Barnes, M. L., 2001, “Are Chinese Stock Markets Really Weak-Form Efficient?” Discussion Paper, No. 0119, Adelaide University.

Ma, Xianghai, 1996, “Capital Controls, Market Segmentation and Stock Prices: Evidence from the Chinese Stock Market,” Pacific-Basin Finance Journal, 4, 219-239.

Ma, Yue and Kanas, Angelos, 2004, “Intrinsic Bubbles Revisited: Evidence from Nonlinear Cointegration and Forecasting,” Journal of Forecasting, 23, 4, 237-250.

Madhavan, Ananth, 2000, “Market Microstructure: A Survey,” Working Paper.

Mahar, Maggie, 2003, “Bull! A History of the Boom, 1982-1999: What drove the Breakneck Market and What Every Investor Needs to Know about Financial Cycles,” HarperCollins.

Malkiel, B. G., and Cragg, J.C. 1970, “Expectations and the Structure of Share Prices,” American Economic Review, (September, 1970), 601-17.

Mankiw, N. Gregory, Romer, David and Shapiro, Matthew D., 1985, “an Unbiased Reexamination of Stock Market Volatility,” Journal of finance, Vol.40, No.3, 677-87.

Marsh, Terry A. and Merton, Robert C., 1986, “Dividend Variability and Variance Bounds Tests for the Rationality of Stock Market Prices,” American Economic Review, 76, 483-98

Marshall, D. A., 1992, “Inflation and Asset Returns in a Monetary Economy,” Journal of Finance, 47, 1315-1342.

Mauro, Paulo, 1995, “Corruption and Growth,” Quarterly Journal of Economics, 110(3), pp. 681-712.

McFadden, Daniel, 1998, “Rationality for Economists”, Working Paper.

McQeen, Grant and Thorley Steven, 1994, “Bubbles, Stock Returns and Duration Dependence”, Journal of Financial and Quantitative Analysis, Vol.29, No.3, 379-401.

Meader, J. W., 1935, “A Formular for Determining Basic Values Underlying Common Stock Prices,” The Analyst (November 29,1935), 749

Mei, Jianping, **Scheinkman, Jose A. and Xiong, Wei**, 2003, “Speculative Trading and Stock Prices: Evidence from Chinese A-B Share Premia,” Working Paper.

Merton, R.C. and Bodie, Z., 1995, “A Conceptual Framework for Analyzing the Financial Environment.” in Crane, et al. ed.: *The Global Financial System: A Functional Perspective*. Boston, MA: Harvard Business School Press.

Miller, Edward, 1977, “Risk, Uncertainty and Divergence of Opinion,” Journal of Finance, 32, 1151-1168.

Modigliani, Franco and Cohn, Richard, 1979, “Inflation, rational valuation, and the market,” Financial Analysts Journal 35(3), 24-44.

Mookerjee, Rajen and Yu, Qiao, 1999, “An Empirical Analysis of the Equity Markets in China,” Review of Financial Economics, 8, 41-60.

Motley, Brian, 1969, “Inflation and Common Stock Values: Comment,” The Journal of Finance, Vol.24, No.3, 530-535.

Nichols, Donald A., 1968, “a Note on Inflation and Common Stock Values,” The Journal of Finance, Vol.23, No.4, 655-657.

Norden, Simon Van and Schaller, Huntley, 1993, “the Predictability of Stock Market Regime: Evidence from the Toronto Stock Exchange,” The Review of Economics and Statistics, Vol. 75, No.3, 505-510.

Ohlson, James A., 1995, “Earnings, Book Values, and Dividends in Equity Valuation,” Contemporary Accounting Research, Vol.11, No.2, 661-687.

Orea, Luis, 2003, “Efficiency Measurement Using a Latent Class Stochastic Frontier Model,” Working paper.

Penman, Stephen H., 1996, “the Articulation of Price-Earnings Ratios and Market-to-Book Ratios and Evaluation of Growth,” Journal of Accounting Research, Vol.34, No.2.

Penman, Stephen H., 1997, “Combining Earnings and Book Value in Equity Valuation,” Working Paper.

Perron, P., 1988, “Trends and random walks in macroeconomic time series,” Journal of Economic Dynamics and Control 12 (12): 297–332.

Pindyck, Robert S., 1984, “Risk, Inflation, and the Stock Market,” American Economic Review, Vol. 74, No.3, 335-51.

Pistor, Katharina and Xu, Chenggang, 2004, “Governing Stock Markets in Transition Economies: Lessons from China,” Working Paper.

Poterba, James M. and Summers, Lawrence H., 1986, “the Persistence and Volatility of Stock Market Fluctuations,” American Economic Review, Vol.76, No.5, 1142-51.

Psaradakis, Zacharias, Sola, Martin and Spagnolo, Fabio, 2001, “A Simple Procedure for Detecting Periodically Collapsing Rational Bubbles,” Economics Letters, 72, 317-323.

Qi, D., Wu, W. and Zhang, H., 2000, “Shareholding Structure and Corporate performance of Partially Privatized Firms: Evidence from Listed Chinese Companies,” Pacific-Basin Finance Journal, 8, 587-610.

Radelet. Steven and Sachs, Jeffrey, 1998, “The Onset of the East Asian Financial Crisis,” Discussion Paper.

Rapach, David E., 2002, “the Long-Run Relationship between Inflation and Real Stock Prices,” Journal of Macroeconomics, 24, 331-351.

Richardson, Sam, 2002, "Efficiency Estimation Using the Stochastic Production Frontier Approach: Evidence from the National Rugby League," Discussion paper.

Ritter, C., and L. Simar, 1997, "Pitfalls of Normal-Gamma Stochastic Frontier Models," Journal of Productivity Analysis, Vol. 8 No.2, 167-182.

Ritter, R. Jay, 2003, "Behavioural Finance," Pacific-Basin Finance Journal, 11, 429-437.

Sachs, J.D., Tornel, A., and Velasco, A., 1996, "Financial Crises in Emerging Markets: The Lessons From 1995," Brooking Papers on Economic Activity, 1, 147-215.

Sam Richardson, 2002, "Efficiency Estimation Using the Stochastic Production Frontier Approach: Evidence from the National Rugby League," Discussion Paper.

Santos, Manuel S. and Woodford, Michael, 1997, "Rational Asset Pricing Bubbles," Econometrica, Vol.65, No.1, 19-57.

Sawyer, Malcolm, 2001, "The UK Economy," Oxford University Press.

Scheinkman, J. and W. Xiong, 2003, "Overconfidence and Speculative Bubbles," Journal of Political Economy, 111, 6, 1183-1219.

Scholes, M., and J. Williams, 1977, "Estimating Betas from Nonsynchronous Data," Journal of Financial Economics, 5, 309-327.

Seddighi, H. R. and Nian, W., 2004, "The Chinese Stock Exchange Market: Operations and Efficiency," Applied Financial Economics, 14, 785-797.

Sharpe, Steven A, 2002, "Reexamining Stock Valuation and Inflation: the Implications of Analysts' Earnings Forecasts," The Review of Economics and Statistics, 84(4),632-648.

Shiller, Robert J., 1978, "Rational Expectations and the Dynamic Structure of

Macroeconomic Models: A Critical Review," J. Monet. Econ., Jan., 4(1), 1-44.

Shiller, Robert J., 1981, "Do Stock Prices Move too Much to be Justified by Subsequent Changes In Dividends?" American Economic Review, 71, 421-36.

Shiller, Robert J., 1983, "Do Stock Prices Move too Much to be Justified by Subsequent Changes in Dividends? Reply" American Economic Review, 71, 421-36.

Shiller, Robert J., 1989. "Comovements in Stock Prices and Comovements in Dividends," NBER Working Papers 2846, National Bureau of Economic Research, Inc.

Shiller Robert J., 1989, Market Volatility, The MIT Press, Cambridge, Massachusetts.

Shiller, Robert J., 2002, "Bubbles, Human Judgment, and Expert Opinion"Financial Analysiss Journal, 58, 3, 18-26.

Shleifer, Andrei, 2000, "Inefficient Markets: An Introduction to Behavioural Finance," Oxford University Press.

Skogsvik, Kenth, 2002, "A Tutorial on Residual Income Valuation and Value added Valuation," Working Paper.

Sjoo, Boo and Zhang, **Jianhua**, 2000, "Market Segmentation and Information Diffusion in China's Stock Markets," Journal of Multinational Financial Management, 10, 421-438.

Spencer, M..,1995, "Securities Markets in China," Finance and Development, 32,28-31.

Stulz, R. M., 1986, "Asset Pricing and Expected Inflation," Journal of Finance, 41, 209-223.

Su, Dongwei, 2003, "Stock Price Reaction to Earnings Announcements: Evidence from Chinese Markets," Review of Financial Economics, 12, 271-286.

Su, Dongwei and Fleisher, Belton M., 1998, "Risk, Return and Regulation in Chinese Stock Markets," Journal of Economics and Business, 50, 239-256.

Summers, L., 1985, "On Economics and Finance," Journal of Finance, 40, 633-635.

Summers, L., 1986, "Does the Stock Market Rationally Reflect Fundamental Values?" Journal of Finance, 41, 591-601.

Sussangkarn, Chalongphob, 1998, "Thailand's Debt Crisis and Economic Outlook", http://www.nectec.or.th/bureaux/tdri/mep_fore.htm

Sutherland, Alan.,1996, "Intrinsic Bubbles and Mean-Reverting Fundamentals," Journal of Monetary Economics, 37, 163-173.

Taylor, Mark P. and Peel, David A., 1998, "Periodically Collapsing Stock Price Bubbles: a Robust Test," Economics Letters, 61, 221-228.

Thaler, Richard H., 1993, "Advance in Behavioural Finance," Russell Sage Foundation**.**

Thaler, Richard H., 1999, "The End of Behavioural Finance," Financial Analysts Journal, 55, 6, 12-17.

Thaler, Richard H., 2005, "Advances in Behavioural Finance, Vol. II," Princeton University.

Thomas, R L ,1997, " Modern Econometrics: An Introduction," Harlow: Addison-Wesley.

Tirole Jean, 1982, "On the Possibility of Speculation Under Rational Expectation," Econometrica, 50, 1163-1181.

Tirole Jean, 1985, "Asset Bubbles and Overlapping Generations," Econometrica, 53, 1499-1528.

Titman, Sheridan and Warga, Arthur, 1989, "Stock Returns as Predictors of Interest Rates and Inflation," The Journal of Financial and Quantitative Analysis, Vol. 24, No.1, 47-58.

Uno, Jun, Shimatani, Takeshi, Shimizu, Tokiko and Mannen, Sachiko, 2002, "Market Microstructure and Spread Pattern in the JASDAQ Market," Working Paper.

West, Kenneth D., 1984, "Speculative Bubbles and Stock Price Volatility," Financial Research Center Memorandum No.54 in Princeton University.

West, Kenneth D., 1987, "a Specification Test for Speculative Bubbles," Quarterly Journal of Economics, 102, 553-580.

West, Kenneth D., 1988, "Bubbles, Fads, and Stock Price Volatility Tests: a Partial Evaluation," Journal of Finance, 43, 639-55.

Whitbeck, V. and Kisor, M., 1963, "A New Tool in Investment Decision Making," Financial Analysts J., 19, 55-62.

White, Eugene N., 1995, "Stock Market Bubbles? A Reply" The Journal of Economic History, Vol. 55, Issue 3, 655-65.

Williams, J., 1938, "the Theory of Investment Value," Harvard University Press.

Wu, S. N., 1996, "The Analysis of the Efficiency of Securities Market in China," Economics Research (China), 6, 1-39.

Wu, Guojun and Xiao, Zhijie, 2002, "Are There Speculative Bubbles in Stock Markets? Evidence from an Alternative Approach," Working paper.

Xu, X. and Wang, Y., 1999, "Ownership Structure, Corporate Performance, and Firm's Performance: the Case of Chinese Stock Companies," World Bank Working paper.

Yao, **C.**, 1998, "Stock Market and Futures Market in the People's Republic of China," Oxford University Press.

Yang, Jian, 2003, "Market Segmentation and Information Asymmetry in Chinese Stock Markets: A VAR Analysis," The Financial Review, 38, 591-609.

Yeh, Yin-Hua, Lee, Tsun-Siou and Pen, Jen-Fu, 2002, "Stock Returns and Volatility under Market Segmentation: The Case of Chinese A and B shares," Review of Quantitative Finance and Accounting, 18, 239-257.

Yougesh, Khatri, Leruth, Luc and Piesse, Jenifer, 2002, **"**Corporate Performance and Governance in Malaysia" IMF Working Paper No. 02/152.

Yu, Dahai, 1998, "Rational Bubbles under Diverse Information," International Finance Discussion Paper, Board of Governors of the Federal Reserve System.

Zhang, Yimin and Zhao, Ronald, 2004, "The Valuation Differential between Class A and B Shares: Country Risk in the Chinese Stock Market," Journal of International Financial Management and Accounting, 15:1.

Zhou, Weixing and Sornette, Didier, 2006, "Antibubble and Prediction of China's Stock Market and Real-Estate," Working Paper.