

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.



AN INVESTIGATION INTO THE TECHNOLOGY STOCK
BUBBLE

by

Ali Ahmed Endi

Submitted in fulfilment of the requirements for the degree
of Master in Commerce, the School of Economics,
University of Cape Town, South Africa

Supervisor: Professor Haim Abraham.

December 2004

Key Words

1. **Efficient Markets Hypothesis (EMH):** The contention that, at each time t , the current prices of financial assets reflect all available information relevant for judging the future returns on those assets. A capital market is said to be efficient if it fully and correctly reflects all relevant information in determining security prices. Formally, the market is said to be efficient with respect to some information set, e.g., ϕ , if security prices would be unaffected by revealing that information to all participants. Moreover, efficiency with respect to an information set, ϕ , implies that it is impossible to make economic profits by trading on the basis of ϕ .
2. **Rational Expectations:** Rational expectations is an equilibrium concept that can be applied to dynamic economic models that have elements of “self reference” that is, models in which the endogenous variables are influenced by the expectations about future values of those variables held by the agents in the model. The concept was introduced and applied by Muth (1960, 1961).
3. **Discounted cash flow model:** The discounted cash flow model is a popular and theoretically justifiable asset pricing procedure that discounts future expected cash flows from an asset at same interest rate to estimate the asset’s present value, see Brennan (1979). The discounted cash flow valuation framework can be practically used not only for assets with a simple stream of cash flows but also for complex assets with a complex system of options attached.
4. **Noise Traders:** Traders have some information that is based on economic fundamentals not common to market participants. They utilize it to deal to maximize their profits. Technical analysis typically calls for the buying of more stocks when stocks have risen that is, Broken through a barrier. Selling of stocks becomes necessary when they fall through the floor. Both

liquidity traders and technical analysts are often called “*noise traders*”(see Shleifer and Summers (1990)). One way to think about noise is that it is the opposite of news. Rational traders make decisions on the basis of news such as facts, forecasts, et cetera. Noise traders make decisions based on something else.

5. **Overlapping Generations economy:** the overlapping-generation (OG) model is a leading alternative to the Arrow-Debreu (AD) model. The two models differ in their demographic assumptions. In the OG model, individuals live finite lifetimes, but the economy goes on forever. Hence the OG model is doubly infinite: there are an infinite number of individuals and an infinite number of dated commodities. The OG model is inherently sequential: the present generations cannot trade directly with future generations. This is not to say that the generations are isolated or that they are merely successive. They overlap. Because of this, the decisions of current generations potentially affect through forward induction the actions of all future generations, and the anticipated decisions of future generations affect through backward induction the actions of the current generation. Hence the OG model is like the AD model, a general-aquarium model, but one that is especially designed for dynamic analysis.
6. **Rational Expectations Equilibrium:** Muth (1961) argued that when making predictions rational agents make the best use of all available information, including the structure of the economic model generating the observables. Thus in stochastic models, if agents are to avoid making systematic mistakes their subjective beliefs about the distributions of variables, both exogenous and endogenous, should be the same as the true conditional distributions implied by the model. Any equilibrium solution to a model in which agents hold rational expectations could be described as a rational expectations equilibrium.
7. **Uncertainty:** Nothing is more certain than the prevalence of uncertainty about the consequences of any economic decision. This is especially true of the kind of portfolio decisions which arise in finance. It is therefore entirely

appropriate that uncertainty has been the subject of a large literature that grew out of important work in the early 1950s, and still flourishing, as testified by the number of recent surveys and books such as Balch, McFadden and Wu (1974), Diamond and Rothschild (1978) among others.

8. **Intrinsic Uncertainty:** The type of uncertainty associated with fundamentals of the economy (endowments, preferences, and technology), is known as intrinsic uncertainty.
9. **Extrinsic uncertainty:** The type of uncertainty that does not associated with fundamentals of the economy.
10. **Rational Bubbles:** A rational deviation of the price from its value, which implies that the economy can support belief-driven equilibria. Examples of belief-driven equilibria are sunspot equilibria.
11. **Stock Market Crash:** This is the collapse of stock price as evidence of bubble occurrence. It is the negative effect of a bubble.

ABSTRACT

An Investigation into The Technology Stock Bubble

Ali Ahmed Endi

Master's Thesis, School of Economics, University of Cape Town

This dissertation investigates whether technology stock prices in the NASDAQ stock market over the past 10 years contain evidence of the existence bubbles. In recent years, a sharp divergence of NASDAQ stock exchange equity prices from dividends has been noted. Our investigation focuses on whether this divergence can be explained by reference to the presence of bubbles. We find that, stock prices diverged significantly from their fundamental values during the late 1990's, and that this divergence has all the characteristics of a bubble i.e., sharp increases and sudden crashes. Speculative bubbles are generated when investors include their expectations of future prices in their information set. Under these conditions, the actual market price of the security, that is set according to demand and supply, will be a function of the future price that contains information distortion, which the noise traders generate. In the presence of speculative bubbles, positive expected bubble returns will lead to increased demand and will thus force prices to diverge from their fundamental value. The general conclusion is that bubbles, in many markets, are consistent with rationality. Testing for bubbles is not easy. Rational bubbles can follow many types of processes. However, the big problem is that it is very difficult to distinguish empirically between bubbles and other phenomena. A variety of other phenomena could cause price behaviour similar to that caused by bubbles. It is difficult to devise tests that distinguish these from bubbles. Thus, the empirical analysis has less power in identifying the bubble. Our final deduction is that a bubble does indeed exist in the NASDAQ stock market.

Date: 02-12-2004

DECLARATION

I declare that *This Investigation into The Technology Stock Bubble* is my own work, and has not been submitted for any degree or examination in any other university. All sources I have used or quoted have been indicated and acknowledged by complete references.

Full name:..... Date.....

Signed:

University of Cape Town

Acknowledgments

I am grateful to Allah, **the most high**, for his generosity in granting me many blessings and bounties. In view of my modest achievements in the past, an attempt to develop an explanation of the behaviour of the U.S. stock market in the 1990's would have simply been a dream. I therefore, gratefully acknowledge Professor. **Haim Abraham** my supervisor, for the advice, guidance, support and tremendous assistance provided to me throughout my studies. All, of which, have been instrumental in realising this dream.

I also wish to express my sincere thanks to the following people: Members of the UCT library staff who assisted me in accessing relevant literature and articles. The most congenial staff in the School of Economics, University of Cape Town for their support and concern throughout my stay in South Africa. All the people at the University of Cape Town for their excellent hospitality towards me throughout my studies in this country. Aishah Ali for her assistance in the proofreading and editing of this paper. Nobanengi Vilakazi for her unfailing encouragement and moral support.

I also would like to express my sincere appreciation to **Dr. Abd-Allah Alzubayde**, the Libyan Ambassador to South Africa, and all the people at the Libyan People's Bureau, for their financial and administrative support.

Ali Ahmed A. Endi

I Dedicate This Work

to:

Allah, my Parents, my Home Country “Libya”, and to my second
Country “South Africa”

And all the Members of my Family

Ali

University of Cape Town

Table of Contents

List of Figures	xi
List of Tables	xii
List of Flowcharts	xiii
Chapter One	1
1.0 Introduction and Background	1
1.1 Introduction	1
Chapter Two	9
2.0 Stock Behaviour Draws Near To The Stock Market Bubble	9
2.1 Introduction	9
2.2 The Efficient Market Hypothesis (EMH)	9
2.2.1 The Divided Discount Model As A Measure of Stock Market Efficiency	12
2.3 Testing (EMH) In The Technology Industry of NASDAQ Stock.....	15
2.3.1 The Model.....	15
2.3.2 Results	17
2.4 Noise Trading and Bubbles	18
2.5 Beyond Dividend Discount Model In Characterizing Fundamental	23
2.5.1 Dividend-Price and Earning-Price Ratios.....	24
Chapter Three	44
3.0 Literatures and Theory of Extreme Price Fluctuation in Assets and Bubbles	44
3.1 Introduction	44
3.2 The General Model and Individual's Optimum Plans.....	48
3.3 Equilibrium with Perfect Foresight	52
3.4 The Historical Development of the OLG Theory.....	56
3.5 Extrinsic and Intrinsic Uncertainties in the Overlapping Generation.....	58
3.5.1 Equilibrium Under Intrinsic Uncertainty.....	58
3.5.2 Description of a Market Economy with Contingent Commodities	60
3.5.3 Arrow-Debreu Equilibrium	62
3.6 Extrinsic Uncertainty.....	64
3.6.1 The Sunspot Equilibrium.....	65
3.6.2 Discussion.....	70

3.6.3	Sunspot Equilibrium From a Different Perspective	71
3.6.4	Discussion and Findings	75
3.6.5	Sunspots and Bubbles are implied by a Self Fulfilling Prophecy	79
Chapter Four.....		83
4.0	Bubbles And Stock Market Behaviour: Rational And Irrational.....	83
4.1	Introduction.	83
4.2	Literature Related To The Assets Bubble.....	90
4.3	Rational Bubbles.....	95
4.3.1	Basic Models by Which Bubbles Are Characterized.	96
	Diamond Model.....	98
	Existence of Asset Bubbles	100
4.4	Estimating Fundamentals	109
4.4.1	Assets Fundamentals And Regime-Switching	110
4.5	The Stock Market Crash And Bubble Busting	113
4.5.1	The Stock Market Crash	114
4.6	Discussion.....	117
Chapter Five.....		126
5.0	Conclusion And Recommendations	126
5.1	Conclusion.....	126
5.2	Recommendations	131

List of Figures

Figure	Page
1.1	Standard and Poor's 500 Composite Stock Price Index from January 1871 through January 2004.....7
1.2	S&P 500, Price-Earnings Ratio from January 1871 through January 2004.....8
2.1	Real S&P Composite Stock Price Index (p) and ex-post rational price (dotted line p*), 1871-1979.....14
2.2	ADBE Stock Performance for past 10 years35
2.3	ADBE Closing Price and Perfect foresight price for past 10 years.....36
2.4	ADSK Stock Performance for past 10 years37
2.5	ADSK Closing Price and Perfect foresight price for past 10 years.....38
2.6	AAPL Stock Performance for past 10 years.....39
2.7	Apple Closing Price and Perfect foresight price for past 10 years.....40
2.8	Jack Henry Stock Performance for past 10 years.....41
2.9	Jack Closing Price and Perfect foresight price for past 10 years.....42
2.10	Apple Closing Price, Perfect foresight price and error for past 10 years.....43
2.11	Stock Price Data Chapter 26 Of Market Volatility, Shiller Press, (1989).....44
3.1	OLG model, there an infinite number of periods and an infinite number of agents in the economy.....51
3.2	Arrow-Debreu equilibrium.....64
4.1	US Share Price Indices, "The collapse in NASDAQ and S&P index".....125

List Of Tables

Table	Page
2.1	ADBE Annual Data: High, Low, Closing and Opening prices.....28
2.2	ADBE Systems Perfect foresight price P_0^* for past 10 years.....29
2.3	ADSK Annual Data: High, Low, Closing and Opening prices.....29
2.4	ADSK Perfect foresight price P_0^* for past 10 years.....30
2.5	AAPL Annual Data: High, Low, Closing and Opening prices.....30
2.6	Apple Perfect foresight price P_0^*31
2.7	Jack Henry Annual Data: High, Low, Closing and Opening prices.....31
2.8	Jack Closing Price and Perfect foresight price.....32
2.9	Adobe System, P - P^* (testing of efficiency).....32
2.10	Autodesk System, P - P^* (testing of efficiency).....33
2.11	Apple System, P - P^* (testing of the efficiency).....33
2.12	Jack System, P - P^* (testing of efficiency).....34
4.1	Stock Market Crashes, Booms, and Recessions.
	United States, 1800–2000.....116

Table Of Flowcharts

Flowchart	page
Flowchart 1.1 The Dissertation Plan And Outlines.....	6
Flowchart 3.1 (OLG) Competitive Equilibrium architecture.....	54
Flowchart 3.2 (OLG) Equilibrium With Perfect Foresight.....	57
Flowchart 3.3 Sunspot Equilibrium.....	70
Flowchart 3.4 Rational Bubble.....	83
Flowchart 4.1 Stock Market Bubble.....	90

Chapter 1

1.0 Introduction and Background

1.1 Introduction

“The way we value the stock market now and in the future, influences major economic and social policy making decisions that not only affect investors, but also society and even the world at large. If we exaggerate the present value of the stock market, we may, as a society, invest too much in business start-ups and expansions, and too little in infrastructure such as education, and other forms of human capital. If we think the market is worth more than it really is, we become complacent in funding our pension plans, in maintaining our savings rate and in legislating an improved social security system” (Shiller (2000)).

The Phenomenon of the Bubble

While the stock market in the United States had its performance already surpassed the bull markets of the late 1920's and the mid 1960's, the greatest and most intense run-up in equity values had yet to occur. Between 1995 and the end of 1999, the S&P surged 207%, from 465 to 1428.68. At the same time, the Dow Jones Industrial Average (DJIA) increased from 3831 to 11497, or 200% in nominal terms.

By the end of 1999 the S&P and DJIA indices had risen an extraordinary 1,118% and 1,209% respectively, from their 1982 levels, in nominal terms to 644% and 636% in real terms. However, nominal S&P 500 earnings and dividends increased approximately 200% and 150%, respectively. That was only 40% and 63% in real terms over the same period. Figures 1.1 and 1.2 on page 8 and 9 respectively show the monthly real Standard and Poor's 500 composite Stock Price Index and Price-Earnings Ratio from January 1871 through January 2004¹. (online <http://www.econ.yale.edu/~shiller/data.htm>).

¹ The S&P 500 is corrected by inflation using the Consumer Price Index. The inflation corrected series is often multiplied by the CPI value for January 2001, thus setting the real values to reflect January 2001 dollars.

The total value of U.S. corporate equity was nearly twice the value of gross national income while key measures of stock market valuation, namely price multiples, appeared to be at unsustainable levels when juxtaposed to the long term historical trend. In particular, technology stocks on the NASDAQ rose to unprecedented levels during the two years leading up to March 2000. Ofek and Richardson (2001) estimate that at its peak, the entire Internet Sector, comprising several stocks, was priced as if the average growth rate of future earnings of these firms would exceed the growth rate experienced by some of the fastest growing firms in the past. At the same time, the required rate of return would be zero percent for several decades. Historically, low dividend yields have served as an important indicator of market over-valuation, with market corrections occurring as the yield approaches 2.65% (Standard and Poor's Stock Market Encyclopaedia, 1999). However, the new millennium, with a yield on S&P500 stock of approximately 1.14%, accentuated the fact that equity prices in the United States had reached levels consistent with expected dividend growth rates that were, by historical standards, unprecedented. This implies that either the run-up in equity values was not well anchored by fundamentals, that is to say there had been a significant shift in the risk or return characteristics of the stock market, or something extraordinary had occurred in the underlying real economy. These possibilities beg questions about the facts underpinning the phenomenal increase in U.S equity prices, the technology industry, in particular the NASDAQ and whether the boom was a result of investor euphoria, portfolio shifts or rational assessments of future prosperity.

With a significant decline in stock values during 2000 as well as the implausibility of the theories that trace stock movements completely back to "fundamentals" other influential theories that identify market conditions as speculative bubbles resulting from "irrational exuberance" on the part of the investing public, appear much more credible. Shiller's 'Bubble Theory' (2000b), which builds on earlier works of his (1981, 1984, 1989), is premised upon socio-psychological dynamics that consequently spawn investing fads and fashions, culminating in the under-pricing of risk and a rupturing of prices from their intrinsic values.

This dissertation therefore offers an empirical and theoretical investigation into the technological stock bubble in the NASDAQ as well as an analysis of the possibility of rational bubbles in technology stock.

The rest of the dissertation is thus outlined as follows. Chapter 2 reviews stock behaviour approaches to the bubble in the Stock Market and covers the following:

- a) The Efficient Market Hypothesis (EMH) as a foundation for most models used to explain the behaviour of asset prices.
- b) Testing the efficacy of the NASDAQ stock market.

Whether price movements in the stock market can be justified in terms of the simple efficient market model, has long been debated, although there is no universally accepted definition of the term “efficient market model.” The conventional model has been the dividend discount model (DDM). Most financial economists believed that the DDM provided a good approximate description of stock price determination for the aggregate market, at the very least. LeRoy & Porter (1981) and Shiller (1981) challenged this view by pointing out that aggregate stock prices appear too volatile to be measured by fundamentals i.e., dividends in the DDM.

- c) Testing of asset price volatility, Shiller’s (1981) post-rational price: P_t^* at date t .
- d) Noise trading and a model of dividend growth Barky and De Long propose a dividend growth model. This model assists us in explaining why stock prices are more volatile than predicted by the net present value with ex post rational prices.

Chapter 3 investigates extreme Asset Price Fluctuations. The goal of this chapter is to clarify a number of ideas within the framework of overlapping generations’ (OLG) models with empirical evidence which initially, settles the question of whether we should expect to observe asset bubbles in overlapping generations’ economies. The overlapping generations’ economy of Samuelson (1958) has become a central construct in monetary economics. Lucas (1972) added an exchange, which was

decentralized from information, and used it to construct a monetary shock theory of business cycles. These typically are equilibria, not only considered by Lucas but many others as well. Calvo (1978) showed that there are typical continuums of deterministic non-stationary equilibria. Azariadis (1981) and Cass and Shell (1983) found a set of sunspot equilibria. Kehoe and Levine (1985) demonstrate that the problem of multiplicity of equilibria increases with the number of goods. Spear and Srivastava (1986) have constructed overlapping generations models with a continuum of stationary equilibria. This chapter is arranged as follows: section one, investigates whether the fundamentalist view of asset pricing extends to overlapping generations' economies. Samuelson introduced the consumption-loan model in (1958). It is a fact well known that there exist economies in which money has a positive value in spite of the fact that it is intrinsically useless i.e., its market fundamental is zero. In other words, a bubble can exist on money where it is defined as the difference between the market price and the market fundamental². Section 2 aims at introducing rational expectations and posing the question of the existence of sunspot equilibria in systems that have a more complex structure than the simple overlapping generations' model. The histories of the OLG model and sunspot equilibria are intertwined. However, the first original source of sunspots is the overlapping-generations model. Chapter 4 focuses on bubbles and stock market behaviour, rational and irrational. It will cover the following: An introduction into asset bubbles and technology bubbles in particular, estimating fundamentals, literature and asset bubble theories, stock market crashes and bubble bursting, rational bubbles and basic models for characterizing bubbles, as well as some examples of past bubbles such as the Wall Street Crash, 1929, the Stock Market Crash, 1987, and the Stock Market Technology Bubble of the 1990's. Chapter 5 offers recommendations and then conclusion.

The case studies to be examined are from the following companies: Adobe Systems Incorporated ADBE, Jack Henry & Associates, Inc. JKHY, Autodesk Inc. ADSK, Apple Computer, Inc. AAPL, Yahoo, Inc. YAHOO and International Business, IBM. These are some of the largest technological companies listed on the NASDAQ stock market. We have chosen to research this topic in order to present a thorough

² Overlapping generations models with money were later thoroughly developed by Gale (1973), Cass-Okuno-Zilcha (1979), Wallace (1980), Hahn (1982), Balasko-Shell (1981) and Grandmont (1985), inter alia.

investigation of the rise and sudden fall of technology stocks over a particular period of time. Results from this study will include the following:

- Examination of the causes for the rise and sudden fall of the technology industry.
- Investigation of the “Bubbles” in the technology industry and the speed with which they emerge.

Methods and Techniques

The research conducted is based on an empirical study, which includes an investigation into case studies from the past 10 years. We will approach this task from Shiller’s (1981) (testing of the efficient market) point of view. Shiller’s test clearly demonstrates that a simple efficient markets’ model may be applied to companies listed on the NASDAQ.

Shiller (1981) refers to the PV (Present Discount) model as an “efficient market model” and views volatility testing as a method to evaluate market efficiency, different from more conventional regression methods. This is also supported by LeRoy and Porter (1981).

Some important studies, which apply co-integration techniques to investigate the behaviour of stock prices, include Campbell and Shiller (1987), Cerchi and Havenner (1988), Diba and Grossman (1988), Kasa (1992), Rappoport and White (1991), and Taylor and Tonks (1989).

The evidence documented in this dissertation suggests that the run-up in NASDAQ equity prices cannot be traced back singularly to the fundamental factors emphasized by conventional asset-pricing models. Therefore, more effort should be devoted to the development of alternative theories of speculative price movements.

Flowchart 1.1: An Investigation Into The Technological Stock Bubble

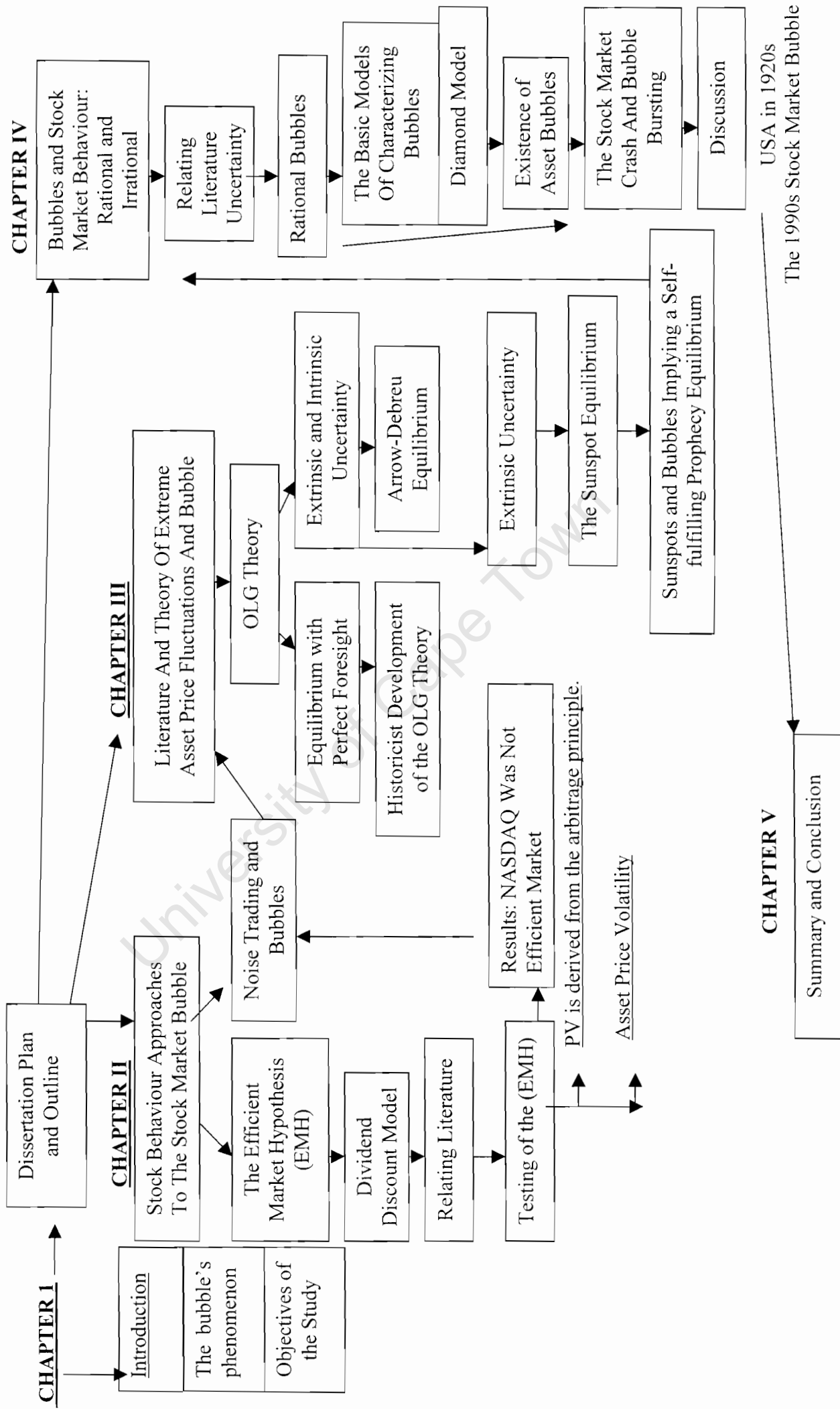


Figure 1.1: Standard and Poor's 500 Composite Stock Price Index from January 1871 through January 2004

Real S&P 500 Price Index

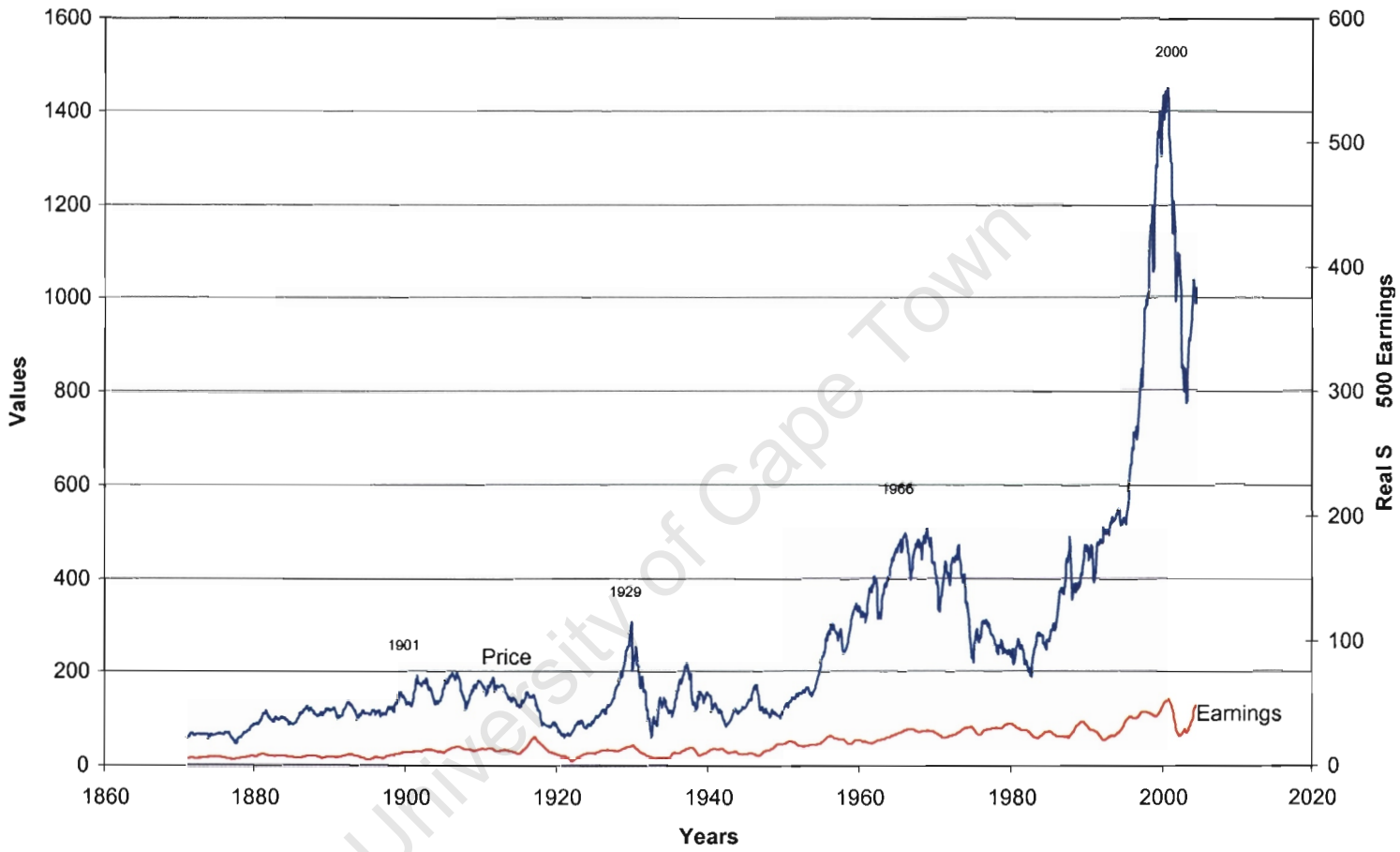
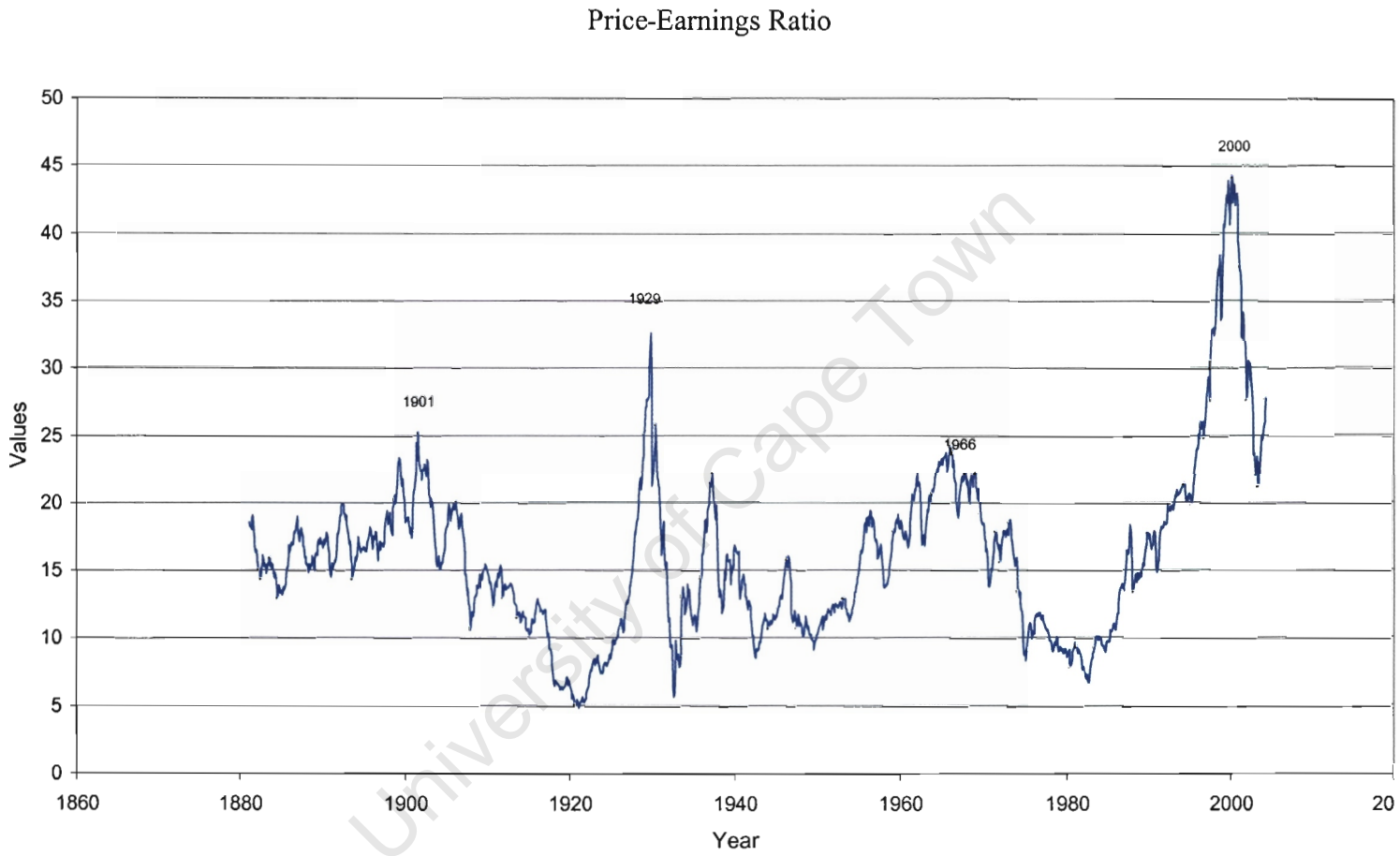


Figure 1.2: Price-Earnings's Ratio from January 1871 through January 2004



Figures 1.1 and 1.2 above represent Stock Market Data Used In "Irrational Exuberance".

Updated by Robert.J.Shiller (2000)

Chapter 2

2.0 Stock Behaviour Draws Near To The Stock Market Bubble

2.1 Introduction

For years economists and investors have tried to develop a model, which would describe the price behaviour of individual stocks. Most market professionals espouse one of the two approaches in predicting stock prices and these methods are technical and intrinsic value. The chartists, or technical theorists, believe that history tends to repeat itself, and that price patterns will reoccur in future. The second approach is that of intrinsic value which presupposes that at any time an individual security will have an intrinsic value, which depends on the earning potential of the security, usually involving the discounting of future cash flows.

This chapter therefore summarises the literature relevant to market efficiency and noise trader risk in financial markets. It also assesses the efficiency of the NASDAQ and the tests conducted for asset price volatility within the NASDAQ.

2.2 The Efficient Market Hypothesis (EMH)

The Hypothesis of an “efficient market” is based on the simple premise that a security’s market price is governed by its “fundamental value”. The fundamental value is the present value of the stream of income that security is expected to generate over its lifetime, equation 2.1

$$P_0 = \frac{E(d_1)}{1+r} + \frac{E(P_1)}{1+r} = \sum_{t=1}^T \frac{E(d_t)}{(1+r)^t} + \frac{E(P_T)}{(1+r)^T} \quad (2.1)$$

where P_0 is the fundamental value of stock, $E(d_t)$ is the expected annual dividend per stock, $E(P_t)$ is the expected price of the stock at the end of year t and r the discount rate of return.

According to Fama (1965) EMH advocates the view that prices correctly and almost immediately reflect all information and expectations. This includes not only the information on events that have already occurred but also takes into account projections and forecasts of what will take place in future. It assumes that there are large numbers of investors who use this information rationally to arrive at their decisions. It is therefore theoretically impossible to predict future price movements based on current, publicly available information. The result, of the hypothesis advocates, is that securities cannot be overpriced or under-priced for a period long enough to obtain abnormal returns.

$$\lim_{T \rightarrow \infty} \frac{E(P_T)}{(1+r)^t} = 0 \quad (2.2)$$

Consequently, an investor cannot consistently outperform the stock market. This is due to the random nature in which information arrives, in addition to the fact that prices react and adjusts almost immediately to reflect the latest information.

According to EMH, only investors willing to take higher risks can ever hope to attain above-average returns because the market so efficiently prices stocks. Risk, in the efficient market model, refers to the systematic or “undiversifiable” risk of the portfolio. It is measured by the portfolio’s co-variance with the general market, and is the beta coefficient, equation 2.3

$$P_t = P_0 + b_t \quad (2.3)$$

A security’s beta is an indicator of the degree to which it responds to movements in the market. In general, the percentage change in a security’s price is its beta multiplied by the percentage change in the level of the market over the same period. For example, when the market goes up one percent, a security with a beta of two will go up 2 percent on average, and security with a beta of 0.5 will rise by 0.5 percent on average. Consequently, a high-risk portfolio is expected to do well when the market rises, and poorly when the market falls (Dreman (1993)).

In the paper 'Stock Prices', Fama (1965) likens the movement of prices to the "random walk" of a drunkard stumbling from place to place. He argues that in an "efficient market", price movements are random since they represent adjustments to information that have been made public. Fama describes the random walk theory, by assuming that stock price changes have no memory. Therefore, the stock's price history has neither bearing on its future value nor usefulness in predicting any future value. He believes that the random walk theory may be acceptable even though it does not fit the facts exactly.

Later, Fama (1970) characterised an efficient market as one where prices fully reflect all available information. According to Jensen (1978) a market is efficient with respect to information if no one can make an economic profit by trading on the basis of past information. Generally, a market is efficient if it fully and correctly reflects all relevant information in determining prices. By considering three different types of information sets, three levels of market efficiency are normally distinguishable, the weak form, semi-strong form and strong form of efficient market hypothesis (EMH) (see Fama (1970, 1976); Copeland and Weston (1992)).

First, the weak form of the efficient market hypothesis (EMH) asserts that prices fully reflect the information contained in the historical sequence of prices. This means that investors cannot contrive an investment strategy to yield abnormal profits based on technical analysis of past price patterns because any information from such as analysis will already have been accounted for in the current market. Fama first looks at using technical analysis, which he calls the weak form of market efficiency. Research on the subject had shown that past price patterns were not a good predictor of the future. The justification, Fama reasons, is that any information from such analysis is already incorporated into market prices. Fama then moves on to fundamental analysis, that is, examining businesses and economic fundamentals as a means to predict stock prices. Again he cites a number of studies that show stock prices changing well before "new information" such as earnings, dividends, and mergers is available. He defines this condition as the semi-strong market efficiency.

Second, the semi-strong form of efficient market hypothesis (EMH) asserts that current stock prices reflect not only historical price information, but also all publicly

available information relevant to a company's securities. If markets are efficient in this sense, an analysis of any public information about a company (the technique of fundamental analysis), such as balance sheets, income statements, announcements of dividend changes or stock splits, will not yield abnormal economic profits. The majority of studies support the semi-strong version of efficient market hypothesis for instance Fama, Fisher, Jensen and Roll (1969) cited in Fama (1991) who studies the impact on share prices of splits. Kaplan and Roll (1972) found that the market correctly interpreted the effect of a change in an accounting method. Fama is careful never to say that all fundamental analysis is useless, but he does point out that with so many professionals attempting to beat the market, it becomes increasingly more difficult to do so consistently. Thus, Fama suggests that there is only limited evidence that, even the use of insider information allows investors to outperform the market. In other words, nothing that is known or even knowable about a company will benefit the analyst. This, he defines as the strong market efficiency.

Third, the strong form of efficient market hypothesis (EMH) states that all information that is known to any market participant about a company is fully reflected in market prices. The interpretation that stock price movements reflect the efficient discounting of new information on market fundamentals, the present value (PV) model of stock prices has become a fashionable tool in testing for market efficiency. For example, Shiller (1981) refers to the PV model as an "efficient market model" and views volatility tests as a method of evaluating market efficiency different from more conventional regression methods, which we will introduce in the next section.

2.2.1 The Dividend Discount Model as a Measure of Stock Market Efficiency

According to modern finance textbooks, stock price fluctuations are explained by changes in the expected present value of future dividends. The dividend discount model (DDM), has been taught extensively and underlies the dividend (cash flow) discount approach to stock valuation that is widely used by many practitioners and academics. This subject received a lot of attention about two decades ago when Leroy & Porter (1981) and Shiller (1981) conducted the volatility test. They analysed data, based on a simple dividend discount model with a constant rate, that stock market volatility was far greater than could be justified by subsequent changes in dividends.

According to Shiller (1981) the efficient market model can be stated as asserting that the price P_t of a share or portfolio of shares representing an index, equals the mathematical expectation, conditional on all information available at the time, of the present value P^* of actual subsequent dividends accruing to that share. P_t^* is an unknown at time t and has to be forecasted. Efficient markets maintain that price is equal to optimal forecast. Different forms of the efficient market model differ in the choice of the discount rate in the present value, but the general efficient market model can simply be written as:

$$P_t = E_t P_t^* \quad (2.4)$$

where E_t refers to mathematical expectation conditional on public information available at time t .

This equation asserts that any surprising movements in the stock market must have at their origin some new information about the fundamental value P_t^* . It follows therefore from the efficient markets model that

$$P_t^* = P_t + U_t \quad (2.5)$$

where U_t is a forecast error.

The forecast U_t has to be uncorrelated to any information variable available at time t , otherwise the forecast would not be optimal; it would not take into account all information. Since the price P_t itself, is information at time t . P_t and U_t must be uncorrelated to each other. Since the variance of the sum of two uncorrelated variables is the sum of their variances. It follows that the variance of P_t^* must equal the variance of P_t plus the variance of U_t , and since the variance of U_t cannot be

negative, the variance of P_t^* must be greater than or equal to that of P_t . Figure 2.1 illustrates these patterns.³

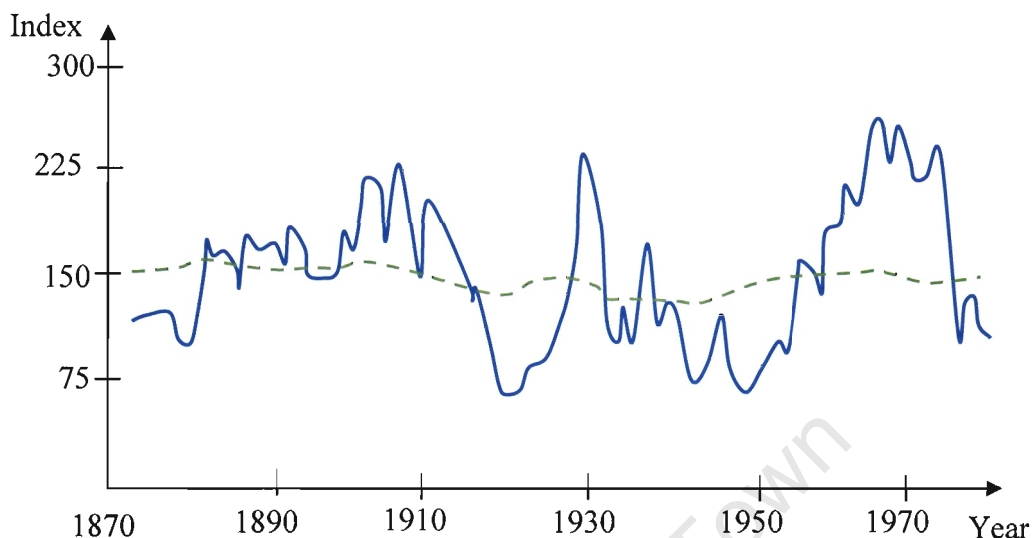


Figure 2.1 Real S&P Composite Stock Price Index (solid line p) and ex-post rational price (dotted line p*), 1871-1979, both de-trended by dividing a long-run exponential growth factor. The variable p* is the present value of actual subsequent real de-trended dividends, subject to an assumption about the present value in 1979 of dividends thereafter. (Source: Shiller (1981))

Shiller (1981, 2000) and others obtain the time series data on actual dividends and (using some additional assumptions) calculate values for P*. Comparing P and P* they claim that the data shows that in reality $\text{var}(P) > \text{var}(P^*)$. In other words, stock prices exhibit excess volatility; stock market prices defy rational explanations; stock market bubbles are likely to exist.

(Online. <http://www.few.eur.nl/few/people/smant/m-economics/shiller.htm>. July 10 2003).

³ Shiller applies this test to the Standard & Poor 500 index for 100 years by computing for each year since 1871, the present value subsequent to that year of the real dividends paid on the Standard & Poor's Composite Stock Price index, discounted by a constant real discount rate

$$P^* = \sum_{t=1}^T \frac{E(d_t)}{(1+r)^t} + \frac{E(P_T)}{(1+r)^T}$$

Flavin (1983), Kleidon (1986), and Marsh & Merton (1986), wrote papers which subsequent to these studies, challenged the statistical validity of the volatility tests. Still, a number of studies provide evidence that stock price fluctuations are too large to result solely from changes in the expected present discounted value of dividends.

West (1988) devised a variance bounds test that is free from small sample bias and valid even when dividends are non-stationary. Campbell and Shiller (1987) derived testable implications of the present value model, taking into account the non-stationarity and cointegration of prices and dividends. Both West and the Campbell & Shiller found strong evidence against the simple present value relationship. Although some argue that a time varying discount rate may help explain the failure of (DDM), various tests have found statistically significant excess volatility of stock prices.

2.3 Testing (EMH) in the Technology Industry of NASDAQ Stock

2.3.1 The Model

LeRoy and Porter (1981) assert that the efficient markets hypothesis implies, and is implied by, the PV relation between stock prices and market fundamentals. Shiller's model is simply expressed by Present Value (PV) derived from the principle of arbitrage.

$$P_t = \frac{d_{t+1} + P_{t+1}}{(1+r)} \quad (2.6)$$

Allowing for multiple future dates:

$$P_t = \frac{d_{t+1}}{(1+r)} + \frac{d_{t+2}}{(1+r)^2} + \frac{d_{t+3}}{(1+r)^3} + \dots + \frac{d_{t+N} + P_{t+N}}{(1+r)^N}$$

where P_t is perfect foresight price (fundamental value), d_t is the dividend during the period t and r discount rate of return.

Asset Price Volatility

Shiller's model of ex post-rational price: P_t^* at date t is expressed as follows:

$$P_t^* = \frac{d_{t+1}}{(1+r)} + \frac{d_{t+2}}{(1+r)^2} + \dots \quad (2.7)$$

$$P_t^* = \sum_{k=1}^{\infty} \frac{D_{t+k}}{(1+r)^k}$$

$$P_t = E_t P_t^*$$

$$P_t^* = E_t P_t^* + u_t = P_t + u_t$$

$$\text{var} (P_t^*) = \text{var} (P_t) + \text{var} (u_t)$$

$$\text{var} (P_t^*) \leq \text{var} (P_t) \quad (2.8)$$

Economic theory suggests that the current rational perfect-foresight price P_t^* , equals the discounted present value of all future realised dividend payments D_{t+k} using the discount rate r (equation 1) and Geeman, and Shiller, (2002) set “ r equal to 0.064, which is the annual average return over all firms and dates”. I will make use of this discount rate in my empirical test on page 17.

The current rational market price P_t should equal the market's expected value of P_t^* (equation 2). Using the rational-expectations hypothesis (perfect-foresight-with-error), the actual ex post P_t^* deviates from its rationally expected value only by a random forecast error u_t (equation 3). In this model, the theory of rational stock

market prices implies that the variance of actual market prices P is smaller or equal to the variance of the perfect-foresight price P^* (equation 5). This key insight is the so-called variance-bound test. See Geeman, and Shiller (2002) as well as

(Online. <http://www.few.eur.nl/few/people/smant/m-economics/shiller.htm>. July 10 2003).

2.3.2 Results

The focus in this study is not on the testing of market efficiency but on testing for the existence of rational bubbles in technological stock, 'NASDAQ'. However, the efficient market hypothesis is almost certainly the right place to start when thinking about set price formation. Evidence suggests that it cannot explain some important and perturbing features of asset market behaviour.

The efficient market hypothesis states that asset prices in financial markets should reflect all available information; and in consequence, prices should always be consistent with 'fundamentals'. See pages 28-31; tables 2.1, 2.3, 2.5 and 2.7 as well as pages 35,37,39 and 41; figures 2.2, 2.4, 2.6 and 2.8 which depict performance of stocks for the past 10 years of the companies Adobe Systems, AutoDesk, Apple Computer and Jack Henry & Associates listed in the technology industry on the NASDAQ stock market. The curves show a sharp increase between 1998 and 2000, and a sudden drop thereafter. In this context, an important issue is whether the increase in stock market prices is justified by a fundamental or reflects a deviation from the fundamental.

By applying equation 2.6 on page 15 to the data described above, we find that the present value, if plotted through time, behaves remarkably like a stable trend. Stock price gyrates wildly up and down around this trend see Figures 2.3, 2.5, 2.7, and 2.9 on pages 36,38,40 and 42 which reflect the results shown in tables 2.2, 2.4, 2.6, and 2.8 on pages 29- 32.

For example, Table 2.2 and Figure 2.3 clearly show that the financial market is not efficient and that stock is driven away from its base at particular times. One example of this was in the year 2000 when the closing price was determined to be 73.81 and the EMH test showed that if the market is efficient, the fundamental price of stock should be 17.2929. This is according to the simplest efficient markets theory where

stock price represents the optimal forecast of this present value with the price responding only to objective information about it. Shiller (1981), as did LeRoy and Porter (1981) argue that the stability of the present value through time suggests that there is excess volatility in the aggregate stock market, relative to the present value implied by the efficient markets model.

In fact, the consumption discount model, while possibly showing some co-movements in time with actual stock prices, does not work well due to justifying the volatility of stock prices. Shiller (1982) shows that the theoretical model implies a lower bound on the volatility of the marginal rate of substitution, a bound which is, in the U.S. data, much higher than could be observed unless risk aversion were implausibly high. Marsh and Merton's (1986) challenge was how to construct a test for expected volatility that modeled dividends and stock prices in a more general way. As such tests were developed, which tended to confirm the overall hypothesis that stock prices had more volatility than an efficient markets hypothesis could explain. For example, West (1988) derived an inequality of the variance of innovations in stock prices which must be less than or equal to the variance of the innovations in the forecasted present value of dividends based on a subset of information available to the market.

In addition, Table 2.9, 2.10, 2.11 and 2.12 as well as Figure 2.10 provide some summarised statistics of the volatility test in our case studies which, show the difference between P and P^* which refers to the fundamental value of the stock which prove the market inefficient as well as show clearly that the level of volatility of the overall stocks cannot be well explained with any variant of the efficient markets model in which stock prices are formed by looking at the present discounted value of future returns.

These results demonstrate the first point that hedge funds were attacking the bubble in technology stock during the 1990's.

2.4 Noise Trading and Bubbles

A number of models in financial economics rely on the existence of traders who are unable to fully exploit available information or to correctly maximize their utility.

Consequently, they (traders) fail to behave optimally and as a result are called “noise traders”.

When there are many noise traders, the market is more liquid in the sense of having frequent trades that allow people to observe prices. On the other hand, the price of the stock reflects both the correct information on the part of informed agents and the distortions generated by the noise traders. The more noise trading, the less information gets into prices, with a resultantly less efficient market.

As the effects of noise trading blur price information, speculators and arbitrageurs cannot be sure that they are trading on information rather than noise. This limits their willingness to take large positions and slows down the process of adjusting to fundamental values. In effect, it is even possible that noise traders may profit more than “rational” traders if the amount of noise trading is large enough to sustain an imbalance that favours noise traders in the short-term. According to Black (1986), “Noise creates the opportunity to trade profitably, but at the same time makes it difficult to trade profitably”.

A form of market risk associated with the investment decisions of noise traders is that the higher the volatility in market price for a particular security, the greater the associated noise trader risk. For example, if the noise trader risk for a particular stock is high, an issuance of good news related to a particular company may influence more noise traders to buy the stock, artificially inflating its market value.

In reality, most people are considered to be noise traders, as very few actually make investment decisions solely using fundamental analysis. Furthermore, technical analysis is considered to be a part of noise trading because the data is unrelated to the fundamentals of a company.

Another strand of literature by Blanchard and Watson (1982) argues that the case for efficient markets has been exaggerated without abandoning its foundations, “Rationality of both behaviour and also of expectation often does not imply that the price of an asset be equal to its fundamental value. In other words, there can be a rational deviation from this value”. Here the stock price is equal to its fundamental value plus a rational bubble term. In any one period, the probability that the ‘Blanchard-Watson bubble’ will burst is constant, but increases should the bubble not be interrupted by a market correction. The use of the word rational emphasises the

fact that the existence of the bubble is held to be consistent with rational expectations and constant expected returns independent of past information.

Clearly, Blanchard and Watson (1982) wish to maintain the central assumptions of the theory of efficient capital markets while retreating from the strong conclusions it draws. In doing so, the theory of rational bubbles is more of an ad hoc justification than a hypothesis since it can neither explain how bubbles are formed in the first place nor how they are maintained for an extended period of time. Furthermore, the rational bubble theory advanced here cannot explain under-valuation since the bubble term cannot be negative.

Bubbles may therefore imply a self-fulfilling prophecy where the existence of abnormally high prices, unwarranted by fundamentals, is justified purely on the basis that investors believe prices will continually increase. Rationality implies that investors know that prices are overvalued and therefore that there will be a reversion to more pragmatic values. More importantly they know this information is common knowledge. This reasoning would constrain the ability of the rational bubble to form in the first place as no rational investor would be willing to pay the “bubble premium” (see Cuthbertson (1996)). Therefore, it is not possible to unite substantive rational expectations and bubble behaviour in a consistent manner, as the two are antithetical. That traders are compensated for the increased risk is no justification for a rational trader purchasing overvalued stock in the first place. Thus, the “rational irrationality” theory cannot be considered a reliable vindication of the conventional approach to financial markets.

Blanchard and Watson (1982) acknowledge that investor irrationality, most likely factors into stock price fluctuations but hold too that while “ it is hard to analyse rational bubbles, it would be much harder to deal with irrational bubbles”. For simplicity, the authors therefore opt for the highly technical, financial market, abstractly treated with the theory of rational bubbles. Rational bubble theory does a service to the theory of asset fluctuation since it admits the overly restrictive nature of EMH and attempts to address it. However, it is not clear that the rational bubble, although relatively easier to model, provides enough insight about financial markets to justify circumnavigating the irrational approach i.e., invoking Occam’s Razor only

makes sense if the phenomena to be explained is explained satisfactorily). Glicknam (1994), rejecting such theories on the basis that they offer little practical value and no suggestion as to how bubbles actually form, sums up the literature here as “exercises in empty elegance. While this statement may be too strong, from the speculative market theorists’ perspective, it is an example of what Shiller deems one of the most serious errors in the history of economic thought. He notes, “ My own attitude toward rational bubble models is that they are too narrow a class of models to focus much attention on ” (Shiller, 1989, p.96).

Theories of noise trading appear to go further in the analysis of how speculative bubbles form in financial markets. In the seminal (1986), article, “*Noise*”, Black presumes that there are noise traders on the fringe of the rational market. These noise traders pursue irrational strategies, basing investment decisions purely on past price movements. This activity causes stock prices to overshoot their fundamental values with noise traders becoming more aggressive as the speculative bubble becomes more intense. Moreover, the longer the duration of an upward trend, the more likely the positive feedback dynamics will continue, owing to the increased confidence of irrational traders. Within Black’s conceptual framework flows move prices with impunity because arbitrage is no longer without risk. Consequently, the arbitrageurs whose activity would ordinarily move prices back in line with intrinsic values, are reluctant to sell overpriced assets short for fear of noise traders initiating further price increases. Thus, the strength of the noise traders leads to speculative bubbles in asset pricing even though rational traders exist.

Arguably the noise concept attracted conventional theorists where some heterodox theories of speculative behaviour did not. This was primarily because the equating of noise, irrational behaviour, with a random error term appears consistent with the Martingale model of stock price behaviour instead of appealing wholesale to a theory of irrationality. Leroy (1989) appropriately notes:

Given the traditional hostility toward irrationality as manifested, for example in Shiller’s fad variable, neither alternative is attractive. Fortunately, Fischer Black (1986) came to the rescue. By renaming irrational trading “Noise trading” Black

avoided the I-word, thereby sanitizing irrationality and rendering it palatable to many analysts who, in other settings, would not be receptive to such a specification

In short, the noise trading theory implicitly proposes that irrational traders are a small enough group so as to deem the collective market rational but large enough to codetermine the course of equity prices. This is an immediate rejection of the rational expectations hypothesis, which presumes that all agents know the correct equilibrium model of expected returns and know that the information is common knowledge. Moreover, by simply changing the wording in Black's noise trading model, a closer association to Shiller's fad model is revealed, than the efficient market model it attempts to reclaim. If we label noise traders as "ordinary money" and rational flows as "smart" money, the difference between Shiller (1989) and Black (1988) is one of scope assumptions about what drives the "ordinary flows" and scepticism about how cleanly the division can be made between smart and irrational traders.

Shleifer and Summers (1990) draw more overt similarities between noise traders and speculative market theory in their representation of the noise trader approach to financial markets. Here the market is familiarly characterized by the activity of both rational arbitrageurs and noise traders. The existence of market participants whose trades are not fully reflective of fundamental news imposes two types of risk, the first being the risk stemming from uncertainty about future prices at which current holdings can be resold. The second is the additional price risk described previously by Black (1986) i.e., "noise-trader risk". Because of the latter type of risk, arbitrageurs cannot discern whether price increase is generated by genuine information about future dividend payments not already incorporated in the current price or the result of the irrational activities of noise traders. Thus, rather than selling the overpriced stock, would be arbitrageurs may elect to hold them, in anticipation that noise traders will further push up prices.

Clearly, central to noise trading theory is the notion that rational traders must endeavour to anticipate the flows of noise traders when devising their own rational trading strategy, creating a bandwagon effect. This of course, is directly in the spirit of Keynes.

With the stock market crash of 1987, during which the Dow Jones Industrial Average declined 30% in six days, more literature appeared which sought to maintain the basic ideas found in Samuelson (1965) and Fama (1970) by further advancing “rational” theories to explain excessive share price fluctuation. Among the most notable are noise trading or feedback trading models of Cutler, et al. (1990) and De Long, et al. (1990) and the rational bubble models of Froot, et al. (1992), Romer (1993) and Bulow and Klemperer (1994). These works maintain the essential flavour of Black (1986), Shleifer & Summers (1990) and Blanchard & Watson (1982) while emphasizing the inefficiency of financial markets. Romer (1993) attempts to forge a middle ground between rational and irrational views. To these ends Romer argues that stock markets are imperfect in an informational sense, resulting in investors attempting to evaluate the beliefs of others rather than forming sensible estimates of the economic fundamentals. Here, the market approximates the “beauty contest” by Keynes (1936) and more rigorously analysed within a psychological context by behavioural finance theorists. Investigations in the next and subsequent chapter will depend on some of the theories that were covered in this section.

2.5 Beyond Dividend Discount Model in Characterizing Fundamental

A large collection of literature on empirical tests of asset price behaviour exists e.g., Flood and Garber (1980), Shiller (1981), Blanchard and Watson (1982), Meese (1990), Kleidon (1986), Santoni (1987), Campbell and Shiller (1988), West (1988), Froot and Obstfeld (1991), Blanchard and Watson (1982), and McQueen and Thorley (1994). Researchers have argued that stock prices are not consistent with the fundamentals that prices are supposed to represent i.e., with the discounted stream of future dividends, discussed earlier in this chapter. One possible solution to this problem would be to improve the model of fundamentals so that they more closely reflect observed asset prices. Yet this approach has yielded limited success, principally because stock prices exhibit much higher volatility than what can be explained by movements in fundamental variables such as earnings, dividends and interest rates (see Shiller (1981)). Moreover, dividend based models seem to be ill equipped to explain some of the stylised facts about stock returns. For example, these models cannot explain the fact that stock returns exhibit time varying volatility,

negative skewness, and asymmetric volatility, i.e. negatively correlated returns and return volatility (see Cox and Ross (1976); Bekaert and Wu (2000)).

However, Campbell and Shiller (1988) present an estimate indicating that data which takes earnings into account, helps to predict the present value of future dividends when averaged over many years. This result holds true even when stock prices themselves are considered. The data used was the real Standard and Poor's composite Index and associated dividend and earnings series 1871-1987. These estimates indicate to what extent dividend-price ratios and returns on this index behave in accordance with simple present value models, and allow them to shed new light on earlier claims that stock prices are too volatile to accord with such models (LeRoy and Porter 1981, Shiller 1981, Mankiw, Romer, and Shapiro 1985, Campbell and Shiller 1987a, 1987b and West 1988). In essence, the results indicate that a long moving average of real earnings helps to forecast future real dividends. The ratio of the earning's variable to the current stock price is a powerful predictor of the return on stock, particularly when the return is measured over several years. These facts make stock prices and returns much too volatile to accord with a simple present value model (Campbell and Shiller (1988b)).

However, Campbell and Shiller (1988b) would argue that a long moving average of earnings is a very natural variable to use when representing fundamental value, and that there are not many competitors for this role. Furthermore, it was noted that they found evidence of excess volatility in earlier research (Campbell and Shiller, 1987b)⁵, which did not use information in earnings. We will discuss Campbell and Shiller's (1988b) framework that dividend-price and earning-price ratios predict stock returns measured over several years.

2.5.1 Dividend-Price and Earning-Price Ratios

Campbell and Shiller (1988b) writes that the real price of the stock index, measured in January of years t , as P_t . The real dividend paid on the index during t is expressed

⁵ A popular approach in testing bubbles is to examine the stationarity (or non-stationarity) of the residuals between asset prices and market fundamentals [usually dividends see Campbell and Shiller (1987), Diba and Grossman (1984, 1988)]

as D_t . The realised log gross return on the portfolio, held from the beginning of year t to the beginning of year $t+1$ is $h_{1t} = \log\left(\frac{P_{t+1} + D_t}{P_t}\right) = \log(P_{t+1} + D_t) - \log(P_t)$.

The realised log gross return over I years, from the beginning of year t to the beginning of year $t+1$, is

$$h_{it} = \sum_{j=0}^{i-1} h_{1,t+j} \quad (2.9)$$

where: h_{it} = one-period return on asset

The short-term interest rate that they use is the annual return on a 4-6 month, commercial paper, rolled over in January and July. If we write the realised log return on commercial paper in year t as r_t and aggregate to a multi-period return r_{it} in the manner of equation (2.9), then the excess return on stock over period I is $h_{it} - r_{it}$. Working with excess returns has the advantage that price deflators are cancelled out so that results are not contaminated by measurement error in the deflators (Campbell and Shiller (1988 b)).

Campbell and Shiller (1988b) begin their empirical work by regressing real and excess stock returns on some explanatory variables. These variables are known in advance (at the start of year t). For real returns, they consider the following variables: The log dividend-price ratio, $\delta_t \equiv d_{t-1} - P_t$ (the dividend is lagged one year to ensure that it is known at the start of year t); the lagged dividend growth rate, Δd_{t-1} ; the log earnings-price ratio $E_t \equiv e_{t-1} - p_t$; and two log earnings-price ratios based on moving averages of earnings. The latter two are a 10-year moving average of log real earnings minus current log real price, $E_t^{10} \equiv ((e_{t-1} + \dots + e_{t-10})/10) - P_t$ and a 30-year moving average of log real earnings minus current log real price, $E_t^{30} \equiv ((e_{t-1} + \dots + e_{t-30})/30) - P_t$,⁶.

⁶ Using this theory, we can even look at a 100-year moving average of log real earnings minus current log real price, $E_t^{100} = ((e_{t-1} + \dots + e_{t-100})/100) - P_t$

The ratio variables are used here with the same motivation that we see in the financial press: As indicators of fundamental value relative to price. The notion is that if stocks are under-priced relative to fundamental value, returns subsequently tend to be high. The opposite is true if stocks are over-priced. A moving average of earnings is used because yearly earnings are quite noisy as measures of fundamental value. They could even be negative though fundamental value cannot be negative.

The use of an average of earnings in computing the earnings' price ratio has a long history. However, Graham and Dodd (1934), recommend an approach that "shifts the original point of departure or basis of computation from the current earnings to the average earnings, which should cover a period of not less than five years, and preferably seven to ten years." (Security Analysis, p 452). However, Vuolteenaho (2002) showed, using vector-autoregressive methods, that the ratio of book-to-market-value of U.S. firms explains a substantial fraction of changes in future firms' earnings. Cohen, Polk and Vuolteenaho (2002) concluded that 75 to 80 percent of the variation across firms in their book-to-market ratios could be explained in terms of future variation in profits. Jung and Shiller (2002) illustrated that, cross-sectionally, for U.S. stocks that have been continually traded since 1926, the price-dividend ratio is a strong forecaster of the present value of future dividend changes. So, dividend-price ratios on individual stocks do serve as forecasts of long-term future changes in their future dividends, as efficient markets assert.

This does not mean that there are no substantial bubbles in individual stock prices, but that the predictable variation across firms in dividends has often been so great as to largely swamp out the effect of the bubbles. This predictable variation across firms usually takes the form of firms paying zero dividends for many years with investors correctly perceiving that dividends will eventually be coming. Investors in firms which are doing badly correctly perceive that they will not be paying substantial dividends much longer. When it comes to individual stocks, such predictable variations, and their effects on price, are often far larger than the bubble component of stock prices.

In concluding this chapter, we see clearly that the overall level of volatility on the stock market cannot be explained well with any variant on the efficient market model in which stock prices are formed by looking at the present discounted value of future returns. Shiller stated in (2003) “there are many ways to tinker with the discount rates in the present value formulae, and someday, someone may find some definition of discount rates that produces a present value series that fits the actual price better than any of the series shown in Figure 2.11. But it is unlikely that they will do so convincingly, given the failure of our efforts, to date, to capture the volatility of stock prices”.

After all the efforts to defend the efficient markets’ theory, there is still every reason to believe that, while markets are not totally irrational, they contain substantial noise. This noise is so extensive that it dominates movement in the aggregate market. The efficient market model, for the aggregate stock market, has however, never been supported by any study effectively linking stock market fluctuations with subsequent fundamentals”.

It is thus questionable whether bubbles exist in stock prices. Possible answers to this will become evident in the next chapter. In recent years there have, however, been a number of studies on testing speculative bubbles in stock prices. Different results have been obtained: For example: West (1987) and Rappoport & White (1993) found evidence of bubbles, while Diba & Grossman (1988) and Dezhbakhsh & Demirgucunt (1990) obtained results which support the conclusion that stock prices do not contain bubbles. Of course the presence or absence of bubbles has important implications for modeling stock prices. It may also have a serious impact on asset and risk management practices that use these models.

A popular approach in testing bubbles is to examine the stationarity or non-stationarity of the residuals between asset prices and market fundamentals which are usually dividends. For applications based on this approach see Campbell and Shiller (1987), Diba and Grossman (1984, 1988), Hamilton and Whiteman (1985), among others. Traditionally the approach in question uses unit root tests on the residuals. By treating the non-stationary bubble process as a unit-root process, the conventional unit root based procedures test the null hypothesis to verify whether the stock price

contains a bubble. If the unit root hypothesis is rejected, the bubble hypothesis is rejected.

In the next chapter, we describe the basic overlapping generation's (OLG) model, which is based on work by Samuelson (1958), Gale (1973) and Diamond (1965).

Since Samuelson (1958) developed his consumption loan model it has become a well-known fact that there exist economies in which money has a positive value in spite of it being intrinsically useless i.e., its market fundamental is zero. What this means is that a bubble can exist on money where it is defined as the difference between the market price and the market fundamental.

Empirical Results

Table 2.1: ADBE Annual Data of Prices: High, Low, Closing and Opening

Years	Price High	Price Low	Closing Price	Opening Price	Divided Yield
1993	4.6	4.44	4.47	4.5	1.1
1994	8.82	8.33	8.33	8.76	0.59
1995	13.02	12.46	12.53	12.84	0.39
1996	9.01	8.45	8.58	8.92	0.58
1997	12.93	12.31	12.62	12.34	0.4
1998	8.25	7.75	8	8.25	0.62
1999	29.33	28.72	29.14	28.91	0.17
2000	77.19	70.16	73.81	74	0.07
2001	29.96	27.2	28.89	28.01	0.17
2002	21.36	20.05	20.32	21	0.25
2003	41.04	40.29	41.04	40.91	0.12

Table 2.2: ADBE Systems Perfect foresight price P_0^* for past 10 years

Years	Closing Price	Divided Yield	P_0^*
1993	4.47	1.1	14.363
1994	8.33	0.59	14.182
1995	12.53	0.39	14.501
1996	8.58	0.58	15.038
1997	12.62	0.4	15.421
1998	8	0.62	16.008
1999	29.14	0.17	16.412
2000	73.81	0.07	17.292
2001	28.89	0.17	18.329
2002	20.32	0.25	19.332

Table 2.3: ADSK Annual Data of Prices: High, Low, Closing and Opening

Years	Closing Price	Opening Price	Price High	Price Low	Divided Yield
1993	10.75	11.13	11.5	10.63	1.12
1994	15.94	16	16.13	15.81	0.75
1995	20.63	20.75	21.25	20.53	0.58
1996	12.09	11.88	12.25	11.63	0.99
1997	24.12	24.94	25.37	24.12	0.5
1998	11.88	12.5	12.5	11.69	1.01
1999	10.44	10.38	10.44	10.13	1.15
2000	11.47	11.55	11.84	11.47	1.05
2001	16.86	16.94	17.13	16.55	0.71
2002	12.39	12.71	12.92	12.36	0.97

Table 2.4: ADSK Perfect foresight price P_0^* for past 10 years

Years	Closing Price	Divided Yield	P_0^*
1993	10.75	1.12	13.01
1994	15.94	0.75	12.72
1995	20.63	0.58	12.78
1996	12.09	0.99	13.02
1997	24.12	0.5	12.86
1998	11.88	1.01	13.19
1999	10.44	1.15	13.02
2000	11.47	1.05	12.71
2001	16.86	0.71	12.47
2002	12.39	0.97	12.56

Table 2.5: AAPL Annual Data of Prices: High, Low, Closing and Opening

Years	Closing Price	Opening Price	Price High	Price Low	Divided Yield
1993	11.81	11.87	12	11.69	2.03
1994	18.12	18.69	18.74	18	1.32
1995	17.84	18.37	18.5	17.81	1.35
1996	11.41	11.44	11.56	11.06	2.1
1997	10.97	11.09	11.12	10.84	0
1998	16.28	16.84	17.16	16.25	0
1999	33.59	34.69	34.81	33.5	0
2000	22.19	22.69	22.94	21	0
2001	16.14	15.4	16.15	14.99	0
2002	14.03	14.36	14.4	14	0
2003	22.29	21.67	22.33	21.58	0

Table 2.6: Apple Perfect foresight price P_0^*

Years	Closing Price	Divided Yield	P_0^*
1993	11.81	2.03	13.38
1994	18.12	1.32	12.20
1995	17.84	1.35	11.67
1996	11.41	2.1	11.06
1997	10.97	0	9.67
1998	16.28	0	10.29
1999	33.59	0	10.95
2000	22.19	0	11.65
2001	16.14	0	12.39
2002	14.03	0	13.19

Table 2.7: Jack Henry Annual Data of Prices: High, Low, Closing and Opening

Years	Closing Price	Opening Price	Price High	Price Low	Divided Yield
1993	1.95	1.95	1.95	1.91	1.54
1994	1.48	1.5	1.5	1.42	2.25
1995	3.38	3.27	3.38	3.27	1.14
1996	5.35	5.35	5.44	5.35	0.87
1997	6.63	6.66	6.66	6.44	0.83
1998	9.13	9.41	9.66	9	0.71
1999	9.5	9.52	9.67	9.44	0.84
2000	22.25	22.03	22.5	21.5	0.45
2001	22.5	23	23.6	22.1	0.53
2002	9	9.25	9.39	8.7	1.56
2003	18.6	18.35	18.74	18.34	0.75

Table 2.8: Jack Closing Price and Perfect foresight price

Price	Closing Price	Divided Yield	P_0^*
1993	1.95	1.54	12.96
1994	1.48	2.25	12.25
1995	3.38	1.14	10.78
1996	5.35	0.87	10.33
1997	6.63	0.83	10.12
1998	9.13	0.71	9.94
1999	9.5	0.84	9.87
2000	22.25	0.45	9.66
2001	22.5	0.53	9.83
2002	9	1.56	9.92

Table 2.9: ADBE System, $P - P^*$ (testing of efficiency)

Years	P	P^*	$P - P^* = U$
1993	4.47	14.36	-9.89
1994	8.33	14.18	-5.85
1995	12.53	14.50	-1.97
1996	8.58	15.04	-6.46
1997	12.62	15.42	-2.80
1998	8	16.01	-8.01
1999	29.14	16.41	12.73
2000	73.81	17.29	56.52
2001	28.89	18.33	10.56
2002	20.32	19.33	0.99

In the above table if the market is efficient, then $P - P^* = 0$

Table 2.10: ADSK, P - P* (testing of efficiency)

Years	P	P*	P - P*=U
1993	10.75	13.01	-2.257
1994	15.94	12.72	3.221
1995	20.63	12.78	7.847
1996	12.09	13.02	-0.931
1997	24.12	12.87	11.255
1998	11.88	13.19	-1.308
1999	10.44	13.02	-2.582
2000	11.47	12.71	-1.235
2001	16.86	12.47	4.392
2002	12.39	12.56	-0.166

In the above table if the market is efficient $P - P^* = 0$

Table 2.11: AAPL, P - P* (testing of efficiency)

Years	CLOSING P	P*	P - P*=U
1993	11.81	13.38	-1.57
1994	18.12	12.20	5.92
1995	17.84	11.67	6.18
1996	11.41	11.06	0.35
1997	10.97	9.67	1.30
1998	16.28	10.29	5.99
1999	33.59	10.95	22.64
2000	22.19	11.65	10.54
2001	16.14	12.39	3.75
2002	14.03	13.19	0.84

In the above table if the market is efficient $P - P^* = 0$

Table 2.12: Jack System, P - P* (testing of efficiency)

Years	Closing Price	P*	P - P*=U
1993	1.95	12.96	-11.01
1994	1.48	12.25	-10.77
1995	3.38	10.78	-7.40
1996	5.35	10.33	-4.98
1997	6.63	10.12	-3.49
1998	9.13	9.94	-0.81
1999	9.5	9.87	-0.37
2000	22.25	9.66	12.59
2001	22.5	9.83	12.67
2002	9	9.92	-0.93

Tables 2.1, 2.3, 2.5, and 2.7 above represent the performance of stocks for the past 10 years of the following companies: Adobe Systems (ADBE), Autodesk (ADSK), Apple Computer (AAPL) And Jack Henry & Associates. These companies are listed in the technology industry on the NASDAQ Stock Market. The data was obtained from The University Of Cape Town DataStream. However, tables 2.2, 2.4, 2.6 and 2.8 represent our empirical results of calculating the DDM for the same companies named above.

Having reviewed these tables and graphs it will become evident that prices are much more flexible. However, the efficient market hypothesis does not apply exactly. Though it is very difficult, if not impossible to regularly “beat” the market and prices do seem to follow a random walk (as suggested by the hypothesis), financial asset prices reflect more than simply the “fundamentals”. For example, market participants pay attention to each other, how others value stocks and bonds. John Maynard Keynes likened the stock market to a situation where people bet on a beauty contest. People don’t bet on the “beauty” of the contestants (i.e., the fundamentals) as much as *who everyone else thinks* is most “beautiful”. Thus, there is the possibility of a “bubble” in which everyone bets that asset prices *will rise*, causing them to rise (a self-fulfilling prophecy).

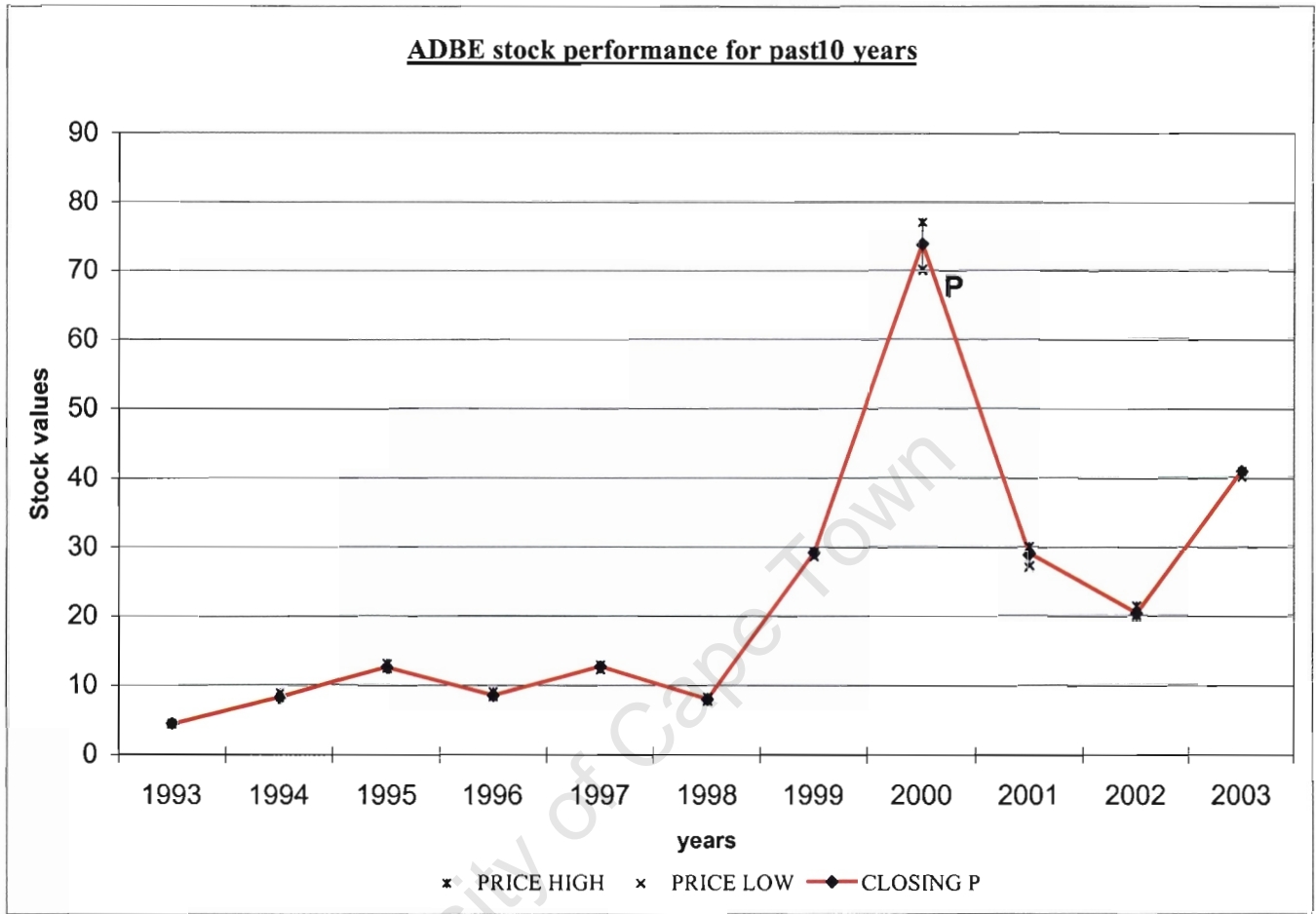


Figure 2.2: ADBE Stock Performance for the past 10 years.

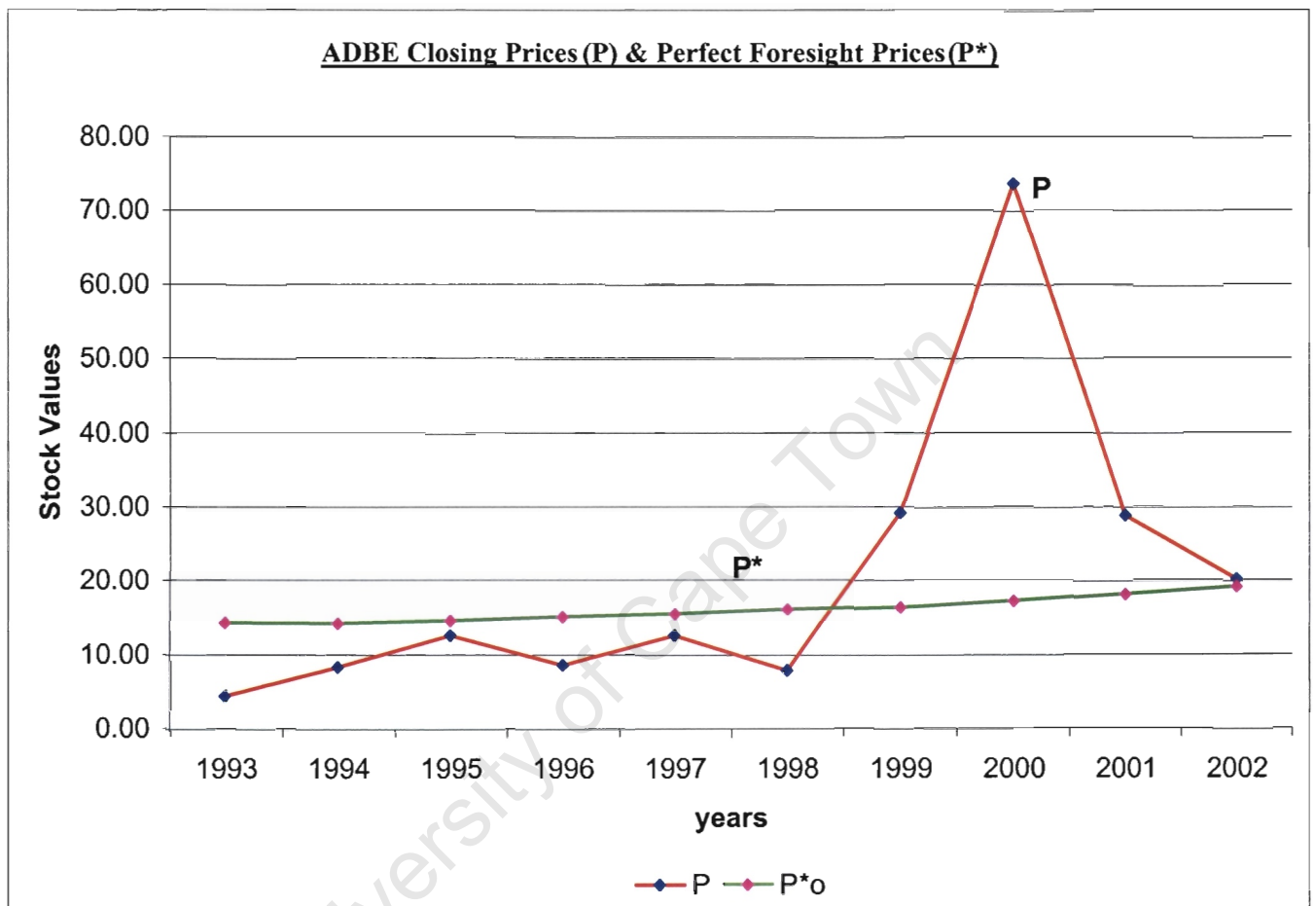


Figure 2.3: ADBE Closing Price and Perfect foresight price for the past 10 years

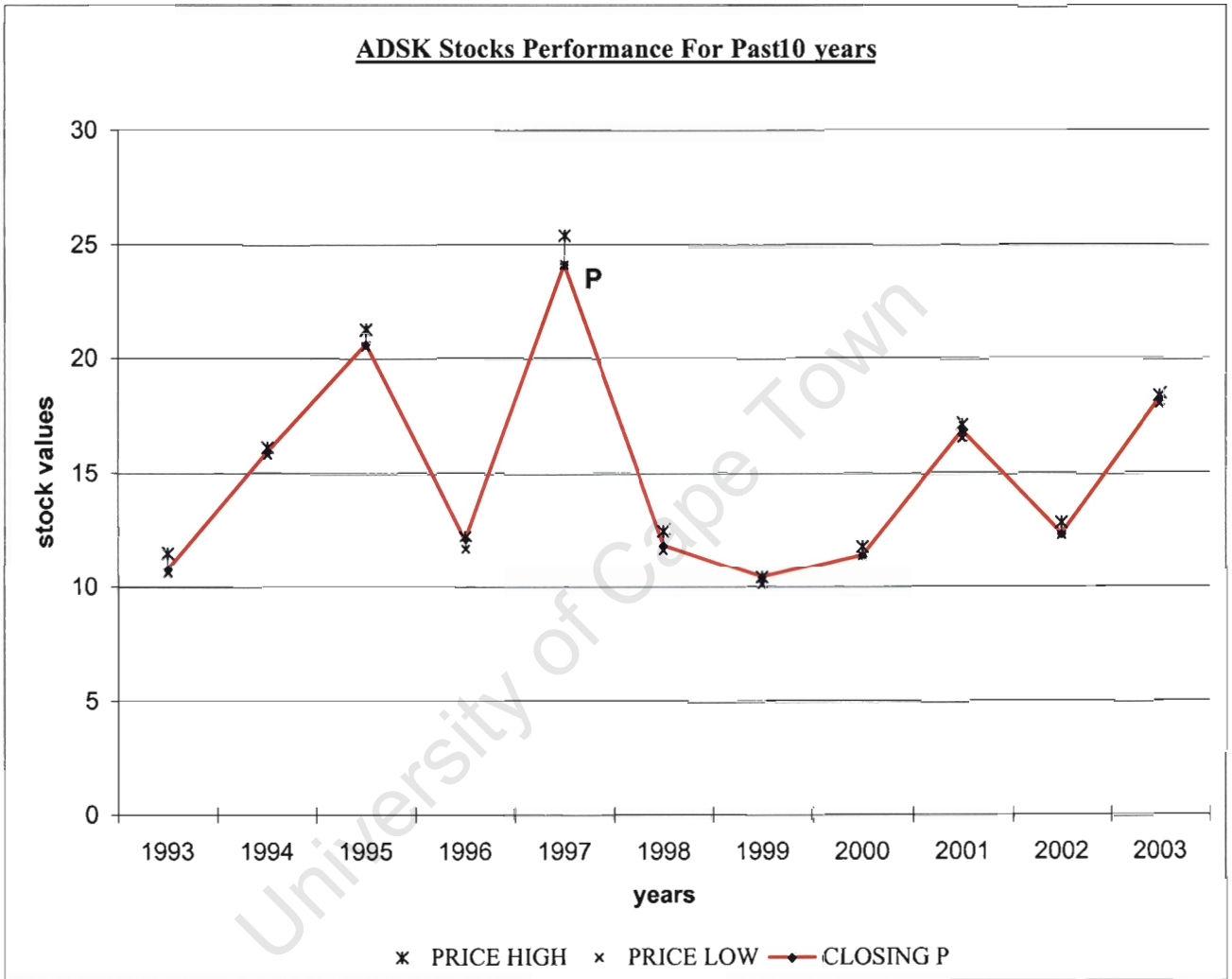


Figure 2.4: ADSK Stock Performance for the past 10 years

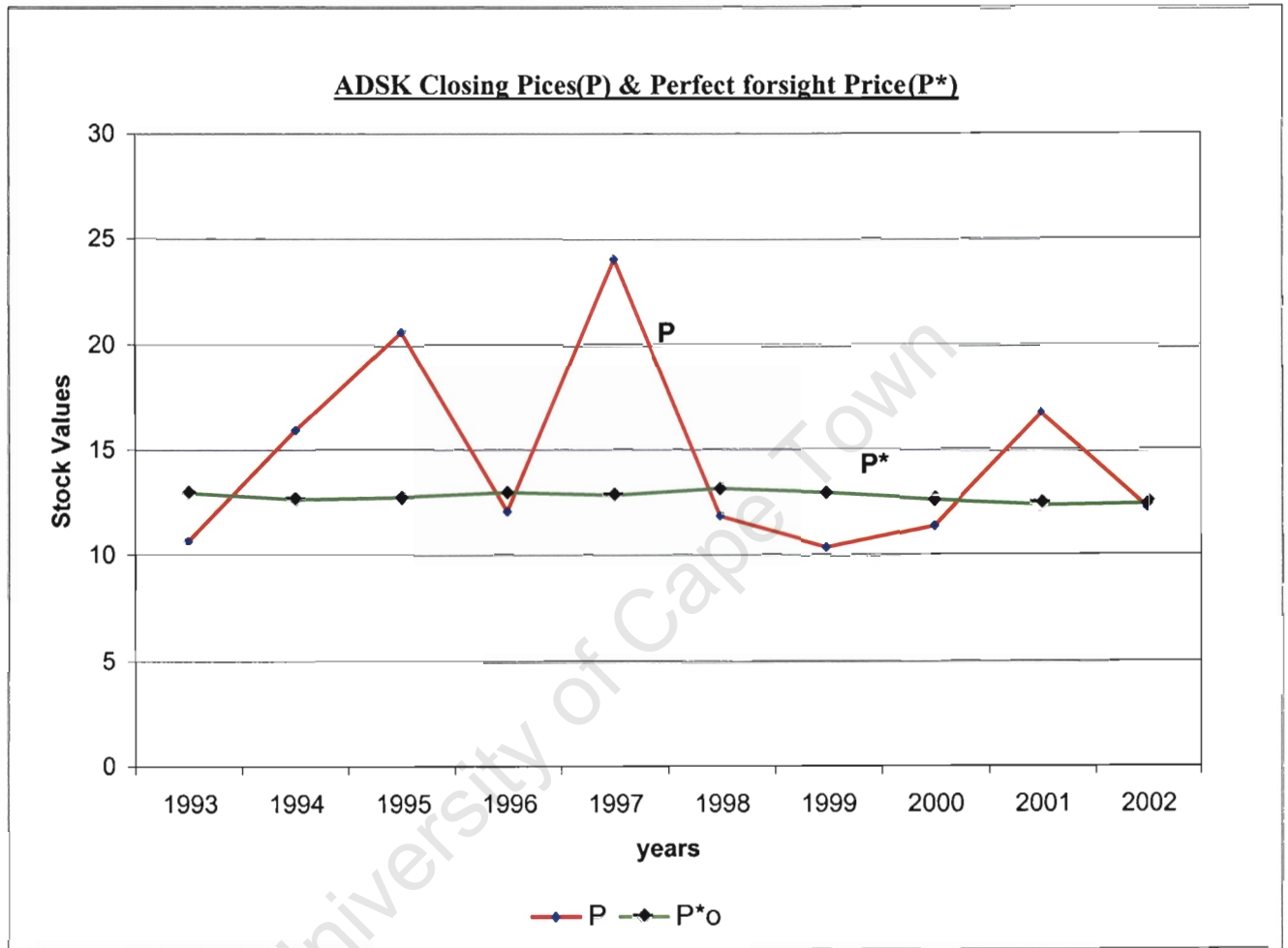


Figure 2.5: ADSK Closing Price and Perfect foresight price for the past 10 years

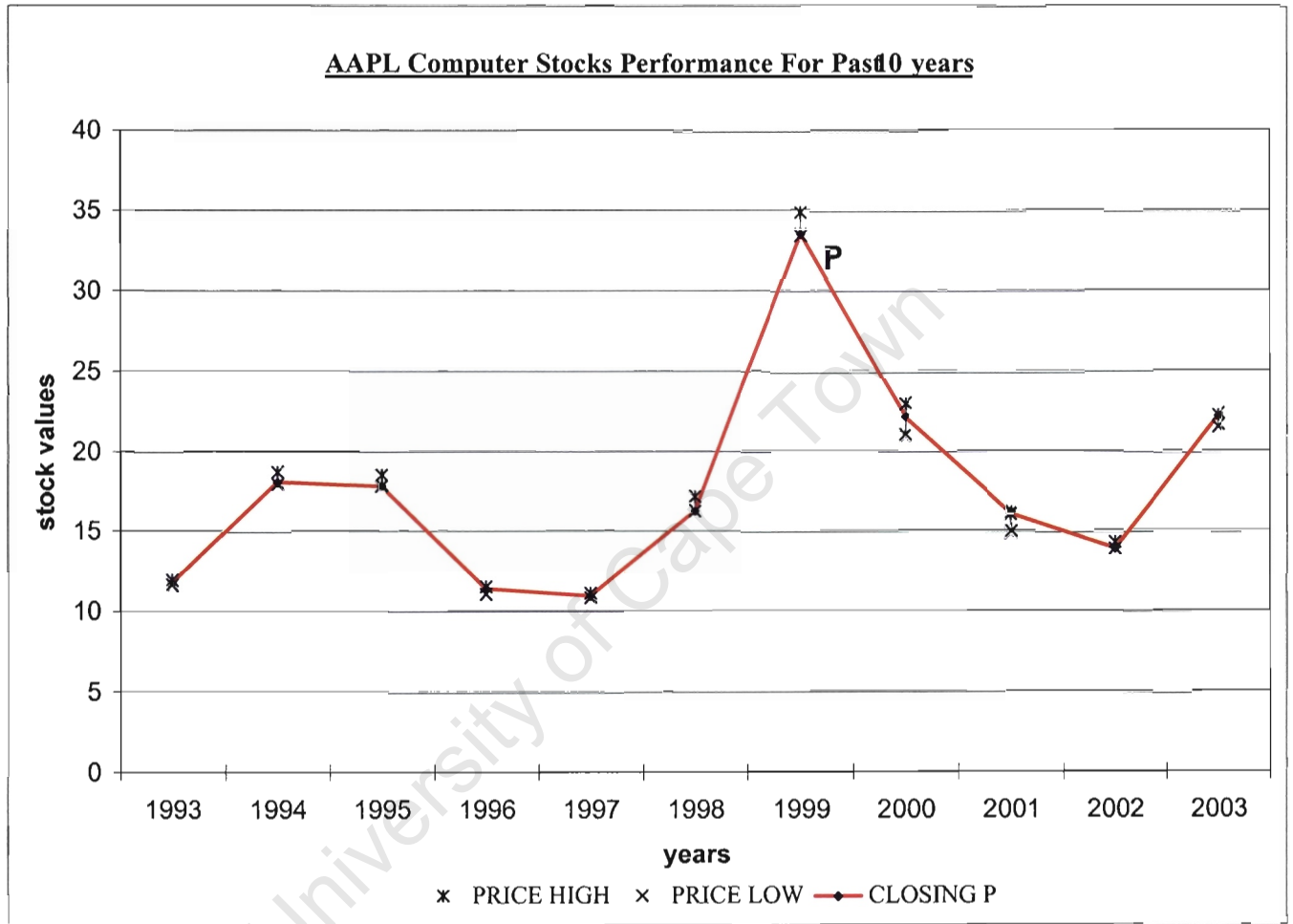


Figure 2.6: AAPL Stock Performance for the past 10 years

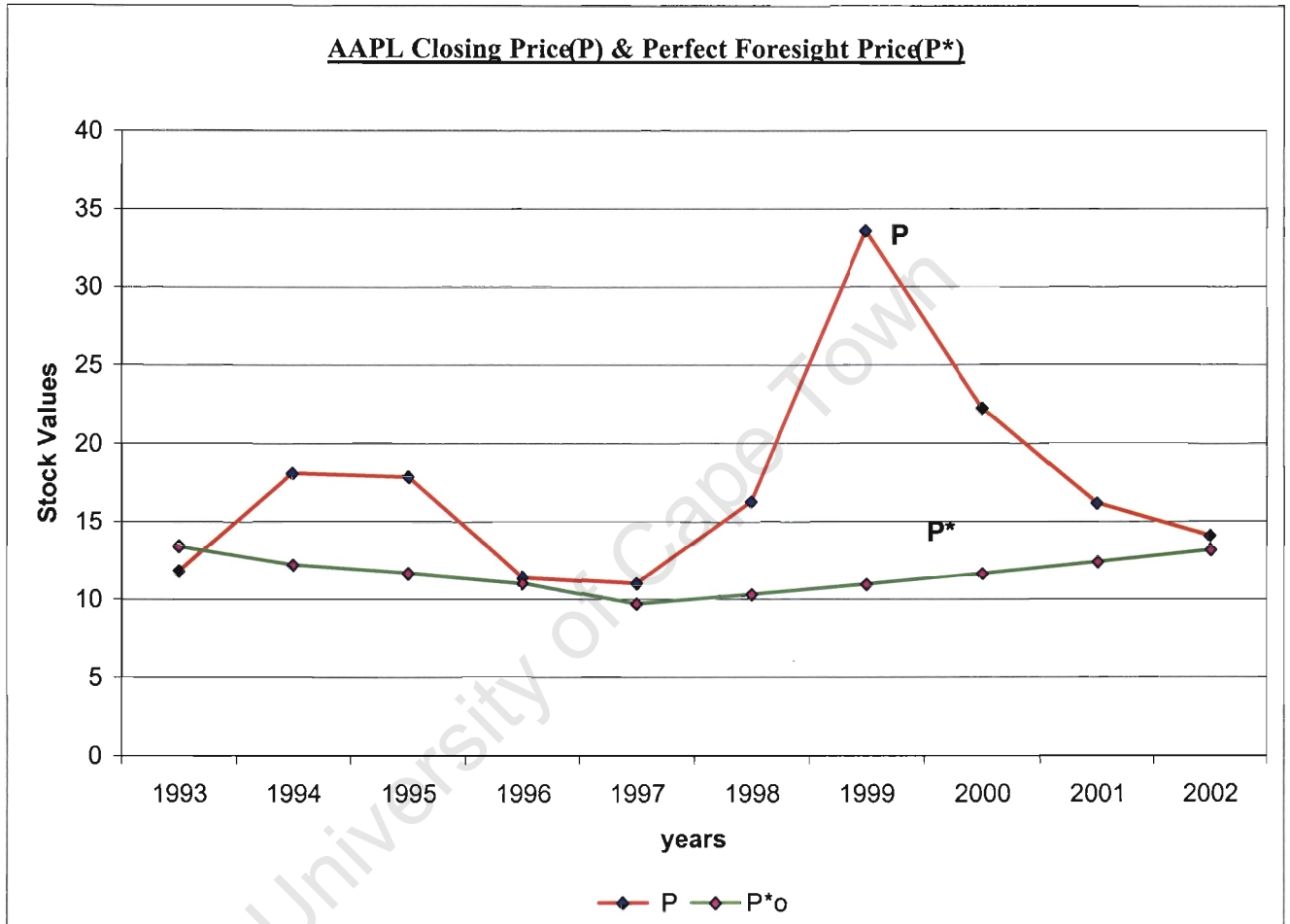


Figure 2.7: AAPL Closing Price and Perfect foresight price for the past 10 years

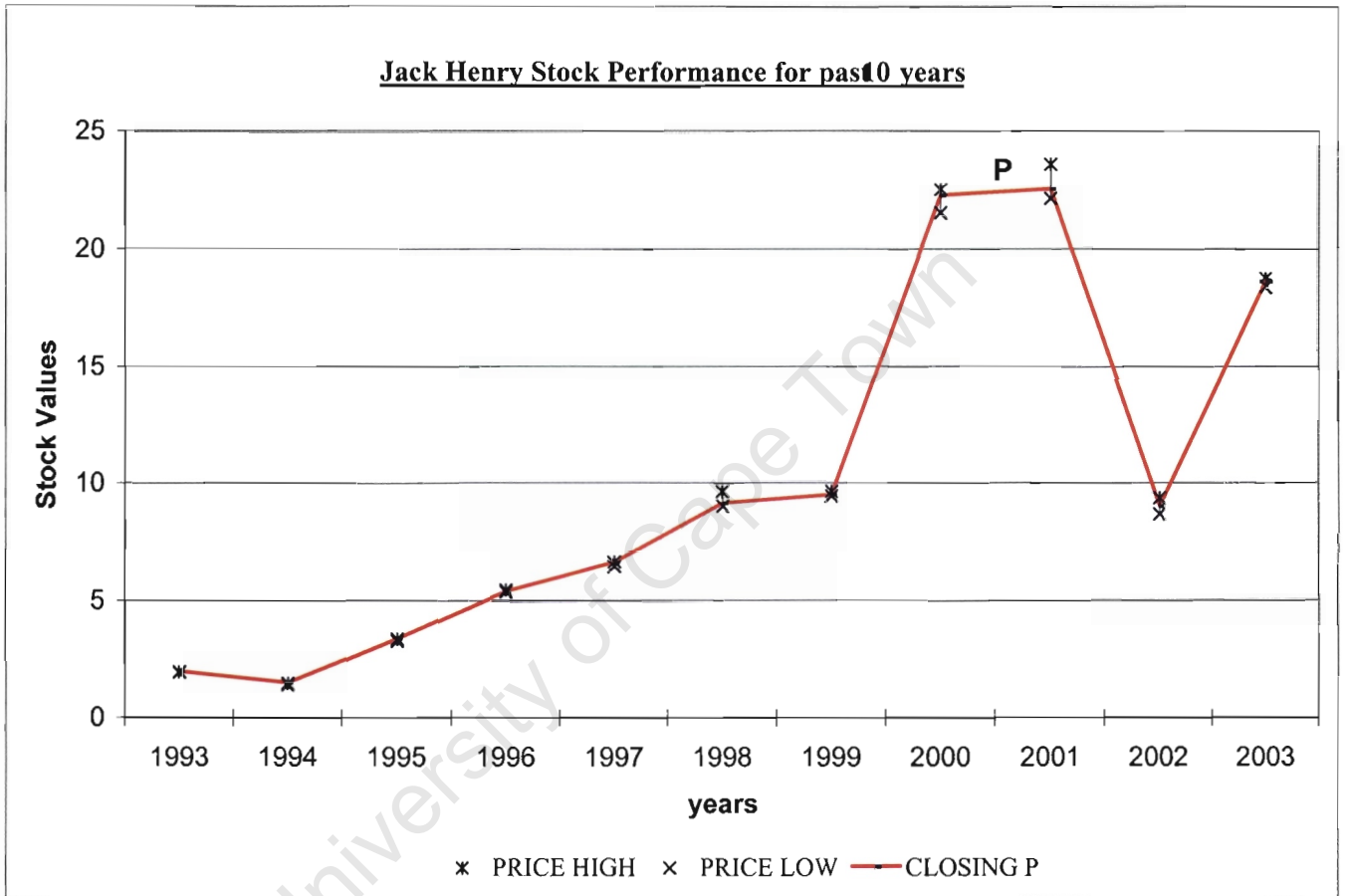


Figure 3.8: Jack Henry Stock Performance for the past 10 years

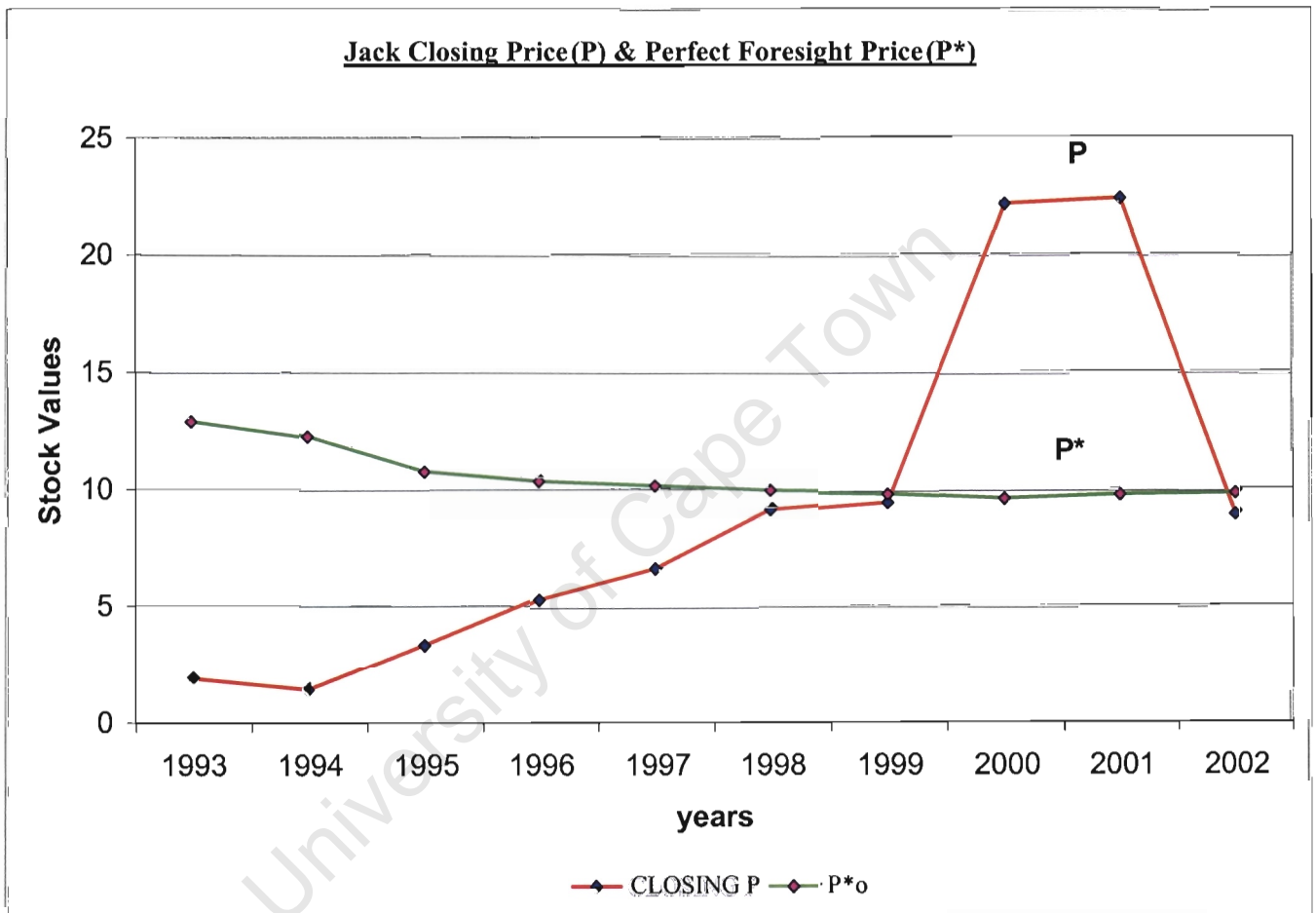


Figure 2.9: Jack Closing Price and Perfect foresight price for the past 10 years

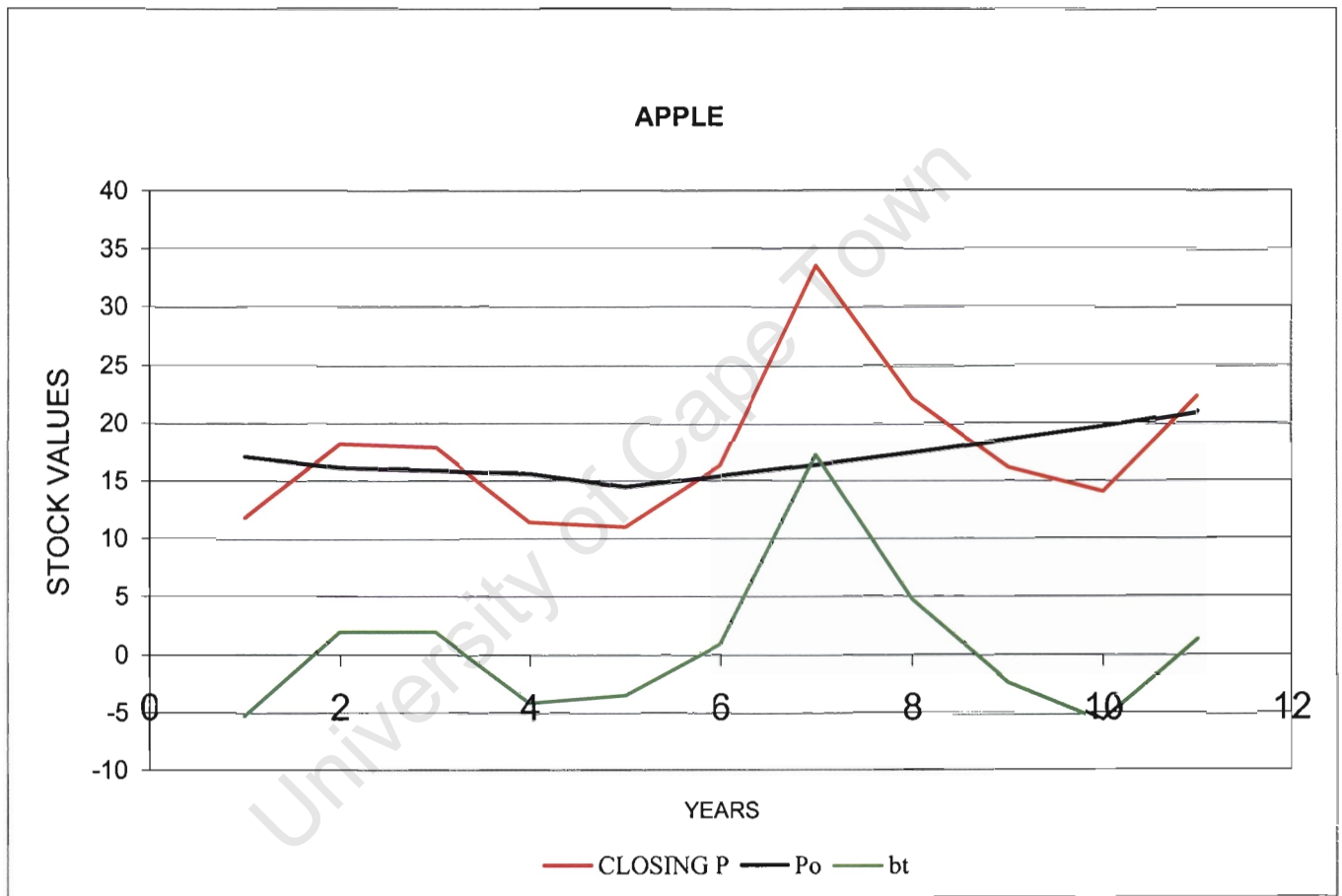


Figure 2.10: Apple Closing Price, Perfect foresight price and error for the past 10 years

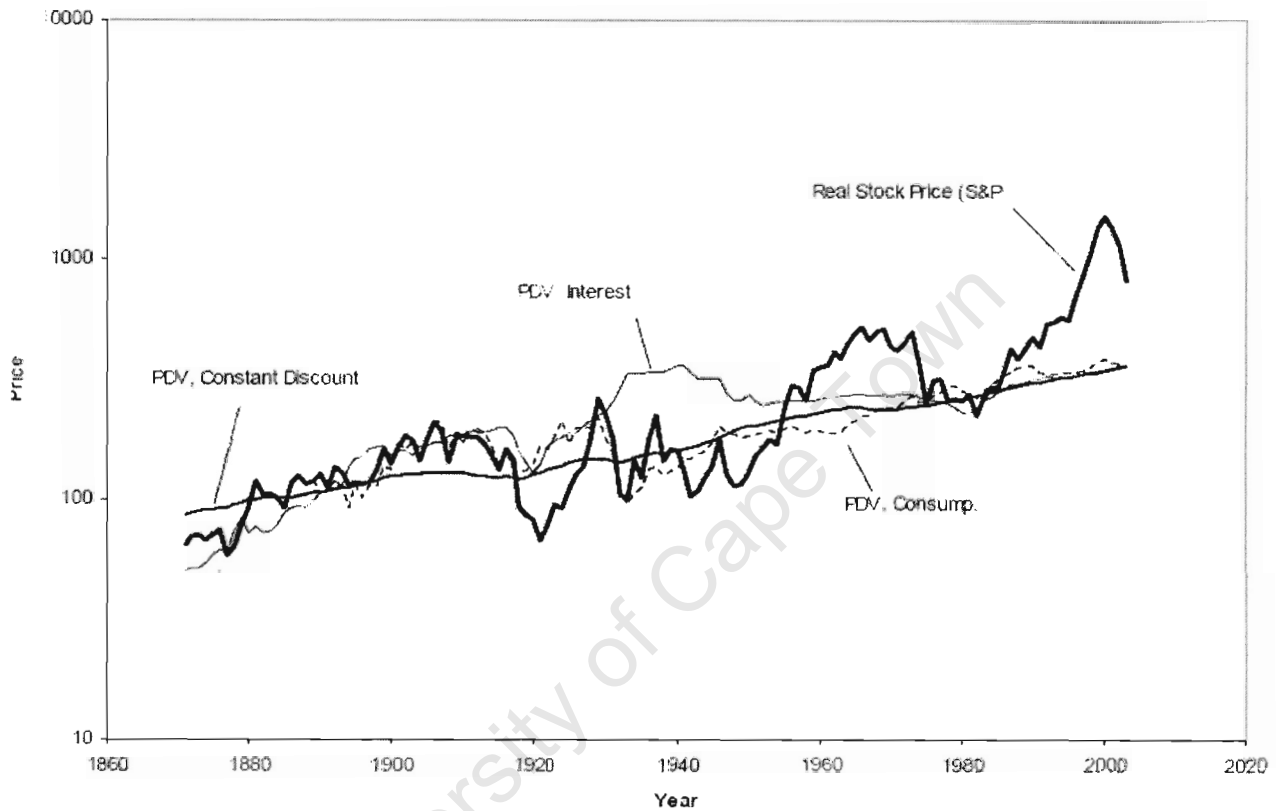


Figure 2.11: Stock Price Data, An Update Of Data Shown In Chapter 26 Of Market Volatility, R. Shiller, MIT Press, (1989), Showing Figure 1 From R. Shiller "From Efficient Markets Theory To Behavioural Finance.

Figures 2.2, 2.4, 2.6, And 2.8 Above Represent The Performance Of Stocks For The Past 10 Years of the Companies Adobe Systems, Autodesk, Apple Computer and Jack Henry & Associates listed in the technology industry on the NASDAQ Stock Market. We obtained this data from The University of Cape Town DataStream. However, figures 2.3, 2.5, 2.7 and 2.8 represent our empirical results of calculating the DDM for the same companies named above.

Chapter 3

3.0 Literature and Theory of Extreme Price Fluctuation in Assets and Bubbles

3.1 Introduction

According to theory asset valuation poses a lot of problems in economics. As was demonstrated in the previous chapter, finance theory generally assumes that the value of an asset, stock, is equal to the expected present discounted value of its dividends, i.e., its market fundamentals. This view, for example, has been taken to test the causes of stock price fluctuations, see Leroy and Porter (1981) and Shiller (1981). At the beginning of the previous chapter, we identified the financial definition of the bubble on an asset as the difference between its price and the present discounted value of its dividends. It was furthermore stated that in some cases, the usual notion of market fundamentals and bubbles is not fully satisfactory, although these magnitudes can still be defined. However, some economists have other views on how bubbles and fluctuations in asset prices begin. A good example is Mankiw and Weil's paper (1989). Mankiw and Weil studied the impact that predictable demographic change has on the housing market. This is an issue, which is closely related to the problem that we propose to study about the stock market. Mankiw and Weil based their analysis on a partial equilibrium model of the demand for housing by agents at different periods of their life. The central theoretical conclusion drawn from this analysis was that the market for housing is not efficient:

“Fluctuations in prices caused by fluctuations in demand do not appear to be foreseen by the market even though these fluctuations in demand were foreseeable.” A similar partial equilibrium and econometric analysis was carried out by Bergantino (1997). According to his model, a significant part (about 40%) of the increase in real housing prices between 1965 and 1980 could be accounted for by the baby-boom induced growth in demand. Since peak demand for equity occurs some twenty years after the peak demand for

housing, a significant part, about 30%, of the increase in stock prices after 1985 can be attributed to the same demographic phenomenon. He then notes:

“What makes this conclusion somewhat believable is that the demographic demand variables used to generate it, are derived from observed age profiles of investment in housing and stocks. This conclusion is unbelievable, however, because it implies predictability of long-run asset price cycles. Many people will undoubtedly be bothered by the thought of predictable booms and busts in stock market prices, since arbitrage by investors with rational expectations would seem to preclude such scenarios . . . A question that does need to be answered is whether or not the observed timing of movements in asset prices, relative to changes in the age distribution of the population, is consistent with rational expectations.”

Our objective in this chapter is to provide an analytical framework for studying the relationship between capital market equilibrium and stock market bubbles. We will conduct a study to establish whether predictable change in dynamic economic, and equilibrium structure can lead to predictable future change in asset prices, and how significant such price changes can be. The natural instrument for such an analysis is the overlapping generations’ (OLG) model. We will therefore begin our chapter with ‘the overlapping generations’ economy. At a later stage, we will find out how uncertainty is intrinsically initiated in the economy and how it affects one of the “fundamental characteristics”, endowments, of an economy. We will also see how uncertainty is extrinsically initiated, possibly influencing current prices through self-fulfilling beliefs or expectations. The overlapping-generations model began with Samuelson (1958), who provided an example of non-monetary perfect foresight.

The goal of the first part of this chapter is to clarify a number of ideas within the framework of overlapping generations (OLG) models with empirical evidence that initially settles the question of whether we should expect to observe asset bubbles in overlapping generations’ economies. The chapter is arranged as follows:

- The first section, investigates whether the fundamentalist view of asset pricing extends to overlapping generations’ economies. Samuelson introduced the

consumption-loan model in (1958). It is a well-known fact that there exist economies in which money has a positive value in spite of the fact that it is intrinsically useless, i.e., Its market fundamental is zero. In other words, a bubble can exist on money where a bubble is defined as the difference between the market price and the market fundamental.

- The second section aims at introducing rational expectations. Thus, we will review the existence of uncertainty in the OLG model. In the 1980's two theories for the treatment of market uncertainty were developed: The first theory is that of Sunspot Equilibria, introduced by Cass and Shell (1983). The second is that of 'rationalisable' expectations, developed by Bernheim (1984) and Pearce (1984). This theory served as a solution to non-cooperative games.

The rational-expectations' equilibrium (REE), however, is a model: It assigns determinate values to all endogenous variables for any possible state of the world. Individuals are assumed to behave as though they know this function. In a model with a single REE, the equilibrium is the prediction of theory. Individual expectations are the same. This notion has a long-standing tradition in security analysis dating back to Graham and Dodd (1934), who urged financial advisors to base their investment decisions on the intrinsic value of shares, that is, to conduct themselves in accordance with 'fundamental value analysis'. In *Security Analysis* (1934), Graham and Dodd purported that actual stock prices fluctuated around their fundamental values, which were approximated by the discounted cash flow accruing to the holder of the security. Gains were then to be had by those investors who traded according to formulae based on fundamental value theory. In short, investors were advised into taking the role of arbitrageurs, purchasing securities undervalued by the market and selling those overvalued by the market (Leroy 1989, p. 1586).

However, in recent years, the Rational Expectations Hypothesis has become the most popular way of preventing an economic system from being dependant on agents' beliefs about future events. When used in conjunction with market equilibrium, this hypothesis

generates a rational expectations' equilibrium (REE). It is a well-established fact that an REE can exist even if agents make predictions about future events on extra market variables. As first proved by Azariadis (1981), this type of REE has the logical status of a self-fulfilling prophecy. One leading example is that of the Stationary Sunspot Equilibrium.

Sunspot Equilibrium theories are other theories for the analysis of market uncertainty: Aumann (1974) observed that non-cooperative games might have equilibria in which the chosen strategies depend on extrinsic random variables. These variables have no influence on the payoff matrix. He named them "a posteriori equilibria."

Cass and Shell (1983) applied this idea to non-strategic market economies. They designed a non-stochastic economy and introduced a random variable, called 'the number of sunspots variable,' which is unrelated to the fundamentals of the economy. They showed that there are rational-expectations equilibria in which the endogenous variables depend on the number of sunspots. The additional equilibria obtained, by considering extrinsic uncertainty, can be interpreted as being consistent with rational behaviour but excluded the REH. The prediction of this theory is the set of price paths that can arise in equilibrium for a certain sequence of sunspots (Aumann (1974); Cass and Shell (1983)).

The following section will see the introduction of intrinsic and extrinsic uncertainty using the Overlapping Generations' Economy as a source for different types of equilibria. We will, furthermore, see how the equilibrium will be with 'Perfect Foresight' as well as in the existence of extrinsic uncertainty i.e., Sunspot Equilibrium. In addition to this we will investigate the ideas behind Sunspot Equilibria.

In section 2.2.3 we will distinguish between Perfect Foresight Equilibria and Sunspot Equilibria by determining the possible equilibrium locations for the economy. In section 2.3 we will discuss and find the main tangible similarity as well as the links between the extrinsic uncertainty of the overlapping generations' economy (Sunspot Equilibrium) and the existence of extrinsic uncertainty in stock markets (Bubbles).

3.2 The General Model and Individual's Optimum Plans

The framework we shall be using is that of the overlapping generations' model with fiat money with production. This is a simple reinterpretation of the related pure-exchange model examined by Samuelson (1958), Gale (1973) and others: Most of the results pertain to economic fluctuations and Sunspot Equilibrium literature using the simple Overlapping Generations (OLG) Model as a framework (See for example Azariadis (1981)) and Azariadis and Guesnerie (1986)).

Time in the (OLG) model is defined as $t = 1, 2, 3, 4, \dots$. The economy constitutes identical individuals, in numbers sufficiently large enough to avoid the likelihood of cooperation, who live for two periods. At the beginning of every period, a constant number of individuals are born, and all of them die at the end of the second period. At every period, then, there are two generations, the young and the old. I favour and make use of an alternative form, which amounts to the same, and will use it here because it sharpens the distinction between a "point in time" and a "period of time". This assumes that at each point in time t individuals of the generation i are born, live for one period i.e., the length of time between times t and $t+1$, and die at time $t+1$. At each point in time t the 'newly' born individuals, that is to say, the young, of generation i have contact, and can eventually trade, with the about to die (old) individuals of the previous generation $i-1$. At their birth at time t , individuals of generation i receive an initial endowment of the single commodity, and another endowment at time $t+1$ just before they die. Call these endowments W_y and W_o . To make the treatment fairly general, assume that if goods are kept as "inventories", or capital stock (say, by an amount I , from one period to the next), then after the "waiting period" it will be transformed into $I(1+r)$, where $(-1) \leq r$. Notice that if $r = -1$ goods are perishable, if $(-1) \leq r \leq 0$ then r is a rate of depreciation, and if $r \geq 0$ then r is a positive rate of return.

There is fiat money in the system that every generation "i" can acquire from the previous generation at birth i.e., at time 't' by a nominal amount M_y , in exchange for goods; at

time " $t+1$ ". Just before dying, the same generation receives a government subsidy, in the form of fiat money, in the amount of ΔM , unrelated to money holdings. Before dying they transfer their total money stock which is represented by $[M_y + \Delta M]$ to the younger generation, in exchange for goods. The mechanics are then that, at the time of birth, individuals use their initial endowment either to consume (C_t'), "invest" .IE: Keep in the form of goods, or to acquire money. They then go into a "period" of inactivity (dormancy or siesta). At time " $t+1$ ", they receive their second endowment, sell their total money holdings to the newborns of generation " $i+1$ ", consume (C_{t+1}) and die. Thus, in this case, consumption occurs only in old age C_{t+1} , production takes place only in youth y_t . We assume that the goods are normal and that the youth would choose positive savings if confronted with a zero real rate of interest. See Samuelson, Gale and Azariadis & Guensrie (1958) (1973) and (1986) respectively. Finally, assume that each generation maximizes its lifetime utility function:

$$U(C_t', C_{t+1}') \quad (3.1)$$

The endowment matrix of Figure 3.1 recapitulates the story.

G	Time Period						
	1	2	3	t-1	t	t+1
0	N_1^0				:		
1	N_1^1	N_2^1			:		
2		N_2^2	N_3^2		:		
3			N_3^3		:		
:	:	:	:		—	:	:
t-2					:		
t-1					:	N_{t-1}^{t-1}	N_t^{t-1}
T					:	N_t^T	N_{t+1}^T
T+1					:		N_{t+1}^{T+1}

Figure 3.1: In OLG model, there are an infinite number of periods and an infinite number of agents in the economy. Where: N_1^0 is an agent of generation 0 at time 1.

In the first step of our investigation we shall take a brief look at Samuelson's pure exchange model (1958).

Individuals attempt to Maximize $U(C_t^t, C_{t+1}^t)$

$$\text{Maximize } U(C_t^t, C_{t+1}^t) = U(1 - S_t^t, 0 - S_{t+1}^t) \quad (3.2)$$

$$\text{Subject to } S_t^t + R_t S_{t+1}^t = 0 \quad (3.3)$$

The resulting saving functions, $S_t^t(R_t)$ and $S_{t+1}^t(R_t)$, are subject to budget identity,

$$S_t^t(R_t) + R_t S_{t+1}^t(R_t) \equiv 0 \quad \text{For all } R_t \quad (3.4)$$

Clearing the market requires:

$$0 = B_t S_t^t(R_t) + B_{t-1} S_{t+1}^t(R_{t-1}) \quad \text{For } 0, \pm 1, \pm 2, \dots \quad (3.5)$$

$$\text{If } B_t = B(1+m)^t \quad (3.6) \quad \text{and } R_t = R_{t+1} = \dots = R,$$

where: m is the rate of growth in population,

Our final equation becomes:

⁷ Consumption $C = \text{Income} - \text{Saving}$, $C_t^t = 1 - S_t^t$, $C_{t+1}^t = 0 - S_{t+1}^t$

⁸ $R_t = 1/(1+i_t)$ i.e., discount rate between goods

⁹ B_t is population growth exponentially or geometrically

¹⁰ $B_{t+1} = (1+m)B_t = (1+m)^2 B_{t-1}$

$$0 = B \left[S'_i(R) + \frac{1}{1+m} S'_{i+1}(R) \right] \quad (3.7)$$

Budget equation 3.4 assures us that equation 3.7 has a solution:

$$R = \frac{1}{1+m} \text{ Or } m = i \text{ because } R = 1/1+i \quad (3.8)$$

The above analysis shows that the rate of interest equal to the rate of population grows because; in each period a new generation is born. In each generation there is only one person. In each period there are then two persons living who exchange ‘a chocolate’ as production so the population grows at a rate of zero. Samuelson used chocolate because it cannot be stored without spoiling. So the young agent cannot store anything, thus the interest is zero. This presents the framework for what Samuelson (1958) calls “the biological rate of the interest rate”. The main cause for suspicion seems to be the fact that a rate of interest has been determined without any reference to impatience and time preference or, more generally, to the utility function U . Somehow, the fact that r_t is a completely mechanistic construction, having no reference to markets, seems to have become blurred.

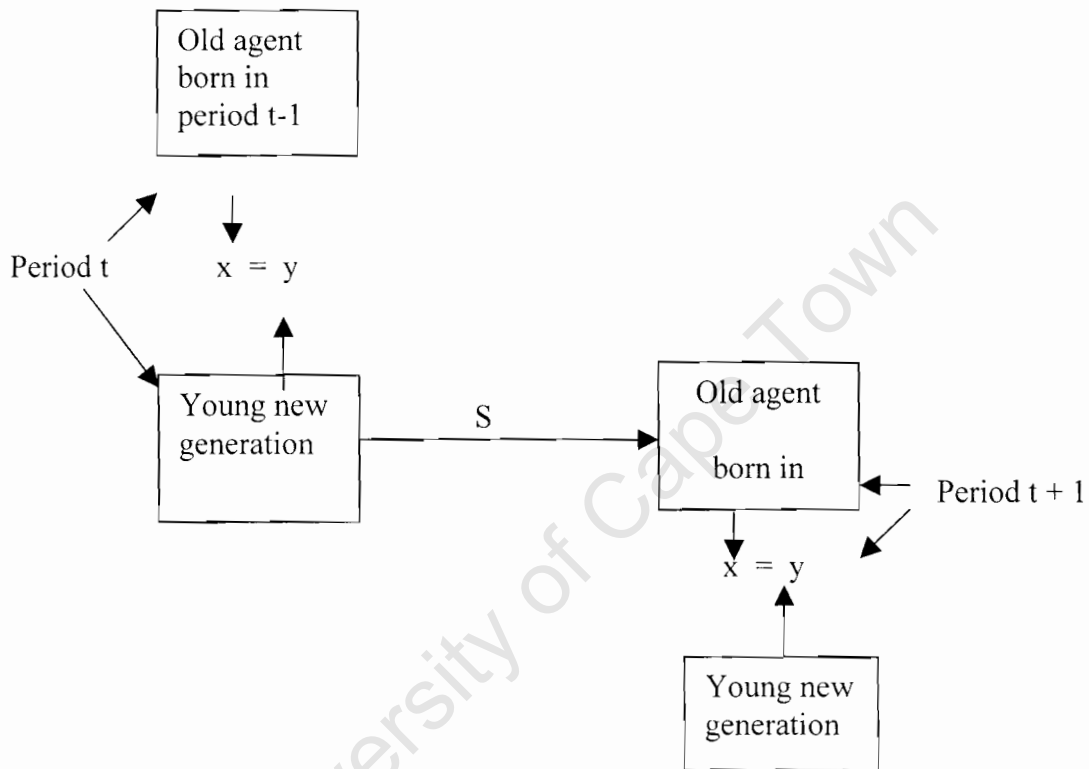
Efficient schemes are precisely those for which the rate of interest is in fact, equal to the rate of growth of population in the pure exchange. (Samuelson (1958))

3.3 Equilibrium with Perfect Foresight

The framework we shall be using is that of the overlapping generations’ model of fiat money with production. The excess demand for consumable goods in period t is the sum

$$x_t - y_t \quad (3.9)$$

x_t Are the excess demands by the old and $(-y_t)$ the excess demands by the young. To clarify this, we began by saying that production takes place only when the agent is young, and the utility of the youth is dependant on the goods or production, he offers y_t which demanded by the old x_t , therefore y_t appeared with a negative sign. See the flowchart 3.1 below:



Where: x_t is the excess demands by the old , y_t is the labour/production supply by the young and S is the savings by the young.

Flowchart 3.1

This flowchart represents the following: In the first stage, at time t, the old, born at time t -1, demand x of goods from the young. The young that are born in time t supply y with goods. The same young agent saves his production value to the next period when he will be old. He does this in order to consume in his retirement .He does this by exchanging S,

his savings, for production from the young born in $t + 1$ and carry on to an unlimited period in the economy as shown in Figure 3.1.

With existing fiat money balances in this model, in period t , the young gives his savings (s_1^y) of consumable goods, to the old agent that is born in period $t - 1$. He gives this in exchange for one unit of money; the exchange rate is determined by P_1 . This unit of money is carried into period 2, the old age of the agent born in period 1 and is exchanged at the rate determined by P_2 for the consumable food saved by the young agent born in period 2 (s_2^y). This process is repeated and can best be explained in details as follows.

1) The Old Agent

$$yP_t = 1$$

where: y is the quantity of goods offered by the young in period t , P_t is the exchange rate or the price at period t 1 one unit of money. Thus

$$y = \frac{1}{P_t} \tag{3.10}$$

This equation represents the purchasing power

2) The Young Agent

$$y_t = C_{t+1} = S_t$$

where: y_t is the quantity of goods offered by the young in period t , C_{t+1} is the quantity of goods consumed by the same agent in period $t + 1$ when he gets old), S_t is the quantity that is saved by the young in period t , which will be transferred to period $t + 1$.

Thus $C_{t+1}P_{t+1} = SP_t$ and $C_{t+1} = S \frac{P_t}{P_{t+1}}$, as long as $y_t = C_{t+1} = S_t$ is true

Then:

$$y_t = S \frac{P_t}{P_{t+1}} \quad (3.11)$$

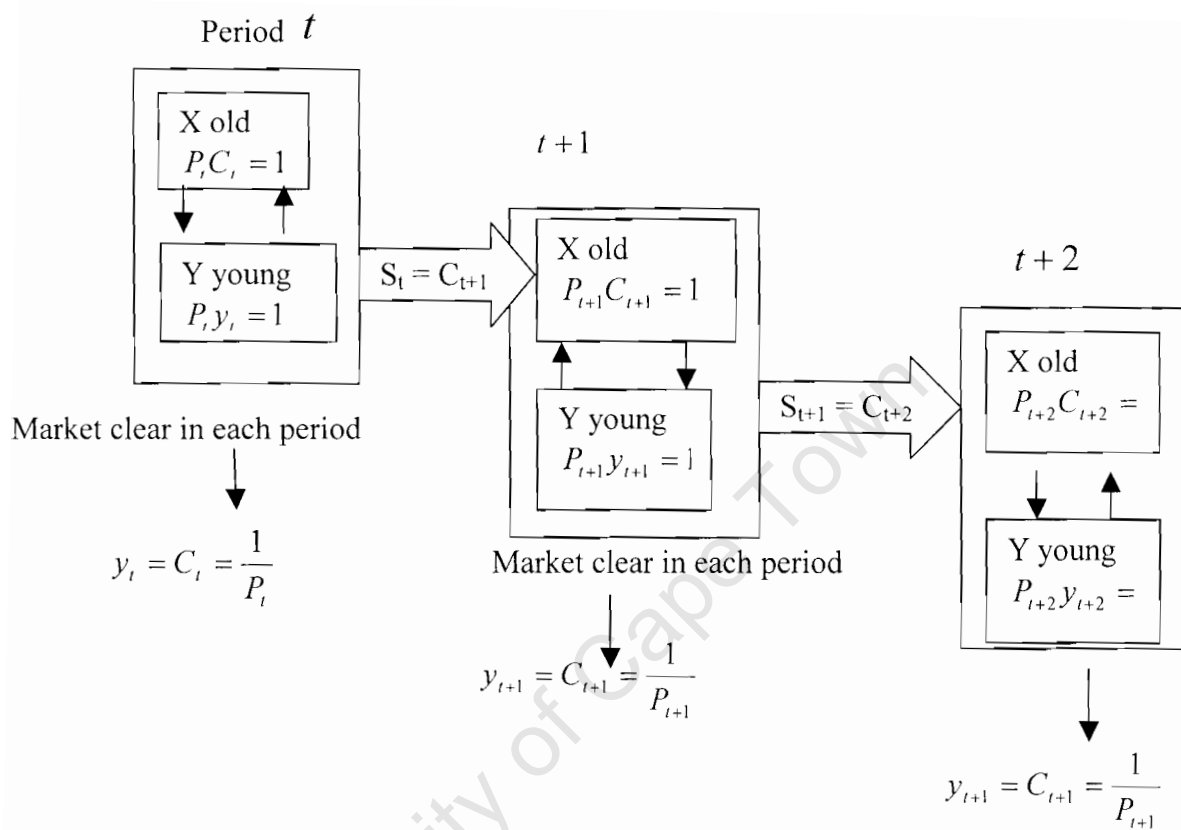
Thus we shall define the perfect foresight equilibrium as aggregate excess demands to be:

$$D(p_t, p_{t+1}) = \frac{1}{p_t} - s \left(\frac{p_t}{p_{t+1}} \right) \quad (3.12)$$

A competitive equilibrium with perfect foresight is associated with a sequence $(p_t)_{t=1}^{\infty}$ of non-negative prices that satisfy $D(p_t, p_{t+1}) = 0$ for all t , or equivalently, with a sequence $(m)_{t=1}^{\infty}$ of real money balances satisfying $D(1/m_t, 1/m_{t+1}) = 0$, where $m_t = 1/p_t$ by definition. Finding equilibria with perfect foresight is equivalent to “solving” the difference in equation $D(p_t, p_{t+1}) = 0$ either backward or forward. A backward solution has the form $m_t = f(m_{t+1})$ and a forward one is of the form $m_{t+1} = \phi(m_t)$, where f and ϕ are known maps. (Azariadis and Guesnsrie (1986))

Flowchart 3.2 in the next page recapitulates the story:

Definition: A competitive equilibrium is a price sequence $\{P_t\}_{t=1}^{\infty}$ and a sequence of allocations $\{X_t, y_t\}_{t=1}^{\infty}$ such as,



Flowchart 3.2

3.4 The Historical Development of the OLG Theory

The first general-equilibrium analysis was by Shell (1971), where it was shown that the failure of perfect-foresight equilibrium to be Pareto optimal is solely due to the double infinity of consumers and dated commodities. Shell used the name "overlapping-generations (OLG) model" as opposed to "consumption-loan model" in order to emphasize the basic demographic structure of the model. The first paper on sunspots, Shell's (1977) Malinvaud lecture that was part of a joint project with David Cass, is based

on the OLG model. The double-infinity, restricted market participation, and incomplete markets are separate sources of sunspots, each of which is inherent to OLG economies. Wallace (1980) gave a strong and successful argument in the Kareken-Wallace (1980) Minneapolis Fed volume, for the use of OLG models in macroeconomics. The contribution of Cass and Shell (1983) to that volume was also influential in this regard. OLG models are important for a number of reasons: Firstly, because of their realism (people are born and do die), secondly, their tractability; individual wealth is finite even if social wealth is not. Thirdly their flexibility for the analysis of money and public debt, neither of which need be retired in OLG economies. OLG models are likely to be even more relevant to 21st century applied macroeconomics, since the relative sizes of the different demographic cohorts are likely to play critical roles. However, models in which money is the only store of value are peculiar. It is sometimes conjectured that if traders hold a real asset, there cannot be price bubbles.

This idea roughly runs as follows: If the long-term interest rate is non-positive and there exists a rent, an asset that distributes real dividends in each period, then the market fundamental of this asset is infinite, so that the asset cannot be transferred between generations. On the other hand, if the long-run interest rate is positive, the asset bubble must grow at the interest rate and eventually becomes so big that young generations cannot buy the asset. Scheinkman (1980) revitalized this loose reasoning. However, Wallace (1980) considers a growing overlapping generations economy; he allows consumers to store real goods but not hold rents. He also shows the existence of monetary equilibria in which money serves no transactional purpose. As starting point of interest in sunspots can be traced back to the Lucas paper (1972), an interesting question arises whether one can get the full characterization of the equilibria in this model. Lucas in the original paper makes a simplifying assumption - footnote 9 in the paper – that restricts the class of equilibria. The subsequent 1983 corrigendum showed that the class of equilibria is larger. Chapter 4 of Guesnerie (2001) provides such a characterization. Chiappori and Guesnerie (1991) show, in a simplified version of the Lucas model (1972), that there is a continuum of equilibria. The Lucas model is the limiting case and is the only stationary equilibria, all other equilibria being non-linear functions of past money.

In the next section, we will discuss, from various perspectives, precisely how sunspot equilibria are created in dynamic economies. We will also see if sunspot equilibria reflect bubble theories in the financial economy. This chapter, therefore, investigates how asset bubbles are initially created and how these bubbles continue to augment until they burst.

3.5 Extrinsic and Intrinsic Uncertainties in the Overlapping Generation

3.5.1 Equilibrium under Intrinsic Uncertainty.

Intrinsic Uncertainty is the type of uncertainty associated with fundamentals of the economy such as endowments, preferences, and technology. Thus, an equilibrium model of a dynamic economy extending over an infinite sequence of dates plays an important role in modern economic theory. The basic equilibrium concept in such a model is the Arrow-Debreu competitive equilibrium (1954). In an Arrow-Debreu, equilibrium it is assumed that agents can simultaneously trade arbitrary consumption plans for the entire infinite and state-contingent future. In most applications of a dynamic economy model a market structure is used which is different from the Arrow-Debreu market structure. Instead of trading arbitrary consumption plans in simultaneous markets, agents trade securities in sequential markets at every date, in every event. The importance of Arrow-Debreu equilibrium rests on the possibility of implementing equilibrium allocations by trading suitable securities in sequential markets. The idea of implementing an Arrow-Debreu equilibrium allocation by trading securities has its origin in the classical paper by Arrow (1954). Arrow proved that every Arrow-Debreu equilibrium allocation in a two-period economy could be implemented by trading in spot commodity markets at every date and complete security markets in the first period. The implementation in the Arrow's model is exact: The sets of equilibrium allocations in the two market structures are exact. Duffie and Huang (1985) extended the results of Arrow to an economy with continuous time i.e., with a finite time-horizon.

The crucial aspect of implementation in infinite-time security markets is the choice of feasibility constraints on agents' portfolio strategies. On the one hand, a feasibility constraint is necessary, without it agents would be able to borrow in security markets and roll over the debt without ever repaying it. On the other hand, a constraint cannot be too "tight". This could prevent agents from using portfolio strategies that generate wealth transfers necessary to achieve a consumption plan of an Arrow-Debreu equilibrium. Wright (1987) employs the wealth constraint that states that a consumer cannot borrow more than the present value of her future endowments. He proved that exact implementation holds with one-period-lived securities: The set of Arrow-Debreu equilibrium allocations and the set of equilibrium allocations in sequential markets are the same. The difficulty in extending the implementation to infinitely lived securities lies in the possibility of price bubbles in sequential markets. As pointed out by Huang and Werner (1999), the wealth constraint gives rise to sequential equilibria with price bubbles on securities that are in zero supply. It follows from Santos and Woodford (1997), that there cannot be price bubbles on short-lived securities or on long-lived securities in zero supply.) We prove that if all securities are in strictly positive supply and security markets are complete, then the exact implementation of Arrow-Debreu equilibria can be obtained. If some securities are in zero supply, then Arrow-Debreu equilibria correspond to sequential equilibria with no price bubbles. Usually, there are also sequential equilibria with non-zero price bubbles.

Gilles and LeRoy (1992a, 1992b) argued that asset price bubbles in infinite-time economies are a manifestation of lack of countable additivity of asset valuation. If the value of an asset differs from the infinite sum of values of dividends at every date, then the difference between the two is a price bubble. In an Arrow-Debreu equilibrium in an infinite-time economy with complete forward markets, asset valuation may lack countable additivity for a certain class of consumers' preferences (Bewley (1972); Epstein and Wang (1985)).

Thus, as part of our investigation of the how bubbles are created, the next section will formalise uncertainty by means of states of the world. We will then introduce the key

idea of a contingent commodity: Commodity of which the delivery is conditional on the realized state of the world. The section thereafter will see these tools being implemented to define the concept of an Arrow-Debreu equilibrium. An important reinterpretation of the concept of Arrow-Debreu equilibrium will also be provided. We show that, under the assumptions of self-fulfilling, or rational expectations, Arrow-Debreu equilibria can be implemented by combining trade in a certain restricted set of contingent commodities with spot trade that occurs after the resolution of uncertainty. This results in a significant reduction in the number of ex ante (i.e., before uncertainty) markets that must operate. To conclude we will consider how the Arrow-Debreu equilibrium is related to asset bubbles.

3.5.2 Description of a Market Economy with Contingent Commodities

The general framework for decision making under uncertainty is expressed as follows:

$$\begin{array}{l}
 X- \quad \text{Set of consequences} \\
 A- \quad \text{Set of acts} \\
 S- \quad \text{Set of states of nature}
 \end{array}
 \left. \vphantom{\begin{array}{l} X- \\ A- \\ S- \end{array}} \right\} (A/S) \Rightarrow X$$

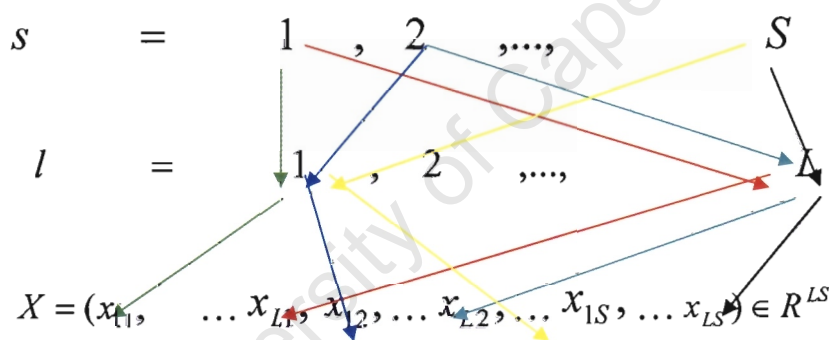
The source of uncertainty is S . The decision maker has a preferred relationship to A . If S is a singleton (no uncertainty), the relation is ported over to X . Now, we consider a pure exchange economy with I consumers, L physical commodities, time is discrete with infinite horizon and indexed by $t = 0, 1, \dots$. Uncertainty is described by a set S of states of the world. Throughout this section, we represent uncertainty by assuming that technologies, endowments, and preferences depend on the state of the world. The concept of state of the world, for example, the monetary payoff of an insurance policy might depend on whether or not a certain accident has happened, the payoff on a corporate stock on whether the economy is in a recession, and the payoff of a casino gamble on the number selected by the roulette wheel. We call these underling causes, states, or states of nature. We denote the set of states by S and an individual state by $s \in S$. A state of the world or nature is to be understood as a complete description of a possible outcome of uncertainty, the description being sufficiently fine for any two distinct states of the world

to be mutually exclusive. However, we assume that an exhaustive set S of states of the world is given to us. For simplicity we take S to be a finite set with S elements. A typical element is denoted $s = 1, S$

Definition. For every physical commodity $l = 1, 2, \dots, L$ and state $s = 1, 2, \dots, S$ a unit of (state) contingent commodity ls is a title to receive a unit of the physical good l if, and only if, s occurs. Accordingly, a (state-) contingent commodity vector is specified by

$$X = (x_{11}, \dots, x_{L1}, x_{12}, \dots, x_{L2}, \dots, x_{1S}, \dots, x_{LS}) \in R^{LS}$$

where: X express all the consequences of all the actions for $l = 1, 2, \dots, L$ at all the different states $s = 1, 2, \dots, S$.



And is understood as an entitlement to receive the commodity vector (x_{1s}, \dots, x_{Ls}) . If state S occurs we can view a contingent commodity as a collection of L random variables, the l^{th} random variable being (x_{1l}, \dots, x_{ls}) . Agents have endowments in the form of a contingent commodity vector

$$w_i = (w_{11i}, \dots, w_{L1i}, \dots, w_{1Si}, \dots, w_{LSi}) \in R^{LS}$$

where i is a consumer, $i = 1, 2, \dots, I$, w_{LSi} : The endowment of consumer i in commodity L if state S occurs.

The preferences of the consumer may or may not depend on the state of the world. Whatever the case is; the preferences \succsim_i are ex ante, i.e., The random variables describing possible consumptions are evaluated before the resolution of uncertainty.

3.5.3 Arrow-Debreu Equilibrium

Now we assume the existence of a market for every contingent commodity ls . These markets are open before the resolution of uncertainty, or in other words, in period 0. In the market for the contingent commodity, agents trade commitments to receive or to deliver amounts of physical goods l if, and when, state of the world s occurs. In order for this mechanism to work, all agents must be able to recognize that state s has occurred. This means that information must be symmetric across all agents.

Definition 3.2. An allocation $(x_1^*, \dots, x_I^*) \in X_1 \times \dots \times X_I \subset R^{LSI}$ and a system of prices for contingent commodities $p = (p_{11}, \dots, p_{LS}) \in R^{LS}$ constitute an Arrow-Debreu equilibrium if

1). For every i , x_i^* is maximal for \succsim_i in the budget set

$$\{x_i \in X_i : p \cdot x_i \leq p \cdot w_i\}$$

2). $\sum_i x_i^* = \sum_i w_i$

More explanations of the Arrow-Debreu equilibrium. Definition above: (verb needed)

1). For every consumer i , and x_i^* his expected location of action at a certain state of world is maximal for \succsim_i in the budget set

$$\{x_i \in X_i : p \cdot x_i \leq p \cdot w_i\} \quad A$$

2). $\sum_i x_i^* = \sum_i w_i$. Total expected locations of actions at certain states of world by consumer i , = the total real endowment of consumer i ,

Number 1 and 2 above are the conditions of Arrow-Debreu equilibrium. Now we can replace x_i in 1 by x_i^* as long as 2 is true. It becomes

$$\{x_i^* \in X_i : p \cdot x_i^* \leq p \cdot w_i\}$$

And the price P will stay the same in all the cases. Now we can formulate a clear definition of the Arrow-Debreu equilibrium.

An allocation $(x_1^*, \dots, x_I^*) \in X_1 \times \dots \times X_I \subset R^{LSI}$ and a system of prices for contingent commodities $p = (p_{11}, \dots, p_{LS}) \in R^{LS}$ constitute an Arrow-Debreu equilibrium.

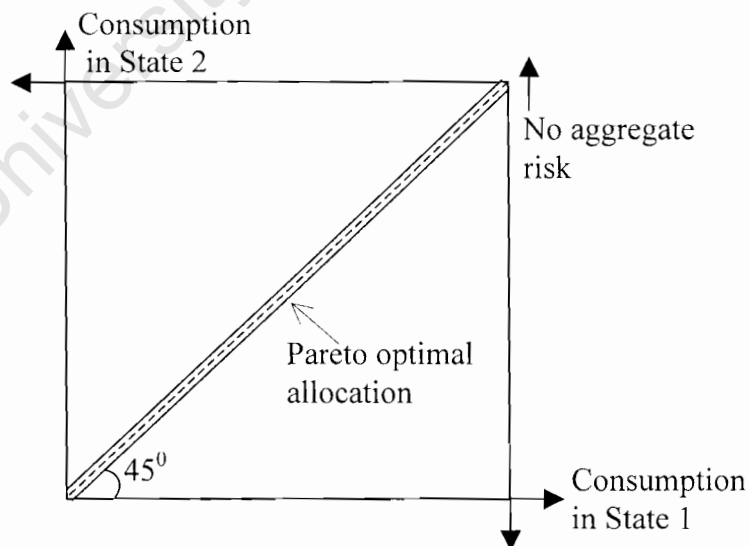


Figure 3.2: No aggregate risk economy (Arrow-Debreu equilibrium)

The welfare theorems and existence theorems still hold true under suitable assumptions. In particular, an equilibrium allocation is ex-ante Pareto optimal. This effectively means that trading in contingent commodities leads to an efficient allocation of risk at equilibrium. An important, easy to work with, type of economy is given the following definition.

Definition: In a no-aggregate risk economy

- Aggregate endowment $\bar{w}_s = \bar{w}_{s'}$, $s \neq s'$
- Agents have an expected utility, often with common probabilities.

Given strict risk aversion and common probabilities, no aggregate risk implies no individual risk. Furthermore, Pareto optimal allocations are state independent See Figure 3.2 for an example. If the agents' probability assessments differ, the Pareto optimal set will no longer be at the 45° line and each consumer's equilibrium consumption will be higher in the state he thinks comparatively more likely. Badur (1997)

(Online <http://www.econ.umn.edu/~kemal/academic/Files/8102.pdf>)

3.6 Extrinsic Uncertainty

Extrinsic uncertainty: The type of uncertainty that affects the beliefs of agents, for example, the agents believe that market prices depend on “sunspots”. Where the fundamentals are the same in all states, the uncertainty is known as extrinsic uncertainty. Clearly, with respect to the probability of survival, extrinsic uncertainty has no direct effect, because it does not affect endowments. However, it may have an indirect effect: Self-fulfilling beliefs of the agents regarding market prices as affecting their wealth. Some agents may be ruined in one state of environment and survive in others, even though the fundamentals of the economy are the same in all states. (Hashimzade (2003))

To study the indirect, or adverse term-of-trade effect, of extrinsic uncertainty on the economy, we turn to a dynamic economy. Guesnerie has been a leading contributor to the study of fluctuations in the economy. His work has extended our understanding of

Sunspot Equilibria in several directions. His book, ‘Assessing Rational Expectations: Sunspot Multiplicity and Economic Fluctuations’ (2001), is a collection of his papers in this area. Some of these papers have become classics and some deserve wider recognition. These papers would be of interest to anyone concerned with dynamic economics and microeconomics. However, in the next section we will discuss some of Guesnerie’s work in more detail with Azariadis (1981), among others.

3.6.1 The Sunspot Equilibrium

Maximise the utility function of the agent born in t . (the model used here is the same as the one described in section 3.2)

$$\max U(c_{t+1}, y_t)$$

If there is no uncertainty, with perfect foresight, the price-taking young agent’s optimisation problem is the following:

$$\max U(c_{t+1}, y_t)$$

$$p_{t+1}c_{t+1} = p_t y_t$$

where p_t, p_{t+1} are the money prices of the consumable goods at time t and $t + 1$.

This program generates a labour supply function $Y(p_t / p_{t+1})$. Demand is equal to the real value of money stock held by agents; hence, excess demand is:

$$D(p_t, p_{t+1}) = \frac{m}{p_t} - Y\left(\frac{p_t}{p_{t+1}}\right) \quad (3.14)$$

Assume now that future prices are random. The young agent’s program becomes:

$$\max E_t (U (c_{t+1}, y_t)) \quad (3.15)$$

$$P_{t+1} c_{t+1} = P_t y_t$$

Or

$$\max_{y_t} E_t \left[U \left(\frac{P_t}{P_{t+1}} y_t, y_t \right) \right] \quad (3.16)$$

Let μ_{t+1} denote the conditional distribution probability of p_{t+1} at date t . The solution of 3.16 is a function

$$\tilde{Y} (p_t, \mu_{t+1}). \text{ We denote } \tilde{D} (p_t, \mu_{t+1}) = (M / p_t) - \tilde{Y} (p_t, \mu_{t+1})$$

In this model, there are several types of deterministic stationary equilibria. There is firstly, a steady state \bar{p} (or \bar{y}) defined by:

$$\frac{M}{\bar{p}} = Y(1) (= \bar{y}) \quad (3.17)$$

and secondly, a periodic equilibrium of order k (or, for short, a k cycle) consisting of k different prices $\bar{P}_1, \dots, \bar{P}_k$ satisfying.

$$\frac{M}{\bar{P}_1} = Y \left(\frac{\bar{P}_1}{\bar{P}_2} \right), \frac{M}{\bar{P}_2} = Y \left(\frac{\bar{P}_2}{\bar{P}_3} \right), \dots, \frac{M}{\bar{P}_k} = Y \left(\frac{\bar{P}_k}{\bar{P}_1} \right) \quad (3.18)$$

However, there can exist stochastic stationary equilibria as well. Assume there is some random process in the economy, and that this process is extrinsic (in the sense defined above). For instance, it follows a stationary Markov chain, with two possible states a (sunspot) and b (no sunspot); the transition matrix is:

$$M = \begin{pmatrix} m_{aa} & m_{ab} \\ m_{ba} & m_{bb} \end{pmatrix}$$

(With $m_{aa} + m_{ab} = 1$ and $m_{ba} + m_{bb} = 1$), and is known to agents. Assume now that for some reason, the agents of the economy believe that there is a perfect correlation between the price that clears the market and the state of the sunspot. Specifically, they believe that whenever the process is in state a , then the price is necessarily P_a ; whenever it is in state b , the price is necessarily P_b . When these beliefs are self-fulfilling, they define a rational equilibrium if $P_a \neq P_b$, the latter is stochastic. This is indeed sunspot equilibrium. Let us now translate this intuition into formal terms. Assume that the process is in state a . According to beliefs, the price tomorrow will be either P_a , with probability m_{aa} , or P_b , with probability m_{ab} . Let μ_a denote the probability distribution on future prices just described. If the relationship,

$$\frac{M}{P_a} = \bar{Y}(P_a, \mu_a) \quad (3.19)$$

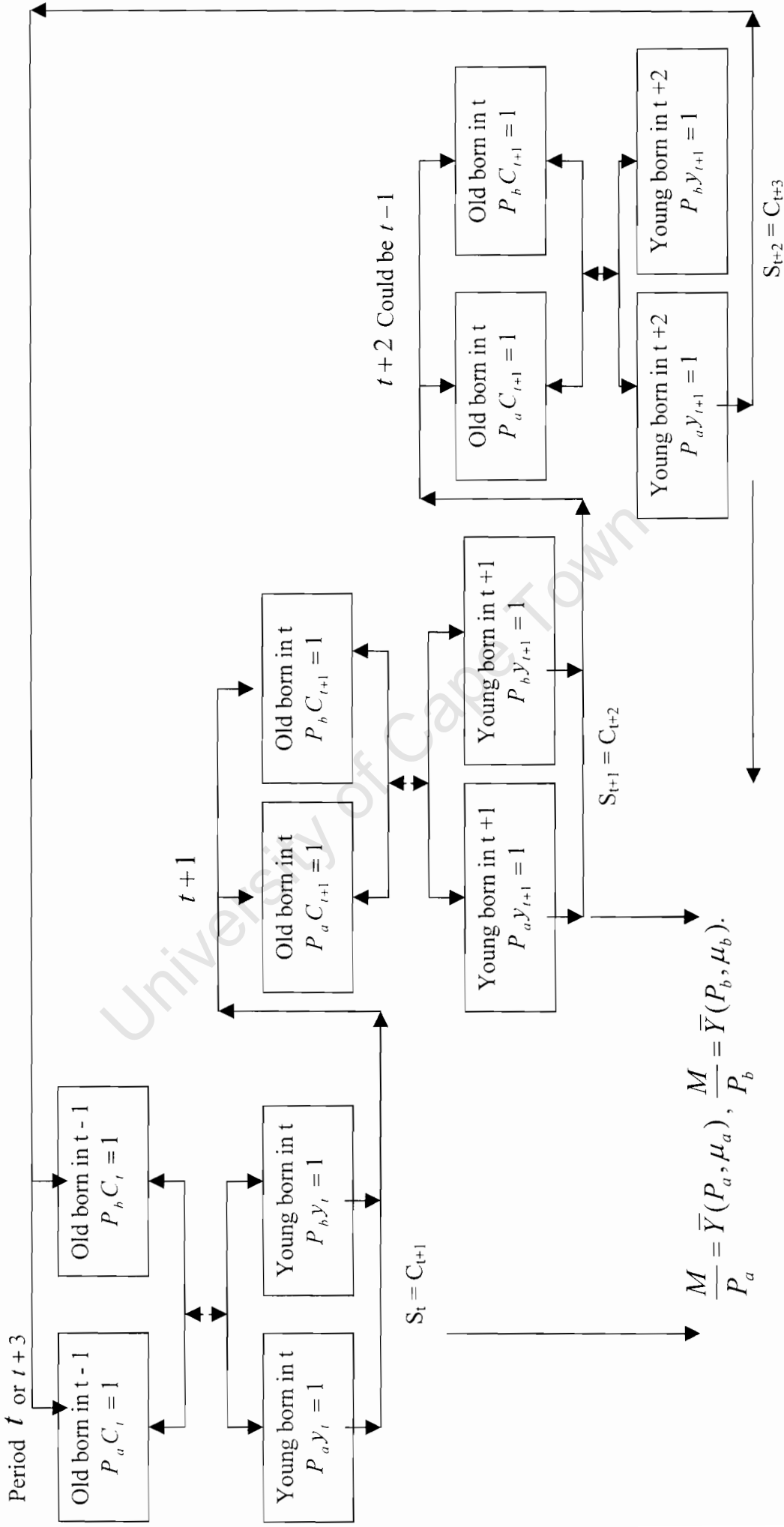
holds true, then the price that clears the market today is P_a , just as predicted by beliefs. Of course, the same argument applies to the other state, and leads to an analogous relationship, namely:

$$\frac{M}{P_b} = \bar{Y}(P_b, \mu_b). \quad (3.20)$$

In other words, equations (3.19) and (3.20), when they hold true for $P_a \neq P_b$, mean that the "theory" " P_a if a , P_b if b " is exactly true. They define a "Sunspot Equilibrium", whose stochastic properties exactly reproduce those of the Markov chain on $\{a, b\}$. The associated fluctuations are endogenous, stochastic and stationary. Actually, such stationary sunspot equilibrium (SSE) can be viewed as prototypes of stationary rational expectation equilibria in this model (of which steady states and periodic equilibria are only particular cases) (Azariadis and Guesnerie (1986)).

University of Cape Town

Flowchart 3.3: Sunspot Equilibrium



3.6.2 Discussion

A first idea would be to relate the existence of sunspot equilibria to multiplicity. Assume for example that $\mu_a = \mu_b = \mu$, as it has to be in the case of random signals being time independent. The existence of sunspot equilibria then requires that the equation $M/P = \bar{Y}(P, \mu)$ have several solutions. In other words, there exist multiple temporary equilibria of the system for given expectations μ . Naturally it is not yet clear whether multiplicity of temporary equilibria, even if held for every possible μ , would be sufficient for the existence of sunspot equilibria;

A second argument, however, suggests that the kind of multiplicity just put forward is not needed for the existence of sunspot equilibria. The idea is as follows: Once they have observed the state of the process today, agents know the probability distribution of the state tomorrow. However, given their belief, this is also the probability distribution of the price tomorrow. Hence, when the random variable is not time independent, the observation of the state today brings information on future prices; and since agents behaviour depends upon expectations, it will actually be influenced by the state of the process. Self-fulfilling beliefs can then be obtained.

A third, and in fact, related proposition is the following: Assume that the process generates strong negative correlation between states. When it is in state a today, it will very likely be in state b tomorrow. The fluctuation is then what is described by Sunspot Equilibrium as being somewhat similar to the deterministic fluctuations associated with the cycle of order 2: The equations determining cycles of order 2 are written $M/p_1 = Y(p_1/p_2)$, $M/p_2 = Y(p_2/p_1)$. These can be viewed as the equations determining the Walrasian equilibrium of a two period economy, in which two agents with symmetric utility functions $u(c_1, c_2)$ and $u(c_2, c_1)$ supply labour at times 1 and 2, respectively. Cycles of order 2 are obtained when this symmetric Walrasian economy has several equilibria (see Maskin and Tirole (1987)).

A similar argument leads us to view Sunspot Equilibria as correlated equilibria of a similar game. The multiplicity, which is associated with the existence of cycles or of sunspot equilibria, then reflects multiplicity of Walrasian equilibria within the associated fictitious economy.

The three above-mentioned accounts provide valuable insight. However, in the particular version presented, multiplicity of temporary equilibria, with deterministic expectations, is not obtained when the consumable goods are normal. Hence, existence of Sunspot Equilibrium has to be intuitively related to the second and third previously mentioned accounts. It again turns out that, these accounts are intimately related to the model under consideration, specifically, sunspot equilibria of order 2. Those, which we have described, exist only if cycles of order 2 exist (Azariadis and Guesnerie (1986)).

This section is a summary of the work by Azariadis and Guesnerie (1982), Sunspot Equilibria in Sequential Markets Models (1991) by Chiappori and Guesnerie, Assessing Rational Expectations, by Guesnerie and, Azariadis and Guesnerie (1986). In the next section we will see if the Sunspot really does matter. Understanding this approach will be useful when considering bubbles.

3.6.3 Sunspot Equilibrium from a Different Perspective

This section provides a first analysis of the phenomenon of sunspots within a general equilibrium framework. The argument is presented in an almost temporal context in which the sunspot phenomenon can only take simplistic forms. However, the so-called "ineffectivity theorem" that is stated below has broad scope. Its discussion allows a rather comprehensive appraisal of one of the central theoretical issues associated with the sunspot phenomenon, i.e., the issue of insurability.

In addition, the ineffectivity theorem is a good starting point for providing a general perspective on sunspot literature and for understanding its branching points. We will present different lines of investigation as well as offer a brief overview of one aspect of

sunspot literature; the detailed analysis of which, is outside the scope of the present survey. The Ineffectivity Theorem and the Insurability Issue:

Let us consider an exchange economy in an n -commodity world. Consumers indexed by $I = 1 \dots m$ are endowed with a vector of initial resources $w_i \in R_+^n$. They have preferences associated with the Von Neumann-Morgenstern utility function $u_i : R_+^n \longrightarrow R$

There is one period, with three sub periods indexed by $t = 0, 1, 2$. At $t = 0$, markets open and transactions are decided upon. At $t = 1$, an exogenous random variable $\theta \in \Theta$ is observed. At $t = 2$, trade takes place as decided at $t = 0$.

The random variable observed at $t = 1$ is "extrinsic". It influences neither initial endowments nor preferences. It can take k values, $\Theta = \{\theta_1, \dots, \theta_k\}$, and its occurrence follows a probability distribution (π_1, \dots, π_k) which is objective and agreed upon by all agents.

Assume first, as it seems natural, that agents disregard the extrinsic variables and that trade occurs on competitive markets. Market outcomes are then competitive equilibria. Formally stated: a competitive equilibrium consists of a price vector P and a sequence of commodity bundles (\bar{x}_i) such as:

$$(\bar{x}_i) \in \arg \max \{u_i(\bar{x}_i) \mid \bar{P} \cdot x_i \leq \bar{P} \cdot w_i\} \quad (3.21)$$

$$\sum_i \bar{x}_i \leq \sum_i w_i \quad (3.22)$$

How could sunspots matter here? As sunspots do not affect fundamentals, there will be no reason, after their occurrence, to reconsider the transactions decided upon at the outset. In addition, as sunspot events do not precede the determination of transactions, they cannot play the role of a selecting device in case of several competitive equilibria. Nevertheless, if sunspot events are contingencies that are considered by the agents, they,

a priori, should be incorporated in a full Arrow-Debreu model with contingent markets. Let us consider the case in which a complete set of markets for sunspot contingencies does exist. The corresponding equilibrium concept is the concept of complete, read sun-complete, equilibrium.¹¹

A complete competitive equilibrium consists of price vectors contingent on θ , $\bar{P}(\theta_l)$, $l = 1, \dots, k$ and of consumption bundles contingent on θ , $\bar{x}_i(\theta_l)$, $l = 1 \dots k, I = 1 \dots n$,

such as $\{\bar{x}_i(\theta_1), \dots, \bar{x}_i(\theta_k)\} \in \arg \max \sum_{l=1}^{l=k} \pi_l u_i(x_i(\theta_l))$

$$\sum_{l=1}^k \bar{P}(\theta_l) x_i(\theta_l) \leq \left[\sum_{l=1}^k \bar{P}(\theta_l) \right] \cdot w_i \quad (3.23)$$

$$\sum_i \bar{x}_i(\theta_l) \leq \sum_i w_i \quad (3.24)$$

A complete set of markets, as described above, allows the agents to insure themselves against extrinsic contingencies. Might such a possibility, which seems irrelevant at first glance, actually effect the allocation of resources, as in the case of a complete set of markets?

We should first clarify that the answer to the above question is positive *only if* the allocation of the -complete equilibrium is random, $\bar{x}_i(\theta_l) \neq \bar{x}_i(\theta_{l'})$ for some $l, l' \neq l$ if the allocation is random, it certainly does not coincide with the competitive equilibrium, which has been defined above. Conversely, if the complete equilibrium allocation is not random, then one can easily check, looking through the definitions, that it does coincide with the competitive allocation (with $\bar{P} = \sum_l \bar{P}(\theta_l)$).

¹¹ For details of a sun complete equilibrium, see Guesnerie and Laffont (1988).

In summary, extrinsic uncertainty matters if, and only if, the complete competitive equilibrium is actually stochastic. In the contrary case, extrinsic uncertainty would be "ineffective". This indeed occurs under a number of circumstances (See Chiappori and Guesnerie (1991)).

The Ineffectivity Theorem, Cass and Shell (1983). Assuming that utility functions are strictly concave; then sunspots "do not matter". More precisely, a complete competitive equilibrium is a competitive equilibrium.

Proof. The proposition is established by contradiction. Assuming that sunspots matter, from the above argument, then the complete competitive allocation is random for agent I . Consider then $E(\bar{x}_i) = \sum_{l=1}^k \pi_l \bar{x}_i(\theta_l)$, $\forall i$. $E(\bar{x}_i)$ is the average bundle of agent I , across states of nature. We then note:

1. The allocation $\{(E(\bar{x}_i))_{i=1, \dots, m}\}$ is feasible,
2. The strict concavity of u_i insures that $u_i(E(\bar{x}_i)) \geq \sum_{l=1}^k \pi_l u_i(\bar{x}_i(\theta_l))$ with one strict inequality at least.

However, (1) and (2) imply that the new allocation is Pareto-superior to the previous one. This contradicts the fact that the initial allocation was, from the first welfare theorem, Pareto optimal in the set of stochastic allocations.

The above proof relies on a variant of Cass and Shell's original argument that was formulated in a two period model. Such an argument can be extended in a straightforward manner to a finite horizon economy, the difficulty chiefly being notational. In addition, a careful reading of the argument will convince the reader that the expected utility hypothesis is not fully needed. Separability across states of nature of the utility function, together with some "generalized" notion of risk aversion would be enough. Balasko

(1983) has investigated the extension of the ineffectivity theorem to cases where consumers do not have Von Neumann-Morgenstern utilities.¹²

The simple and general message associated with the ineffectivity theorem, Cass and Shell (1983) can be loosely summarized as follows: A priori, the rational expectations hypothesis is compatible with the garbling of expectations by extrinsic noise. However, the additional noise so introduced is undesirable on the grounds of welfare. Hence, such a noise cannot have real effects on the allocation of resources when adequate insurance markets are open.

After seeing how economy equilibrium can be in the presence of certainty, Perfect foresight Equilibrium, or uncertainty, Sunspot Equilibrium. Distinguishing between them now will allow us a clear view of how a sunspot or uncertainty could be created.

3.6.4 Discussion and Findings

Equilibrium with rational expectations is a central construct of modern economic theory. This chapter investigates how the bubble and fluctuations in asset prices begin. The studies that are surveyed here are primarily aimed at introducing the discussion of a preliminary example of sunspot equilibrium. Stationary sunspot equilibrium, to be precise, is intended to offer the essence of the forthcoming analysis, using the framework of a simple OLG model. Our objective in this chapter is to provide an analytical framework for possible links between capital market equilibrium and stock market bubbles. Moreover, it will also illustrate how uncertainty exists in the economy, intrinsically and extrinsically. The uncertainty is: State where environmental agents are operating is uncertain and cannot be predicted completely. Effect where agents cannot predict the effects of environmental changes on the economy. Response where the consequences of decisions are unpredictable. Uncertainty effects the economy directly and indirectly.

¹² This idea stresses the symmetry properties of preferences over contingent bundles. For a systematic exploitation of this idea (see Balasko (1990)).

It has a direct effect on the fundamental characteristics of the economy such as endowments and technology. However, this type of uncertainty is called intrinsic uncertainty. As we discussed in this chapter there are two market structures that economists use, to deal with this uncertainty. One is the Arrow-Debreu market structure. In this structure markets are complete in the sense that agents can purchase assets that payoff should certain events occur. These assets payoff in terms of future consumption and are known as state-contingent claims. In this framework, all traders for all future periods make decisions prior to actual consumption in period 0. The second market's structure allows trade to occur sequentially in each period. This recursive structure is known as the sequential complete market equilibrium. In this later structure, market completion occurs because of the existence of Arrow securities. These securities are of one period duration to future consumption. Markets are complete in the sense that agents can make trades in a set of claims to one-period-ahead state-contingent consumption. In the Arrow-Debreu world, all transactions and plans are decided at the outset, based on the prices that clear future and/or contingent markets. Actual trade can take place later, when time passes and/or contingencies are obtained? It, nevertheless, does not depart from the decisions initially taken. Actual markets differ substantially from the idealized Arrow-Debreu markets. They do not take place once for all; on the contrary, they open in sequential order. Spot markets, in particular, open at successive calendar dates for transactions related to commodities available at these dates. The spot markets coexist with other markets often referred to as financial markets that allow agents to redistribute wealth, at least to some extent, across periods and across contingencies.

Three modeling ingredients are used to reach the conclusion that the evolution of consumption and production in a sequential economy is similar to the one predicted by the inter-temporal Arrow-Debreu model: (1) the horizon is finite, (2) the market structure is rich enough, and (3) future prices are correctly foreseen. Failure of one of these conditions alone, may lead to the consideration of economic paths, which are no longer Pareto optimal. The incompleteness of markets, i.e., failure of condition (2) above, generated a series of literature surveyed in this chapter. The discussion of condition (3) also opened a large area of research. The validity of the perfect foresight hypothesis or

more generally of the rational expectations hypothesis, has been the subject of intensive scrutiny. Two main lines of investigation that can be referred to as the general categories of "internal" and "external" criticism, have been developed. External criticism leads one to consider whether, and under which circumstances, the hypothesis can be justified. The viewpoint of internal criticism takes the hypothesis for granted, but emphasises the issues of non-uniqueness and "indeterminacy". It specifically investigates the possible occurrence of extraneous, stochastic equilibria where Radner's original framework is concerned with the introduction of 'extrinsic uncertainty' popularly referred to by this name because of the term's original use in the pioneer work of Shell (1977) and Cass & Shell (1983). Such uncertainty is unrelated to the fundamentals of the economy but occurs, "far away" from the economic world, a sunspot, or in people's minds. It has been argued that such extraneous equilibria might jeopardize both the predictability of the system and its welfare properties.

Thus, Arrow-Debreu equilibrium as we present it in this chapter, traders clear the market of tomorrow, today, because trade takes place before any uncertainty has realized. In reality, however, trade takes place to a large extent sequentially over time, and frequently as a consequence of information disclosures. However, if we touch the intrinsic uncertainty unique to the financial economy fluctuation and stock market bubbles in particular, we will clearly see that bubbles are totally different from intrinsic uncertainty, defined as equilibria in which prices and allocations depend on the realization of random variables not related to the "fundamental" of preference, technology or information. However, the stock market bubbles resulted from the effect of extrinsic uncertainty, which has no direct effect, on the economy because it does not effect the endowments, preference, etc. It may have an indirect effect on the self-fulfilling beliefs of the agents with regard to market price, or expectations.

As we discussed earlier, in determining sunspot equilibrium, we could not clear the market price of tomorrow today for certain, because the future price depends on expectations and sunspots as well as the possible incompleteness of the market. Nevertheless, we can only clear the market in the current period of time, and expect

future prices that will be more likely to clear the market tomorrow. And when tomorrow comes, the prices might be different from what we expected. For example if we expect that Adobe stock prices are going to increase from 10 to 15, next month, and we clear the market based on this expectation of future prices today. When next month comes, if our expectations were true then the sunspot equilibrium and rational expectations are indeed rational bubbles. However, if our expectation of future prices were not true, then the new prices will determine the created equilibrium and these prices will indeed be irrational bubbles. See Azariadis (1981), Azariadis & Guesnerie (1982), and Azariadis & Guesnerie (1986). We conclude this section thus; since rational expectations' equilibria are essentially self-fulfilling equilibria, of which the difficulty is chiefly notational; the idea was to see what the entire class of such equilibria are. In other words, whether self-fulfilling equilibria other than stationary equilibria can exist. Sunspots or extrinsic uncertainty is a shorthand device to introduce an expected coordinating variable to see the potential for these additional equilibria. The presence of such equilibria would also indicate the potential for endogenous self-fulfilling fluctuations, however, in the standard asset price model, the only systematic force driving asset prices is the expected dividend stream. If prices conform to this expectation, (perfect foresight equilibria) the rational expectations equilibria are said to be driven by fundamentals. Many other rational expectations' equilibria are possible in principle (self-fulfilling expectation and sunspot equilibria). These equilibria depend on expectations that are unrelated to the dividend stream, or other fundamentals. They are called "bubble solutions" or Rational Bubbles. To preserve a rational expectations' solution, the value of the bubble expected today must equal the discounted value of periods following it with anticipated value and be independent of fundamentals. By iterated substitution, today's value depends on all future bubble values discounted to the present. Thus the price today has two parts, the contributions of the systematic and bubble components.

In retrospect, we can say that the NASDAQ in early 2000 was clearly subject to irrational exuberance, and found itself to be in the midst of a speculative bubble. How about the broader market in 2001? Had the 27 percent fall in the S&P Composite in the past six months purged it of speculative excess? I strongly agree with Shiller: There is still a lot of

air in the broad market, and a lot of companies with stock prices that appear disconnected from their profits.

In fact, I believe the rise in U.S. stock prices in 1929 and 1999 was based on exaggerated beliefs about the potential of new technology and organizational structures to generate earnings, which was followed by a collapse. In the next chapter, we will discuss and find out more about bubbles. This would confirm that bubbles do exist in the technology industry in the NASDAQ stock market: Investors place too much money into an overvalued USA stock market, and is so doing, put their faith in companies which are losing money in the hope of the companies doing well in future. Most of the money being invested in the stock market is borrowed money. As a result, personal debt increases rapidly. Increasing debt causes the strong growth of and investment in shares, which, in turn, further empowers the powerful who could crash the market at a whim and gain complete control over it.

3.6.5 Sunspots and Bubbles are implied by a Self Fulfilling Prophecy

Stationary Sunspot Equilibrium: In recent years, the Rational Expectations' Hypothesis has become the most popular way to close the dependency of an economic system from agents' imagination of future events. When used in conjunction with market equilibrium, this hypothesis generates a rational expectations' equilibrium. As it is well known, an REE can exist even if agents base their ideas of future events on extra market variables. As proved first by Azariadis (1981), this type of REE has the logical status of a self-fulfilling prophecy. One leading example is that of Stationary Sunspot Equilibrium. See Negroni (2000). However Shiller's 'Bubble Theory' (2000), which builds on earlier work of his (1981, 1984, 1989), is premised upon socio-psychological dynamics that consequently spawn investing fads and fashions, culminating in under-pricing of risk and a rupturing of prices from their intrinsic values.

The efficient market hypothesis and its proponents have undoubtedly stimulated much intellectual development and progress in the general understanding of financial markets

and asset price dynamics. Samuelson, Fama and Modigliani amongst others, injected mathematical tools into the study of finance and helped transform it from a field that was closer to accounting than economics, to a field that blends financial theory with economic hypothesis. Unfortunately, the negative aspect of this revolution was that it stripped human conduct from the analysis of financial markets (Thaler (1998)).

It is this human element that many Keynesian theorists attempt to reinstate into the field of financial economics indicative of their significant contribution to understanding asset price movement¹³. Nevertheless, in (1988) Richard Roll, expressed uneasiness over the lack of progress made in the area of financial markets stating “the immaturity of our science is illustrated by the conspicuous lack of predictive content about some of its most interesting phenomena, particularly changes in asset prices” (Canova (1995)).

This statement suggested both that previous mainstream theories, on the subject of share price determination, had been deficient and perhaps that alternative theories had been ignored, engendering a substantial number of studies that added significantly to the already voluminous literature on the content of stock prices.

Lehman (1991) observes that the first “empirical cracks in the efficient markets’ edifice” came courtesy of the documentation of the many stock market anomalies observed in U.S stock markets. For example, the “P-E anomaly” uncovered as early as 1968, reveals that stocks with high ratios of price earnings under perform those with low price earnings’ ratios as well as the “high volume of trade anomaly” which often goes unacknowledged (Thaler, 1998, Leroy, 1989, Pratten, 1993). The latter refers to the fact that although traders are assumed to be rational and assume others to be rational, agents are still willing to buy what another sells and vice versa, in fact millions of shares are traded daily. Amongst others, there are also calendar anomalies such as the “January Effect”, the “Weekend Effect”, the Friday-the-Thirteenth Effect” and the “Holiday Effect”, all indicative of a pattern in stock prices incompatible with the basic tenets of the efficient market model (Aggrawal and Schirm, 1995) Additionally, there is the “small firm anomaly”: stock returns of small firms dominate those for large firms, particularly in

¹³ The relatively new area of behavioural finance also attempts to inject psychology and human behaviour into the realm of financial economics. See Barberis (1998) in the *Complete Finance Companion*.

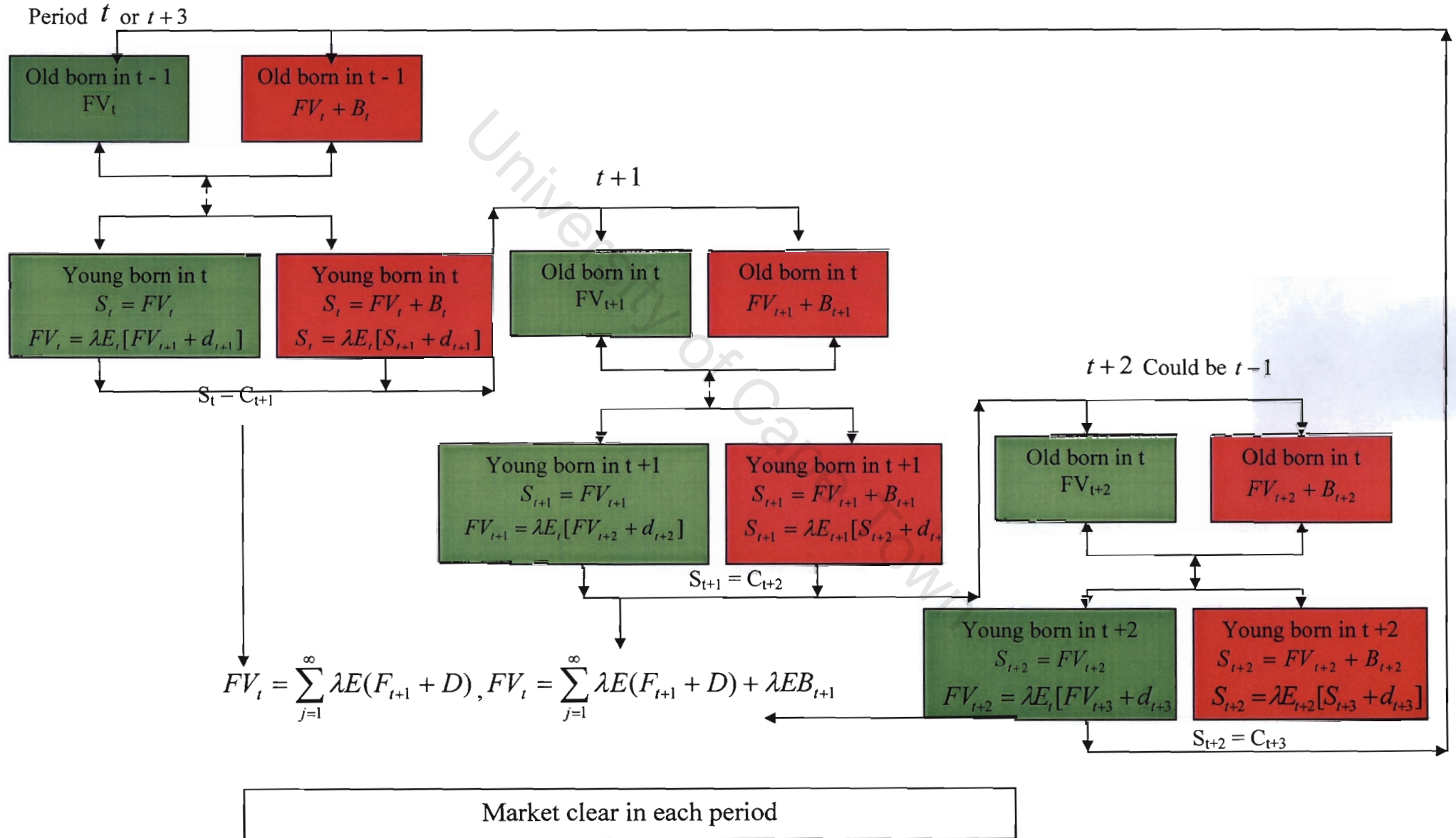
January. Moreover, Aggrawal and Schirm (1995) found that the “January effect” is present in several other countries.¹⁴ Even more anomalous is the significant relationship found between New York City weather and daily security returns chronicled by Saunders (1993). At best, these “anomalies” imply that the theory of efficient markets is too restrictive to explain price movements at all times.

Leroy (1989) notes that these findings pose two unattractive choices for the conventional financial theorist; either considers the contradictory findings inconsequential or, incorporate “irrationality” into their models of equity price determination. The response however, was to choose neither alternative. Instead Blanchard and Watson (1982) and Black (1986) advanced theories of “rational bubbles” and “noise trading” respectively while attempting to maintain the basic premise and tenets of the EMH. With technical precision, Blanchard and Watson (1982) illustrated that there can be rational deviation from the fundamental values of assets without creating the possibility for arbitrage by including a concept of risk compensation; this work is predated by Flood and Garber (1980) which was one of the first works to consider price bubbles within a rational expectations context.

According to the “rational bubble” theory, as prices overshoot their fundamental values there is an increase in the probability of the bubble bursting. In turn, the possibility of financial loss increases the risk associated with the ownership of bubbling stock, thereby justifying the acceleration of its price. (Pratten (1993)). Thus, the increased price appropriately reflects the associated risks of riding a speculative bubble and speculators cannot make profits off the existence of the bubble since all relevant information is still contained in current prices.

¹⁴ For a thorough review of stock market anomalies see Dimson, E., (1988), *Stock Market Anomalies*. Cambridge: Cambridge University Press.

Flowchart 3.4: Rational Bubble



Chapter 4

4.0 Bubbles And Stock Market Behaviour: Rational And Irrational

4.1 Introduction

Our goal in this chapter is to continue the investigation of the stock market bubble in financial markets. A bubble is a sharp rise in the price of an asset or a range of assets in a continuous process, with the initial rise generating expectations of further rises and attracting new buyers, generally speculators, interested in profits from trading in the asset rather than its use as earning capacity” Kindleberger (1978). Since the publication of Kindleberger’s ”Manias, Panics and Crashes” (1978), a large body of literature has flourished on bubbles and crashes in financial markets. One of the more common things said of bubbles is that ‘you know one when you see one’. Unfortunately this means different things to different people. Some economists do not believe that there has been any asset market bubbles, merely examples of unrealised expectations, see Garber (1990). Others even suggest that periods of ‘irrational despondency’ are more common than periods of ‘irrational exuberance’, see Siegel (2003). There are numerous academic papers discussing whether certain episodes are, or are not, bubbles and there is no consensus in the literature see for example, Mackay (1980: 46-88) and Chancellor (1999: 58-95) for further details. Two key questions have ultimately been analysed in this literature. One is whether bubbles can occur in theory; the other is whether they occur in practice see (chapter 2). In this chapter we will analyse the first. In order to analyse the question of whether bubbles can occur in theory, one has to be precise about the nature of a bubble. We begin our investigation in this chapter with a brief introduction of the major theories behind bubble identification .By the end of the chapter, a clear definition will have been provided. With the introduction of rational expectations in economic models, a bubble was given a precise meaning. It is well known that a rational expectations model produces an undisclosed amount of solutions for the asset price. One is the ”fundamental” solution, and the other (in fact infinitely many) is the bubble solution. The latter is an

explosive path of the asset price that increasingly deviates from the fundamental, but that continues to satisfy the no-arbitrage condition. Clearly such a definition of a bubble is not interesting in a perfect foresight environment because it means that either the bubble goes on indefinitely, or if a crash is expected at some future date, the bubble will not start, due to backward induction. This has led to the efficient market view that bubbles cannot occur. The insight provided by Blanchard and Watson¹⁶, was to formulate a bubble theory in a stochastic environment, and to assume that when the asset price is on an explosive bubble path, rational agents expect a future crash but do not know its exact timing. This analysis concluded that a bubble, defined as an explosive path of the asset price, is a theoretical possibility. Blanchard and Watson's analysis has spurred a large literature extending this initial insight and analysing the conditions for the emergence of bubbles in rational expectations models. The discovery that bubbles can arise in rational expectations models is significant. Yet this "rational bubble" theory is not all together satisfactory. The weak point in rational bubble theory lies in the modelling of the crash. The latter is introduced in an ad-hoc fashion, i.e., Agents are assumed to expect a crash, although this expectation does not come from the structure of the model itself. It is based on some "reasonable" but model-exogenous assumption that bubbles cannot continue indefinitely.

A further extension of the rational bubble theory consisted of allowing for heterogeneity of traders. Models were developed in which rational traders interact with "noise traders" see Delong, Shleifer, Summers and Waldmann (1990) and Shleifer and Vishny (1997). The essence of these models is that some constraints exist on the capacity of the rational traders to exploit the profit opportunities generated by the bubble. These limits to arbitrage arise because of risk aversion or capital constraints. More recently, Abreu and Brunnermeier (2003) have developed models in which the arbitrage failure by rational traders arises because they have different views about the timing of the crash and fail to synchronize their exit strategies.

¹⁶ See Blanchard (1979), Blanchard and Watson (1982)

The rational expectations' definition of a bubble as an unstable path in asset price is not the only possible definition of a bubble. Shiller (1981) refers to the PV model as an "efficient market model". Thus we applied the Shiller test (1981) on the NASDAQ stock market for the period covering the past 10 years. Our results showed that the market was not efficient; therefore, we adopted the definition of the bubble as a deviation from the asset's fundamental value. Based on our result, we start by looking at the most likely factors that allow the stock price to deviate from the fundamental.

The first theory we encountered was the theory of "noise traders". In this case, the price of stock reflects both the correct information given by informed agents, and the distortions generated by the noise traders. The more noise trading, the less information gets into prices, and the less efficient the market becomes (See chapter 2).

In chapter 3 we investigate the phenomenon of Sunspot Equilibria. A sunspot is a random shock unrelated to the real fundamentals of the economy, based on rational expectations. David Cass and Karl Shell who questioned the strong stationarity results, that seemed to emerge from the rational expectations models in macroeconomics such as Lucas's (1972) paper, first introduced sunspots. However, we conducted a study to establish whether predictable changes in the dynamic economy, and equilibrium structures can lead to predictable future changes in asset prices, and how significant such price changes can be. However, this chapter investigates the technology bubble in particular. Furthermore, it presents some bubble theories. We begin our investigation by looking at the major events that took place in the technology industry, which generated major fluctuations in related stocks prices. The US stock market prices began to increase dramatically when favourable developments, such as sudden victory in World War II, and/or the commercialisation of new technology such as the Internet, occurred suddenly and unexpectedly. These events inspired stock market participants to become more optimistic about future returns. In addition, the rising share prices increased technology firms' net worth, and facilitated the issuance of new shares to fund investments in capital assets. However, we shall consider the four significant events amongst others, which drove investors into purchasing US stocks in the mid 1990's.

1. US victory of the Cold War. As a result, declining national defence outlays helped to swing the federal budget from deficit into surplus (i.e. from \$298.3 billion or 4.8% of GDP in 1992 fiscal year to \$294.5 billion or 3.0% of GDP in 2000 fiscal year. The unified federal budget swung from a deficit of \$290.4 or 4.7% of GDP in the 1992 fiscal year and a surplus of \$236.4 billion or 2.4% of GDP in 2000 fiscal year).
2. Acceleration of U.S. productivity growth ¹⁷.
3. The advent of the World Wide Web in 1991 and the Internet browser in 1993 facilitated the rapid commercialisation of the Internet. Stock market participants attributed great economic importance to the Internet, and hence anticipated that internet-related firms would reap huge profits in the future.
4. American voters elected a fiscally conservative Congress on November 8, 1994. In response, President Bill Clinton proclaimed in his 1996 State of the Union Address: “The era of big government is over...”¹⁸ Higher stock prices mirrored rising corporate profits through the middle of the 1990’s. Aggregate net corporate profits grew on average 11.6% annually from \$260.9 billion or 4.50% of GDP in 1990 to a peak of \$555.2 billion or 6.67% of GDP in 1997. Meanwhile, the combined market capitalization of stocks listed on the NYSE and the NASDAQ grew from 53.5% of GDP at the end of the fourth quarter of 1990 to a drastic 132.7% of GDP at the end of the fourth quarter of 1997 (U.S. Department of Commerce, Bureau of Economic Analysis and Haver Analytics).

¹⁷ Average private non-farm business sector labour productivity grew at an annual rate of 2.60 percent from 1995 to 2001 compared to an annual rate of 1.39 percent from 1973 to 1995. Executive Office of the President, Council of Economic Advisers, *Economic Report of the President together with the Annual Report of the Council of Economic Advisers* (Washington, D.C. U.S. Government Printing Office, February 2002): 58-61.

¹⁸ Bill Clinton, “State of the Union Address,” Before a Joint Session of the Congress, Washington, D.C., January 23, 1996.

In consequence of the above, the economy generated an increase in stock market prices, an effect which was seemingly rational to market participants. However, this increase in stock prices could not be explained by market fundamentals. The following are some of the reasons behind the surge in stock prices above the justification of market fundamentals:

1. Rising share prices made it easy for firms to borrow or issue new shares so as to finance expanded investment. This optimism appeared to be justified, as a growing business investment that resulted in rising aggregates of corporate net profits from 1990 to 1997.
2. Subsequently, over-investment and mal-investment became widespread during the late 1990's. Over-investment occurs when firms acquire too many capital assets for production of goods and services; for example, automakers build new assembly plants to increase manufacturing capacity to 20 million vehicles per annum. Whereas consumer demand is only 15 million vehicles a year. Mal-investment means that firms acquire the wrong capital assets for production of goods and services; for example, record companies purchasing equipment to make cassette tapes. Whereas consumer preferences have shifted towards Compact Discs. Generally speaking, it can be said that over-investment and mal-investment in the second half of the 1990's depressed business investment sharply over subsequent years.

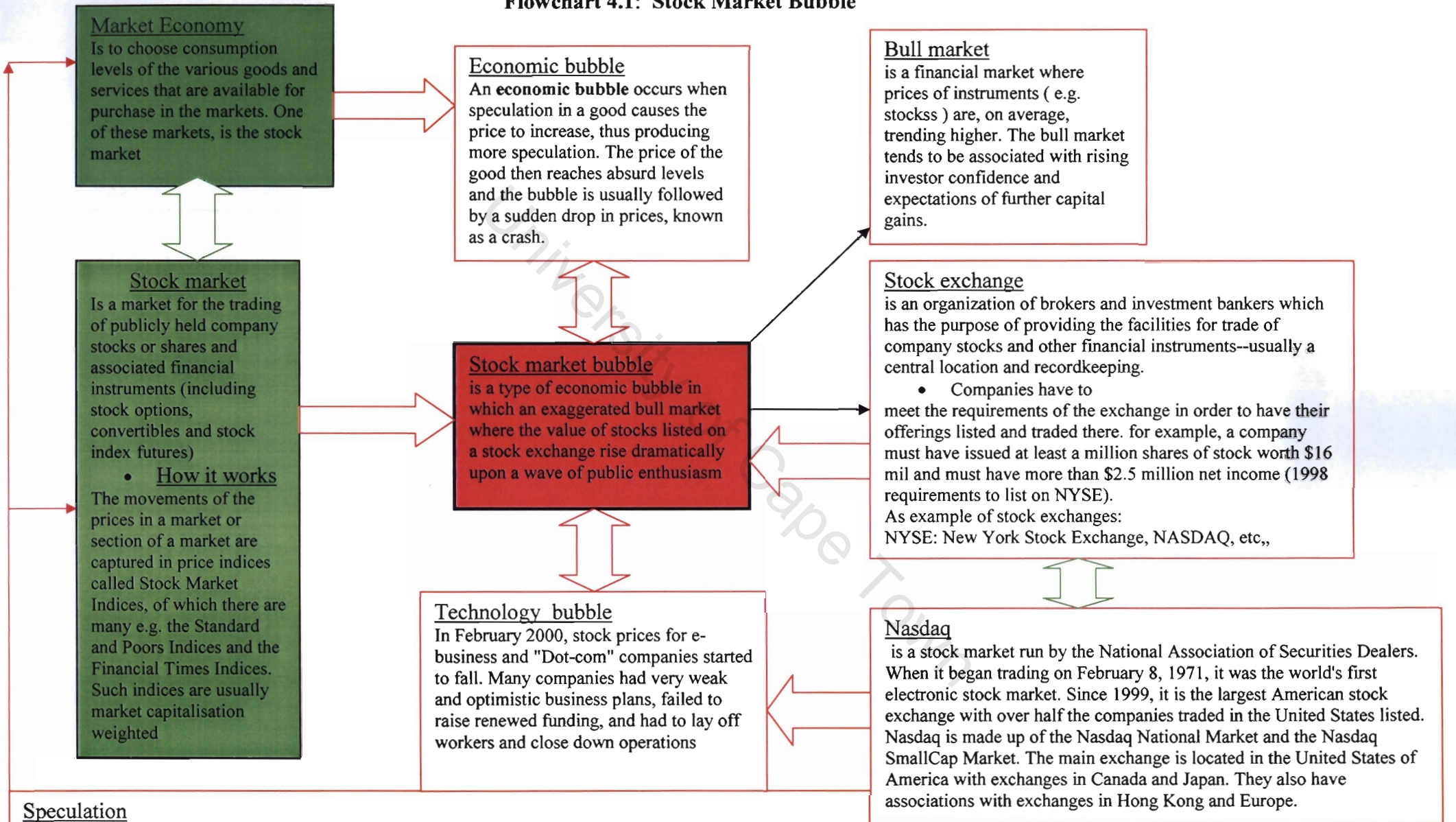
Together these factors created a speculative mania in the stock market. As the 'peak' approached, expectations about the future profitability of purchasing stocks reached their zenith. A number of factors came together near the end of the 1990's suggesting that aggregate uncertainty was actually much larger than had been perceived. As the year 2000 began, increasing uncertainty completely dimmed the hopes embedded in high share prices. Prices of information technology and telecommunications stocks plunged, starting in the first quarter of the year 2000. Between March 10, 2000 and January 19, 2001, the NASDAQ composite index fell 2,278.24 points, or 45.1 percent. This decline in the stock market severely depressed business investment, the reason being that as a firm's

share prices fall, the firm's market value declines, thereby reducing its ability to borrow or issue stock to finance investments. As a result, many firms found themselves under immense financial pressure, and in extreme cases even resorted to insolvency. (Saxton (2003))

The Flowchart 4:1 below shows the biological occurrence of the bubble. By now we have briefly explained the stock market bubble as a deviation from the market's fundamental value. In the next section we will, thus, investigate some of the main theories behind the estimation of the market fundamentals of an asset in more detail, in order to classify whether the sharp increase in the stock price is a bubble or not.

University of Cape Town

Flowchart 4.1: Stock Market Bubble



Speculation

is the buying, holding, and selling of stocks, commodities, collectibles, real estate, or any valuable thing to profit from fluctuations in its price as opposed to buying it to use.
Sometimes speculative purchasing can cause particular prices to rise above their "true worth" simply because the speculative purchasing is artificially increasing the demand. Speculative selling can also cause prices to fall below "true value" in a similar fashion. In some situations price rises due to speculative purchasing cause further speculative purchasing in the hope that the price will continue to rise (Self-fulfilling beliefs) . This creates a positive feedback loop in which prices rise dramatically above the underlying "value" or "worth" of the items

4.2 Literature Related to the Assets Bubble

Shiller (2000) uses psychology to explain investors' actions and argues they are inclined to exhibit herd behaviour, i.e., they may try to follow the lead of someone they believe to be better informed, and as a result securities' markets will be filled with anomalies, bubbles, crashes and higher volatility. The inevitable result is the emergence of market inefficiency in which market values are relatively above or below their fundamentals. This implies that there are profit opportunities that have not yet been exhausted and that there is a chance of beating the market by earning higher returns on investment than those justified by the risks inherent to them. With respect to asset prices bubbles in the year 2000, Shiller and Siegel offer different views on the future of both the stock market and the growth rate of the US economy. Siegel (1998) offers a more optimistic view by arguing that the stock market remains very promising for long -run investments and the potential to further rise. Investors overstated the market risk and underestimated the market growth prospects. As a result the market is under priced. However, Shiller (2000) offers a more pessimistic view by arguing that the stock market has been experiencing years of slow growth since the market is overpriced and will soon fall. Barro (2000) offers a third view, that it is possible for prices to reflect fundamentals and that future earnings are factored efficiently in market prices. Barro (2000) argues that using some basic ideas on stock valuation one can evaluate different competing theories. He states that stock prices should be higher for any given level of earnings if the real interest rate is lower, or the risk premium goes down, or if dividends are adjusted for inflation, are expected to grow rapidly. This in turn would imply a higher P/E ratio. He applied these three factors using numbers from Siegel's book "Stocks From The Long Run" and found that the average real rate of return on U.S. stocks was 7.0% per year, while that on short-term government securities was 1.7% per year, hence the risk premium required by stockholders averaged 5.3%. Combining these numbers, with Siegel's estimate of 1.0% rate of growth for dividends per share gave him a warranted P/E ratio of about $(0.01/0.07)=14.3$, which is close to the historical median of 14. However, he argues that the risk premium on stocks remains quite high. One possible answer is that there could be a weight problem.

Siegel (1998) argues that stocks have been undervalued during the last two centuries and that they are, on average, no riskier than bonds for holding periods of 10 years or more. Investors overestimated the inherent risk and underestimated the growth prospects for corporate earnings. Hence the proper risk premium on stocks may have been close to zero and the required rate of return on stocks and risk-free rate should have coincided. Hence, Siegel predicts a boom in the stock market as long as the market is fairly valued and has the potential to grow. However, Shiller (2000) argues that the stock market was overpriced and stock prices are not rational since investors underestimated the risk premia and overestimated the growth prospects for expected future earnings. He assumes future values of the risk premium and dividends' growth rates will not differ much from their historical averages and notes that the observed high P/E reflects irrational exuberance and excess volatility. He predicts that the bubble will eventually burst and P/E ratio will revert to its normal value causing a market crash, as was shown in chapter 2.

Barro (2000) argues that the Fed chairman seems to recognise the difficulties involved in specifying the extent of risk associated with stock returns and their growth prospects, especially when new technologies largely impose uncertain impact on productivity. This in turn makes P/E ratios highly volatile and market prices will always reflect the two possibilities, i.e., The market may experience a boom or a bust.

Shiller examines the P/E ratio of America's S&P 500 over a long time-series (1881-1999) in which enormous technological advances took place: America's railway boom, electricity, telephones, radios and cars. He finds that P/E is a good predictor of real stock market returns over the next ten years. When P/E ratio is high, the real return on stocks tends to be low. If P/E is low the real return tends to be high, i.e., past or current prices are a good forecast of future returns. He finds that stock prices climbed simultaneously with each wave of technology and later fell. He was not concerned with proving that the market is overvalued since he assumes the existence of the bubble. He does, however explain how this overvaluation was brought about. He was, furthermore not scarred that much by the probability of a short-term market crash. Rather, he was scarred of the possibility that such a crash would be followed by prolonged market downturns and he

predicted that the bear market would soon follow. Shiller attributes the bubble to several factors; structural, cultural and psychological. He argues that structural factors include the arrival of the Internet, lower transaction costs, higher volume of stocks trades, demographic shifts that affect the pattern of spending and saving, a new political consensus favouring low taxes and the resulting capital gains from such tax cuts, the rise of pension plans and the declining quality of professional investment advice that is becoming increasingly optimistic. He argues that other structural factors augment such events and occur in a ponzi-like process, i.e., An asset bubble will continue as long as there are plenty of irrational people who are willing to pay mounting prices. This would create a sustainable rise in investor- confidence inducing them to bid the stock prices up. When he turns to cultural factors, he pointed out, “ the history of speculative bubbles began roughly with the arrival of newspapers, which helped to create the first bubble of any consequence”. He then goes on to describe how the media are drawn into bubble-inflating processes.

The risk premium in the US stock market has fallen far below its historical level, which Shiller attributes to a bubble driven by psychological factors. He emphasised in his book, “Irrational Exuberance”, renown in economics circles, that a bubble existed in the US stock market, especially in the NASDAQ index of high-tech stocks. The NASDAQ experienced rapid growth before collapsing by more than 60% in March 2000. This in turn implied that people were speculating on continued price increases and that they bought the existing stocks as well as the new issues in a way that seemed consistent with “irrational exuberance”. Theories of noise trading appear to go further in the analysis of how speculative bubbles form in financial markets.

In short, the noise trading theory implicitly proposes that irrational traders are in an amount small enough so as to deem the collective market rational, but large enough to co-determine the course of equity prices. This is an immediate rejection of the rational expectations hypothesis, which presumes that all agents know the correct equilibrium model of expected returns and know that the information is common knowledge. Moreover, by changing the wording in Black’s noise trading model, a closer association

to Shiller's fad model is revealed than the efficient markets' model it attempts to reclaim. If we label noise traders as "ordinary money" and rational flows as "smart" money, the difference between Shiller (1989) and Black (1988) is one of scope, the assumptions about what drives the "ordinary flows" and scepticism about how cleanly the division can be made between smart and irrational traders, is evident.

Shleifer and Summers (1990) make these similarities between noise traders and speculative market theory more overt in their representation of the noise trader approach to financial markets. Here the market is familiarly characterised by the activity of both rational arbitrageurs and noise traders. The existence of market participants whose trades are not fully reflective of fundamental news imposes two types of risk. The first is the risk that stems from uncertainty about future prices at which current holdings can be resold. The second is the additional price risk described previously by Black (1986), i.e. "noise-trader risk". Because of the latter type of risk, arbitrageurs cannot discern whether price increase is generated by genuine information about future dividend payments not already incorporated in the current price, or as a result of the irrational activities of noise traders. Thus, rather than selling the over-priced stock, would-be arbitrageurs may elect to hold onto them in anticipation that noise traders will further push up prices.

Clearly, central to the noise trading theory is the notion that rational traders must endeavour to anticipate the flows of noise traders when devising their own rational trading strategy, creating a bandwagon effect. This of course, is directly in the spirit of Keynes. With the stock market crash of 1987, during which the Dow Jones Industrial Average declined 30% in six days, more literature appeared which sought to maintain the basic ideas found in Samuelson (1965) and Fama (1970) by further advancing "rational" theories to explain excessive share price fluctuation. Among the most notable are noise trading or feedback trading models of Cutler, et al. (1990) and De Long, et al. (1990) and the rational bubble models of Froot, et al. (1992), Romer (1993) and Bulow and Klemperer (1994). These works maintain the essential flavour of Black (1986), Shleifer and Summers (1990) and Blanchard Watson (1982) while emphasising the inefficiency of financial markets. Romer (1993) attempts to forge a middle ground between the rational

and irrational views. To these ends Romer argues that stock markets are imperfect in an informational sense, resulting in investors attempting to evaluate the beliefs of others rather than forming sensible estimates of the economic fundamentals. Here, the market approximates the “beauty contest” by Keynes (p.1113) and more rigorously analysed within a psychological context by behavioural finance theorists.

The majority of the above theories were criticized because of their assumption that there was stationarity in stock price and dividends. Also, questions by Flavin (1983) and Kleidon (1986) concerning sample bias and sample error were raised. Kleidon reports time series evidence against stationarity for both stock prices and dividends and, using simulations, shows that Shiller’s findings occur for non-stationary dividend processes and rationally determined stock prices. Thus Shiller’s test (1981) reflects only a joint hypothesis and not necessarily a rejection of market rationality. As a result thereof, economists have recently suggested the existence of a rational bubble. Rational speculative bubbles allow stock prices to deviate from their fundamental values without assuming irrational investors. These bubbles are generated by extraneous events or rumours and driven by self-fulfilling expectations see Blanchard (1979), Blanchard and Watson (1982). These earlier tests for bubbles and sunspot equilibria yield mixed results. For example, Blanchard and Watson (1982) fail to reject the theory that no bubble hypothesis exists. One reason that a bubble hypothesis is difficult to test, if not impossible, is that expectations are measured relative to some maintained hypothesis and, with rational expectations, exploit all of the information that is relevant according to the maintained hypothesis. Bubble phenomena are what remain unexplained by the hypothesis. As we found out in chapter 2 regarding the testing of market efficiency in the NASDAQ Stock Exchange, our test results clearly indicated that the market was not efficient. However, all the companies examined showed a sharp increase during the year 2000 in stock prices caused by the bubble effect (see Tables 2.1, 2.3, 2.5 and 2.7 as well as figures 2.2, 2.4, 2.6 and 2.8). Subsequent to this increase, stock prices declined dramatically. IE: Crashed Our previous investigations in Chapter 3 into Rational Expectations and Sunspot Equilibria, was as introduction to our main investigations in this chapter which relates to the characterising of bubbles as well as the sharp increase in

the asset price and how it is caused. However, further on in this chapter we will also consider another event, a sharp decline, which is usually followed by the bubble phenomenon as it happened in the IT Sector in the Nasdaq Stock Exchange in 2000, and in the 1929 US crash.

4.3 Rational Bubbles

Economists and financial market participants often have different views about the pricing of an asset. Economists usually believe that given the assumption of rational behaviour and rational expectations, the price of an asset must reflect market fundamentals, which depend on information about current and future returns from the asset. For example Shiller (1981) amongst others. However, any deviations from this market fundamental value are taken as evidence of irrationality. Financial market participants on the other hand, often believe that fundamentals are only part of what determines the prices of assets. It turns out that economists have overstated their case. Rationality of both behaviour and of expectations often does not imply that the price of an asset be equal to its fundamental value. In other words, there can be a rational deviation of the price from this value, which implies that the economy can have belief-driven equilibria. This, in fact, is a “rational bubble”. Examples of belief-driven equilibria are sunspot equilibria, i.e., Equilibrium paths that depend on extrinsic uncertainty (Azariadis (1981)).

Keynes (1936) has long entertained the idea that movement in stock prices can involve “bubbles”, which are psychologically based responses to extraneous factors. Tirole (1982) has shown that bubbles cannot exist with a finite number of infinitely living rational agents. He argues, “When short sales are permitted, infinite lived agents could sell the asset short, invest some of the proceeds to pay the dividend stream, and have a positive wealth left over. Although it does not depend on the possibility of short sales or the existence of a positive bubble. This arbitrage opportunity rules out bubbles”. Tirole has studied the possibility of bubbles within the Diamond (1965) overlapping generations model. In this model there are an infinite number of finitely living agents. But Tirole (1985 p.1076) shows that even here, a bubble cannot arise when the interest rate exceeds

the growth rate of the economy. This is because the bubble would eventually become infinitely large relative to the wealth of the economy, which would violate some agent's budget constraint. Thus, he concludes that bubbles can only exist in dynamically inefficient overlapping generations economies that have over accumulated private capital, driving the interest rate down below the growth of the economy. However, many economists feel that dynamic inefficiency is likely to occur in practice, and Abel, Mankiw, Summers and Zeckhauser (1989) present empirical evidence that it does not describe the U.S. economy. In a seminal contribution, Tirole (1985) proposed a theory of rational asset price bubbles. To satisfy their need for a store of value, markets may accumulate capital assets even when the investment required keeping these assets exceed the income they produce. That is, economies might find themselves using a costly or inefficient store of value. In this situation, a bubble with negligible maintenance costs constitutes a more efficient store of value and can favourably compete with capital. As the bubble displaces capital in the portfolios of investors, it liberates resources that are used to raise consumption and welfare. Since bubbles do not have intrinsic value, their size depends on the market's expectation of their future size. In a world of rational investors, this opens the door to self-fulfilling expectations to play an important role in bubble dynamics and accounts for their unpredictability.

4.3.1 Basic Models by which Bubbles are Characterized

Tirole (1985) has established that "bubbles" can sometimes exist in the general equilibrium of a growing economy with overlapping generations. In this section we investigate Tirole's model (1985) by which bubbles are characterised as well as whether the fundamentalist's view of asset pricing extends to overlapping generations economies. Tirole's idea of characterization of bubbles roughly runs as follows:

- If assets pay dividends or rents, they are intrinsically useful. Examples of intrinsically useful assets are land, natural resources or company stock market shares. A normally intrinsically useful asset has only fundamental value, which consists of the discounted future dividends or rents of the asset. If dividends or

rents grow at a lower rate than the rest of the economy. Intrinsically useful assets can also have non-fundamental values i.e., a bubble.

The same is true if the aggregate stock of the assets grows in time and new assets are not a gift to the owners of the old assets. In this case the dividends or the rents of the new assets cannot be discounted and valued before the actual creation of the assets. IE: The dividends or the rents are non-capitalized. Examples of assets with non-capitalized dividends are future inventions or stock market shares of the firms in the industry with free entry. On the other hand examples of assets with capitalized dividends are land and stock market shares of the firms in the industry with blockaded entry. Thus, an asset that distributes real dividends in each period has an infinite market fundamental. This asset cannot thus, be transferred between generations (see Tirole (1985); Rhee (1991) and Grossman and Yanagawa (1993)).

- In the case of intrinsically useless assets the fundamental value of the asset is zero. Because intrinsically useless assets are owned by old agents and sold to young ones of the next generation, bubbles work in a similar way as gifts, i.e., they move resources from the young-age agents to the old-age agents. The asset bubble that has to grow at the interest rate eventually becomes so big that young generations cannot make purchases. A rational investor will only hold an asset priced differently than its fundamentals if he expects that the bubble component will yield at least a normal rate of return, i.e., It will grow at least at the real rate of interest. Nevertheless, if bubbles grow at the rate of interest in every period, eventually their value will exceed the income of the young generations who must purchase these assets from the old. Unless the income of these generations is growing, at least at the same rate. Tirole (1985) investigated the conditions under which a Diamond (1965) economy with an expanding population would grow fast enough to allow for the existence of bubbles in asset prices.

Diamond Model

The Diamond Model is the Overlapping Generations Model (OLG). In every period t with, $t = 0, 1, \text{ and } 2 \dots$, i.e., time is discrete. The consumer lives for two periods, "youth" and "old age." but works in the first exclusively. He supplies one unit of labour. Thus the labour force at time t , L_t . The population is assumed to grow at rate $n > 0$. Thus

$$L_t = (1 + n)L_{t-1} = (1 + n) \quad (4.1)$$

where $L_{t-1} = \frac{L_t}{(1 + n)} = \frac{1}{(1 + n)}$

Each young consumer within each generation supplies one unit of labour in return for a real wage w_t . Young consumers use the wage income to provide consumption c_t^1 and savings s_t . Old-age consumption c_{t+1}^2 is provided entirely by savings and accumulated interest.

$$\begin{aligned} w_t &= c_t + S_t \\ C_{t+1} &= S_t(1 + r_{t+1}) \\ w_t &= c_t + \frac{c_{t+1}}{1 + r_{t+1}} \end{aligned} \quad (4.2)$$

The aggregate savings at time t can be written: $(1 + n)^t s(w_t, r_{t+1})$ where w_t is the agent's wage, r_{t+1} interest rate at time $(t + 1)$ and s is the individual savings function. The Output in the Tirole Economy is one physical item of goods per period and two factors of production at the beginning of each period by

$$Y_t = F(K_t, L_t) = L_t f(k_t) \quad (4.3)$$

where Y_t is total output; K_t is the capital stock, and k_t is the capital stock per worker (Letting $k \equiv K/L$ and $y \equiv Y/L$ denote the capital-labour ratio and the output-labour ratio, respectively, the production relation can be expressed in per-capita (i.e., per-worker) form as

$$y = F(k,1) \equiv f(k) \quad (4.4)$$

Each firm hires capital up to the point where its (private) marginal product equals the rental rate, r_t , and it hires workers until their marginal Product equals the wage rate. In view of the homogeneity:

$$r_t = F(K_t, L_t) = f'(k) \quad (4.5)$$

where r_t is the rental rate (interest rate), $F(K_t, L_t)$ is $(\frac{K_t}{L_t}, 1)$ and $f'(k)$ is marginal product. The wage is expressed as follows:

$$w_t = F(K_t, L_t) - K_t F(K_t, L_t) = f(k_t) - k_t f'(k_t) \quad (4.6)$$

In question 4.6 above, we subtract the growth in capital per unit, which, generated by the interest rate from the output by unit of effective labour, we obtain the real wage. Combining (4.5) and (4.6) gives a relationship between equilibrium factor prices:

$$r_t = F(K_t, L_t) = f'(k) \quad w_t = F(K_t, L_t) - K_t F(K_t, L_t) = f(k_t) - k_t f'(k_t)$$



$$w_t = \phi(r_t) \quad (4.7)$$

Product market equilibrium is obtained when aggregate investment equals aggregate savings, i.e., The sum of desired savings by the young and desired expenditure by the old. Since the old wish to consume their entire holdings of capital, K_t , this implies:

$$k_{t+1} - k_t = S(w_t, r_{t+1}) - k_t \quad (4.8)$$

$$k_{t+1} = s(w_t, r_{t+1})$$

Diamond has shown that a unique competitive equilibrium. In this equilibrium the interest rate converges to \bar{r} . The equilibrium path is efficient if $\bar{r} > n$ and inefficient if $\bar{r} < n$. The interest rate will play a crucial role in what follows. Tirole (1985) extended Diamond's model to include rents and bubbles.

Existence of Asset Bubbles

We now assume that the generation that is old at time 0 has M paper assets that are intrinsically worthless. That is, the assets produce no real output and therefore generate no dividends. The old attempt to sell these assets to the young at a positive price P_0 (in terms of goods) for each piece of paper. Would a rational, foresighted, young investor be willing to purchase one of these assets? Only if he believed that he could resell the asset when old to a member of the next young generation for a price that includes a real rate of return comparable to that available on other assets i.e., in period 1. The real (gross) rate of return on alternative assets is $1 + r_1$ units of output in period 1. Therefore, the young investor in period 0 is willing to buy the intrinsically useless asset if he expects its price in period 1 to be at least $P_1 = (1 + r_1)P_0$. Similarly, the young generation in any period t must expect the price of the paper to be $P_t(1 + r_{t+1})$ in period $t + 1$. If it is to acquire the asset from the old generation at that time at price P_t . If all expectations for capital were reality, the asset could be fulfilled. Then the intrinsically useless paper can be traded indefinitely; that is, there can exist a bubble.

Let $B_t = P_t M$ be the aggregate value of the bubble at time t , and assume for the moment that the self-fulfilling prophecy can be realized. By the condition of no-arbitrage between bubbles and other assets, we have:

$$B_{t+1} = (1 + r_{t+1}) B_t \quad (4.9)$$

The young generation must purchase all the existing bubbles from the old generation in each period. The condition for the goods market equilibrium becomes:

$$K_{t+1} - K_t = s(w_t, r_{t+1}) - (B_t + K_t) \quad (4.10)$$

From equation (8) above we can write the aggregate value of the bubble per efficiency unit of labour as:

$$b_t \equiv \frac{B_t}{L_t} \quad (4.11)$$

And as long as $L_t = (1 + n)^t$ equation 1. Thus, if we combine equations (4.9) and (4.11) we get:

$$b_{t+1} = \frac{1 + r_{t+1}}{1 + n} b_t \quad (4.12)$$

On the other hand, there exist assets that bring a real rent (dividend), such as natural resources e.g. land, for its consumption value, or decreasing returns to scale technologies. For simplicity Tirole (1985) assumes that total rent in the economy is R units of real goods per period. The market fundamental of the corresponding assets is for a sequence of real interest rates:

$$F_t = R \left[\sum_{s=t+1}^{\infty} \frac{1}{(1 + r_{t+1}) \dots (1 + r_s)} \right] \quad (4.13)$$

The market fundamental per capita, f_t , is defined by $f_t = \frac{F_t}{(1+n)^t}$.

$$f_{t+1} = \frac{1+r_{t+1}}{1+n} f_t - \frac{R}{(1+n)^{t+1}} \quad (4.15)$$

However, as we shown above, the consumers can invest in assets with a zero market fundamental. These assets are best thought of as pieces of paper, wherever their origin, and are called bubbles. The aggregate bubble per capita is denoted b_t . Under perfect foresight the bubble must bear the same yield as capital, as, by definition, it does not distribute any dividend equations 4.12 and 4.15

Lastly bubbles must be positive: there cannot be a negative bubble on an asset that can be freely disposed of: if p_t and d_t denote its price and dividend at time t , the arbitrage equation requires that for $T > 0$:

$$P_t = \sum_{T=1}^T \frac{d_{t+T}}{(1+r_{t+1}) \dots (1+r_{t+T})} + \frac{P_{t+T+1}}{(1+r_{t+1}) \dots (1+r_{t+T+1})}$$

The first term on the right-hand side converges to the market fundamental, and the second term is always non-negative. Therefore the asset's price must exceed its market fundamental.

When $\bar{r} < n$, the asymptotically bubble free equilibria are inefficient, and the asymptotically bubbly equilibrium is efficient. We have assumed that the total rent in the economy R remains constant over time, so that its value per capita becomes negligible if the long run rate of interest is strictly positive. This assumption, which was made to simplify the analysis, gives rise to the following objection: Imagine that rents per period grow at the rate of population growth, i.e., at the asymptotic rate of growth. If this is the case, perfect foresight equilibrium must be efficient. Otherwise the rent per period would grow at a rate exceeding the rate of interest and the market fundamental would be

infinite. If $\bar{r} > n$, then a unique equilibrium exists. This equilibrium is bubble free and the interest rate converges to \bar{r} states that the existence of bubbles is conditioned by the efficacy of the bubble free equilibrium. Note, when the economy is asymptotically bubble free, the total bubble $B_t \equiv (1+n)^t b_t$ grows indefinitely (as $\bar{r} > 0$), see Tirole (1985). When the bubble free and rent- free economy is efficient, the interest rate in the same economy with bubbles and rents must, in the long term, exceed the rate of population growth. But since the bubble B_t must grow at the rate of interest, it ends up growing faster than the resources of the economy.

In this section of the chapter, we investigated the conditions under which asset bubbles can exist in a simple model of endogenous growth. As in the neoclassical growth setting, a bubble can survive only if the equilibrium growth rate exceeds the interest rate in the bubble free economy. However, the equilibrium growth rate, like the interest rate, is determined by parameters of tastes and technology. When bubbles do exist, they retard economic growth along the transition path to the steady state and possibly even have long- term affects. The bubbles also harm all generations born after the period in which the asset first appears. To an extent that exceeds the gain to the generation that benefits from the bubble. However, a bubble can exist on intrinsically useless assets too.

Let us apply Tirole's findings from (1985) to the standard valuation of stock. We will consider an investor who buys stock at time t , holds it for one period, and sells it at time $t+1$ after receiving a cash dividend d_{t+1} . The value of the stock is V_t . According to the standard treatment in finance, the stock price P_t is:

$$P_t = V_t = \frac{E_t(d_{t+1})}{1+r} + \frac{E_t(P_{t+1})}{1+r} \quad (4.16)$$

where P_{t+1} is the stock price at time $t+1$, $E_t(\cdot)$ is investor expectation at time t , r is discount rate

If the stock matures at time $t+n$, its fundamental value F_t at time t is the sum of discounted present values of future expected inflows (dividends):

$$F_t = \frac{E_t(d_{t+1})}{(1+r)} + \frac{E_t(d_{t+2})}{(1+r)^2} + \dots + \frac{E_t(d_{t+n})}{(1+r)^n} \quad (4.17)$$

For the sake of simplicity we will assume that all investors within and across generations are homogenous in information sets, expectations, and behaviour.

Price P_t in equation 4.16 can take any value depending on $E_t(P_{t+1})$. A number of economists such as Shiller (1981) equates P_t to F_t . But how does the investor form expectations for $E_t(P_{t+1})$? According to Shiller, among others: investors form rational expectations. This means that they use all available information to form their expectations and know that the price equation 4.16 holds true for every period. Thus at time $t+1$ the price is:

$$P_{t+1} = \frac{E_{t+1}(d_{t+2})}{(1+r)} + \frac{E_{t+1}(P_{t+2})}{(1+r)} \quad (4.18)$$

The investor uses equation (4.18) to form his expectation of P_{t+1} :

$$E_t(P_{t+1}) = \frac{E_t(E_{t+1}(d_{t+2}))}{(1+r)} + \frac{E_t(E_{t+1}(P_{t+2}))}{(1+r)} \quad (4.19)$$

However, today's expectations of what agents in the next period will expect of $E_t(E_{t+1}(d_{t+2}))$, is the same as today's expectations about the future. Thus we rewrite (4.19) as:

$$E_t(P_{t+1}) = \frac{E_t(d_{t+2})}{(1+r)} + \frac{E_t(P_{t+2})}{(1+r)} \quad (4.20)$$

Equation (4.20) shows that investor needs to form $E_t(P_{t+1})$ in order to get $E_t(P_{t+1})$. By substituting (4.20) into (4.16):

$$P_t = \frac{E_t(d_{t+1})}{(1+r)} + \frac{E_t(d_{t+2})}{(1+r)^2} + \frac{E_t(P_{t+2})}{(1+r)^2} \quad (4.21)$$

We also need $E_t(P_{t+2})$ in order to get the current period price, P_t . Thus

$$P_t = \frac{E_t(d_{t+1})}{(1+r)} + \frac{E_t(d_{t+2})}{(1+r)^2} + \dots + \frac{E_t(d_{t+k})}{(1+r)^k} + \frac{E_t(P_{t+k})}{(1+r)^k} \quad (4.22)$$

where $k \leq n-1$. We can clearly see that P_t in (4.22) depends not only on the expectations of dividends for periods $(t+1)$ to $(t+k)$, but also on the expectations $E_t(P_{t+k})$ of prices at time $(t+k)$. However, this equation cannot be altered unless we assume a finite time frame of maturity. The security matures in finite time $(t+n)$. After paying dividend d_{t+n} , the stock value becomes worthless (See Shiller (1981)).

$$E_t(P_{t+n-1}) = \frac{E_t(d_{t+n})}{(1+r)} \quad (4.23)$$

Substituting equation (4.23) into (4.22), we get:

$$P_t = \frac{E_t(d_{t+1})}{(1+r)} + \frac{E_t(d_{t+2})}{(1+r)^2} + \dots + \frac{E_t(d_{t+n})}{(1+r)^n} = F \quad (4.24)$$

The stock price is determined through the investor recursively forming a series of $(n-1)$ rational expectations. This valuation process yields the standard textbook case when the price P_t is equal to the fundamental value of the stock, F_t . The investor will determine P_t by equation (4.22) in terms of the dividend stream, and the expectation of the price at

time $(t + k)$. Without the rational expectation's assumption, we cannot substitute the expectations of dividends after $(t + k)$ for P_{t+k} . In this case, the stock price determination process stops at equation (4.22), and therefore price P_t would not be equal to the fundamental value F_t . However, if the maturity of the stock extends indefinitely ($n \rightarrow \infty$). In this case, investors cannot use the terminal condition (4.23) even if they are able to create rational expectations far into the future.

Again equation (4.22) describes the prices, which are contingent on an undetermined terminal value. This price indeterminacy, arising from indefinite maturity, is called "rational bubbles" (see Blanchard and Watson (1982); Tirole (1982, 1985)).

While the stock price level of rational bubbles is indeterminate, the deviation of price from the fundamentals, defined as a price bubble, must satisfy some conditions over time. By subtracting (4.17) from (4.22) we will get:

$$E_t(P_{t+1} - F_{t+1}) = (1 + r)(P_t - F_t) \quad (4.25)$$

$$E_t(P_{t+k} - F_{t+k}) = (1 + r)^k (P_t - F_t) \quad (4.26)$$

As long as the bubble is defined as the different between the price and the fundamental, thus from equation 4.26 we get:

$$E_t(B_{t+k}) = (1 + r)^k B_t \quad (4.27)$$

That is, in a "rational bubble" the deviation of price from the fundamental value is expected to grow at the discount rate (see Flood and Hodrick (1990) and Hirota and Sunder (2001)). This is the first type of bubble we identify which is known as the 'Deterministic, Ever-Expanding Bubble', where the discount factor in equation 4.27 above $|r| < 1$ and B_0 is given. This bubble satisfies the following equation:

$$F_t + B_t = \frac{E_t(F_{t+1} + B_{t+1})}{(1+r)} \quad (4.28)$$

White (1990) also provides an alternative definition where rational bubbles reflect a self-fulfilling belief that an asset's price depends on variables other than the fundamentals. There are models of rational agents in which stock prices can deviate from their fundamentals. That is the stock prices can be higher than the present discounted value of future dividends, and such price deviations are called bubbles. (Campbell et al (1997)) provide a theoretical formulation for stock prices (P_t) and bubbles (B_t):

$$P_t = P_\alpha + B_t \quad (4.29)$$

where $P_\alpha = \sum \frac{CF_{t-i}}{(1+R_i)^i}$ and $B_t = E_t \left[\frac{B_{t-1}}{1+R} \right]$. From this we have P_α equal to the fundamental value, CF Cash flows, B_t rational bubble and $(1+R)$ interest rate or require rate of return

The fundamental value is assumed to equal the present value of future cash flows plus a rational bubble, and appears in the price only because it is expected to be present next period with an expected value of $(1+R)$ times its current value. (Campbell (1997)).

Note, their definition of a bubble is based on a number of famous episodes in financial history in which asset prices rose far higher than could be easily explained by fundamentals, and in which investors appeared to be betting that other investors would drive prices even higher in the future. They also noted that the adjective "rational" is used because the presence of B_t in (4.29) is entirely consistent with rational expectations. Thus recently, economists have suggested the existence of rational bubbles. Rational speculative bubbles allow stock prices to deviate from their fundamental values without assuming irrational investors. These bubbles are generated by extraneous events or rumours and driven by self-fulfilling expectations (see Blanchard (1979), Blanchard;

Watson (1982)). These theoretical studies on the possibility of rational bubbles in asset markets include Diba and Grossman (1988), Gilles and Leroy (1992), Shiller (1984) and Tirole (1982,1985).

The second type of bubble is known as the ‘Periodically Popping Bubble’, which follows the Blanchard and Watson (1982) model of a rational bubble as follows:

$$B_{t+1} = \begin{cases} E_{t+1} \left(\frac{1+R_{t+1}}{\pi} \right) B_t + \zeta_{t+1} & \text{with } \rightarrow \text{probability } \pi \\ \zeta_{t+1} & \text{with } \rightarrow \text{probability } 1-\pi \end{cases} \quad (4.30)$$

This bubble satisfies equation 4.28 above where π : In each period there is a probability π that the bubble will remain. $1-\pi$: Probability $1-\pi$ that the bubble ends and the market crashes. ζ_{t+1} : Noise error

Campbell et al (1997) see model above, provided that the shock ζ_{t+1} satisfies $E_t \zeta_{t+1} = 0$. The Blanchard and Watson bubble has a constant probability, $1-\pi$, of bursting in any period. If the bubble part of the price does not burst, it grows at a rate $\left(\frac{1+R}{\pi} \right)$, faster than R (the required rate of return on stocks) in order to compensate purchasers of the stock for the probability of bursting. A lower probability of the bubble continuing is associated with a higher rate of increase of the bubble part of the price if the bubble continues. When the bubble bursts, the expected growth rate of the bubble term is zero. Zero expected growth is then the equilibrium solution until another bubble begins.

However, Diba and Grossman (1988) argue “ the reason is that if the bubble ever has a zero value, its expected future value is also zero by condition $(B_t = E_t \left[\frac{B_{t+1}}{1+R} \right])$.

But since the bubble can never be negative on an asset that can be freely disposed of, it can only have a zero expected value if any realisation of a rational bubble in the future equals zero with probability one". Their bubble models are mostly infinite horizon models in which the bubble cannot restart if it has crashed. They define a price bubble as a deviation in the price of an asset from the price consistent with fundamentals.

4.4 Estimating Fundamentals

An asset has a bubble in its price if $B > 0$ in (4.31),

$$P_t = F_t + B_t + \varepsilon_t \quad (4.31)$$

where P is the price of the asset in time t , F is the fundamental Value of the asset in time t . B is the value of the bubble component in time t , and ε_t is an identically and independently distributed stochastic process (see Rosser (1997)).

The unspecified fundamental problem arises from the difficulty in identifying the true fundamental of any asset from a set of observable data. Underlying this, are serious problems in the theory of what the fundamental is, such as in the following:

- One definition of an asset fundamental is a competitive general equilibrium value for the asset (see Flood and Garber (1980)). A complication can arise here if there are multiple equilibria of this nature. In such a case, what appears to be a bubble dynamic might really be just a movement from equilibrium to equilibrium.
- For an asset earning a real return, the fundamental is identified with the present value of a rationally expected future stream of real returns, which is the sum of those returns properly discounted. Of course we can easily see how the unspecified fundamental problem can arise as there is no way to know for sure what the rationally expected stream of future returns is for most assets (See for example LeRoy and Porter (1981); Shiller (1981)) among others. However, for a non-income earning asset, it would be the sum of the discounted streams of rationally expected future net utilities.

Economists use different definitions of a "bubble" in their analytic work. The common element is that asset or output prices increase at a rate that is greater than can be explained by market fundamentals. See Kindleberger (1992). A price is above its fundamental value today simply because investors believe it will be higher tomorrow. However, the Japanese stock market in the late 1980s, and the U.S. stock markets in 1929 and 1999-2000 are usually described as driven by irrational, or non-rational, anticipations.

Having demonstrated how a bubble is a deviation from the market fundamental, we now look at the various possible methods of determining that fundamental.

4.4.1 Assets Fundamentals and Regime-Switching

Consider a simple asset-pricing model, which only requires:

$$P_t = f(X_t) + a.E_t(p_{t+1}) \quad (4.32)$$

where P_t is the logarithm of the asset price, E_t is the operator for expectations conditional on information at time t . $0 < a < 1$, a the discount rate and X_t is a vector of other variables.

By solving the equation (4.32) forward gives the general result of

$$P_t = \left(\sum_{j=0}^{T-t} a^j . E_t(f(X_{t+j})) \right) + a^{T-t+1} . E_t(P_{T+1}) \quad (4.33)$$

One solution to equation (4.32), which we will denote P_t^* , occurs when

$$\lim_{T \rightarrow \infty} a^{T+1} . E_t(P_{T+1}) = 0 \quad (4.34)$$

$$P_t^* = \sum_{j=0}^{\infty} a^j . E_t(f(X_{t+j})) \quad (4.35)$$

We refer to (4.35) as the fundamental solution, since it determines the asset price solely as a function of the current and expected behaviour of other variables. However, equation (4.35) is not the only solution to (4.32). We define bubble solutions to be any other set of asset prices and expected asset prices that satisfy equation (3.32) but where $P_t \neq P_t^*$. We define the size of the bubble B_t as:

$$B_t \equiv P_t - P_t^* \quad (4.36)$$

Note that since P_t^* satisfies equation (4.32), it follows (Blanchard (1979)) from (4.32) and (4.36) that

$$B_t = a . E_t(B_{t+1}) \quad (4.37)$$

Since $a < 1$, this means the bubble must be expected to grow over time. A considerable literature exists on the conditions under which such bubbles are feasible rational-expectation solutions. Important contributions to this debate include Obstfeld and Rogoff (1983, 1986), Diba and Grossman (1987), Tirole (1982, 1985), Weil (1990), Buiter and Pesenti (1990), Allen and Gorton (1991), and Gilles and LeRoy (1992). In single-representative-agent model, a truly rational agent cannot expect to sell an over-valued asset (one with a positive bubble) before the bubble bursts. Therefore, bubbles should exist in such models only if they can be expected to grow without limit. Some researchers, such as Froot and Obstfeld (1991), have therefore suggested interpreting empirical tests for bubbles as tests of whether agents are fully rational, or whether they exhibit some form of myopia instead, when considering events that are either very far in the future or very low in probability. An alternative interpretation would be to consider evidence of bubbles as suggesting that non-representative-agent models (such as those of

De Long et al. (1990), Allen and Gorton (1991) or Bulow and Klemperer (1994)) are required.

Nothing in the above model has any implications for regime switching. Some of the early literature on rational speculative bubbles considered purely deterministic bubbles. Regime-switching stems from the descriptions of asset market behaviour (for example, those surveyed in Kindleberger (1989)) to which the above model of bubbles is often applied. The first example of regime switching in the rational speculative bubble framework is Blanchard (1979), who proposes that a bubble that moves randomly between two states, C and S . In state C , the bubble will collapse, so¹⁹

$$E_t(B_{t+1} | C) = 0 \quad (4.38)$$

state S , where the bubble survives and continues to grow, occurs with a fixed probability q . Since

$$E_t(B_{t+1}) = (1 - q) \cdot E_t(B_{t+1} | C) + q \cdot E_t(B_{t+1} | S) \quad (4.39)$$

It follows from (4.36) that

$$E_t(B_{t+1} | S) = \frac{B_t \cdot (1 + r)}{q} \quad (4.40)$$

This model was subsequently generalized by Evans (1991) and Norden and Schaller (1993) to consider the case where both the size of collapses and their probability were functions of the size of the bubble. For more details see (Norden and Vigfusson (1996))

¹⁹ The notation $E_t(X_t | C)$ (or $X_t | S$) denotes the expectation of X_t , conditional on the fact that the state at t is C (or S) and on all other information available at time t .

4.5 The Stock Market Crash and Bubble Busting

As discussed earlier, the asset bubble refers to rising asset prices, and in particular stock prices, which escalate further than the economic fundamentals. This becomes an area of concern, as bubbles often, if not always, tend to burst. The burst is often sudden, and when it does occur, share prices can collapse very quickly, an effect that can actually impose detrimental consequences on the economy, and hence force the economy into a recession, such as was demonstrated in technology stocks on the NASDAQ (Chapter 2) which rose to unprecedented levels during the two years leading up to March 2000. They were immediately followed by a drastic decline the year thereafter. Ofek and Richardson (2001) estimate that, at its peak, the entire internet sector, comprising several hundred stocks, was priced as if the average future earnings growth rate of these firms would exceed the growth rates experienced by some of the fastest growing firms in the past, and, at the same time, the required rate of return would be zero percent for several decades. By almost any standard, such valuation levels are so outrageous that this period appears to be another episode in the history of asset pricing bubbles (see Brunnermirmir and Nagel (2002)).

The recent boom and bust in high technology stocks, as well as the ensuing recession thereafter, raises the imminent question: 'Could this possibly have been an observed pattern before?' Financial history is replete with stock market crashes and the business cycle goes back at least to the first Industrial Revolution in the mid-eighteenth century. The record suggests that while not all stock market crashes are proven to be associated with recessions, many are. The record also suggests that most stock market crashes are not associated with the collapse of productivity booms, but rather with monetary instability and political events such as wars. However, there have been a few earlier historical episodes, which may have resonance for today (see Bordo (2003)).

Initially, we documented some evidence from historical experiences in the United States for the past two centuries on stock market crashes, recessions, and possible productivity

boom busts. We then considered several factors that are more likely to propagate stock market crashes.

4.5.1 The Stock Market Crash

The United States has had about 20 stock market crashes in the past two centuries and most have been associated with recessions. Also, before 1933, many of these were associated with banking panics and severe financial distress. Indeed, a well-known phenomenon in United States' macro history is that serious financial instability characterized most severe recessions (Zarnowitz (1992)).

In the first step of our investigation into the stock market crash we look at the Figure 1.1 in chapter 1, developed by Robert Shiller which incorporates the monthly real Standard and Poor's 500 Composite Stock Price Index from January 1871 to through January 2004, (data from Shiller's web site. As it can be clearly observed from the Figure, the sharpest increase in stock prices, which was followed by a subsequent sharp decline, appears in years 1901, 1929, 1966 and 2000.

Table 4.1 below presents the statistical record, as well as a brief explanation associated with each crash. We show evidence of stock market crashes (column 1) defined as a 20 percent or higher decline in prices from peak to trough (See Mishkin and White (2002)). Indications as to the cause or causes of the crash, e.g., war (column 2); recessions that coincided with stock market crashes, defined as one or more years of a decline in real GDP, (see WEO April 2002 Chapter III) (column 3); stock market booms (changes from preceding to succeeding peak) (column 4); an indicator of banking crises (column 5); and an indicator of severe financial distresses (column 6) based on an 'Index of Financial Stability'

Table 4.1. Stock Market Crashes, Booms, and Recessions. United States, 1800–2000 (continued)

Episode	(1)				(2)	(3)		(4)				(5)	(6)
	Crashes				Major Causes	Recessions		Preceding Booms				Banking Panic	Severe Financial Distress
	Stock Price Changes (In percent)							GDP Contraction			Stock price changes		
	Peak	Trough	Nominal	Real ¹		Peak	Trough	In percent	Previous Peak	Peak	In percent		
	United States												
(1)	1809	1814	-11.4	-37.8	War	1811	1812	-1.6	--	--	--	1804	--
(2)	1835	1842	-50.6	-46.6	Bank War	1836	1837	-2.0	1828	1835	57.2	1837	1837
						1839	1840	-6.4	--	--	--	1839	--
						1841	1842	-1.0	--	--	--	--	--
(3)	1853	1859	-50.6	-53.4	Railroad Boom	1857	1858	-8.6	--	--	--	1857	1857
(4)	1863	1865	49.9	-22.5	Civil War	1864	1865	-6.2	1860	1863	20.5	--	--
(5)	1875	1877	37.7	-26.78	Railroad Boom	--	--	--	1863	1872	50.5	1873	1873–74, 76
(6)	1881	1885	-26.7	-22.2	Railroad Boom	--	--	--	1875	1881	51.3	1884	--
(7)	1892	1894	-21.0	-16.4	Silver agitation	1892	1894	-3.0	--	--	--	1893	1893 1894 1896
(8)	1902	1904	-16.3	-19.4	Rich man's panic	--	--	--	1899	1902	29.9	--	--
(9)	1906	1907	-19.4	-22.3	World Financial Crisis	1906	1908	-6.9	--	--	--	1907	--
(10)	1912	1914	-15.5	-17.6	War Scare	1913	1914	-7.6	--	--	--	--	--
(11)	1916	1918	-20.4	-42.5	War	1916	1917	--	--	--	--	--	--

Table 4.1. Stock Market Crashes, Booms, and Recessions. United States, 1800–2000 (continued)

Episode	(1)				(2)	(3)		(4)				(5)	(6)
	Crashes				Major Causes	Recessions		Preceding Booms				Banking Panic	Severe Financial Distress
	Stock Price Changes (In percent)							GDP Contraction			Stock price changes		
	Peak	Trough	Nominal	Real ¹		Peak	Trough	In percent	Previous Peak	Peak	In percent		
(12)	1919	1921	-22.0	-24.5	Disinflation, disarmament	1918	1921	-8.3	--	--	--	--	--
(13)	1929	1932	-73.4	-66.5	Roaring 20s and policies	1929	1933	-29.7	1922	1929	201.8	1930 1931–33	1931 1932
(14)	1936	1938	-25.7	-27.0	Tight Monetary Policy	1937	1938	-4.5	--	--	--	--	--
(15)	1939	1942	-28.1	-38.8	War	--	--	--	--	--	--	--	--
(16)	1946	1949	-10.8	-27.1	Post war slump	1944	1947	-22.7	--	--	--	--	--
(17)	1968	1970	-15.7	-24.4	Bretton Woods	--	--	--	--	--	--	--	--
(18)	1972	1975	-24.1	-38.7	Oil shock	1973	1975	-0.6	--	--	--	--	--
(19)	1976	1979	1.0	-20.9	Oil shock	--	--	--	--	--	--	--	--
(20)	2000	2002	-27.7	-30.8	Information Technology boom	2001 ²	--	-0.5 ²	1993	2000	165.2	--	--

Data Sources by column.

Bordo, Michael D (2003.p6-7)

¹ Stock market crashes, including their peaks and trough, were determined on the basis of real stock prices. In a few cases peaks and trough in nominal stock price differed from those for real stock prices. The changes in nominal stock prices are based on peaks and troughs of real stock prices.

² The Business Cycle Dating Committee of the National Bureau of Economic Research (NBER) determined that a recession began in 2001 Q2. In the absence of a date for the end of the recession, the GDP contraction covers the period 2001 Q1 - 2002 Q3, when level declines were recorded.

4.6 Discussion

This discussion attempts to highlight prominent stock market crashes in the history of the United States. Table 4.1 and graph 1.2 will also be used to do this. The post Civil War era was characterised by rapid growth, particularly of heavy industry, and the opening up of the west. Two major episodes of crashes and recessions: 1892-94 and 1906-08 seem mainly to be offshoots of a number of events: Political and monetary instability, the free silver movement of the 1890's, international events and possibly, the aftermath of the 1906 San Francisco earthquake from 1906-08. Banking panics featured in both these episodes.

The USA in the 1920's. This period holds the most resonance for today is the time from 1928-33. The 1920's was to experience a major stock market boom associated with massive investment that brought major inventions of the late nineteenth century to fruition. These included: electricity, automobiles, communications, and petrochemicals, which many believe, were responsible for a great surge in productivity that lasted through much of the century. See Gordon (2000), David and Wright (1999). However, White, (1990, p.169) argues, "While Blanchard and Watson believe that bubbles are less likely to appear in blue-chip stocks, the stock market of the 1920s displayed characteristics conducive to the emergence of bubbles. Fundamentals were difficult to assess because of major changes in industry. In the automobile industry, there was an abrupt shift from the dominance of the Ford Motor Company to General Motors (GM) with its multidivisional system of modern management aimed at reaching all market segments. While investors had every reason to expect dividends to grow, they lacked the means to evaluate the future path of dividends easily. The same was true for the RCA, which was a highly successful firm in a new industry whose technology was changing rapidly." In addition, White, (1990, p. 179) argues, "The spectacular rise and collapse of the stock market in the 1920's is one of the premier examples of an asset bubble. The central question of whether volatile movements in asset prices reflect changes in fundamentals or speculative bubbles, remains critical. A speculative bubble drove stock price movements where fundamentals played an initiating role. The Federal Reserve, rather than letting the

boom run out of steam, attempted to slow its advance. Tighter monetary policy did not directly stop stock price from rising; instead it helped to push the economy into recession. The market responded to the downturn and the bubble burst, sending an additional shock to the weakening economy.”

Galbraith (1954) selects March 1928 as the month when the stock market began its ascent. At that time, the New York Stock Exchange had two dominating stocks, namely General Motors and RCA, and even when the market crashed on October 24, 1929, these stocks had the highest volumes on the NYSE. He emphasises the element of irrationality; the public’s hysterical eagerness to participate in and profit from the bull market, followed by panic and selling when prices began to drop. He argues that the stock market bubble was formed during the long period of sustained economic growth of the twenties when unemployment was low and the price level was stable. This produced a climate of rarely equaled in faith, of economic expansion and eliminated any caution residing from World War I and the post-war recession. Investors were drawn to the stock market as a result of the Florida land boom collapse of 1929, which first began to rise in early 1928. The belief that stock prices would climb steadily, modified investor behavior. Those who had followed a buy-and-hold strategy began to speculate and those who had never bought stock before were drawn into the market. Galbraith further argues that the market’s rise depended on “the vested interest in euphoria that leads individuals and institutions to believe that all will be better off and that they are meant to be richer.”

Kindleberger (1989) also describes this situation by illustrating that each investor, consumed by “pure speculative instinct”, presumed he could ride the market up and get out before it collapsed, unaware of the fallacy of composition that this reasoning entailed, i.e., The belief that what is true for an individual investor is also necessarily true for all investors as a whole.

In this dominant explanation of the boom, Kindleberger and Galbraith contend that the rise in stock prices was fuelled by an expansion of credit in the form of brokers’ loans that encouraged investors to become dangerously leveraged. In addition,

investors were inclined to believe anything. This naivety allowed for widespread financial fraud to take place. The vertical price drops of Black Thursday, and Black Tuesday, October 24 and 29, 1929, forced margin calls and distress vending of stocks, forcing a further plunge in prices. Friedman and Schwartz (1963) argue that when the stock ticker ran late as prices fell, investors became alarmed and sold their holdings. In the following weeks and months, the market, driven by the depression, bounced downwards erratically. This might have been a driving force behind the depression in itself. White argues that easy credit in the form of loans to brokers is partly responsible for encouraging people to speculate, but growth of this easy credit seems strange at a time when the Federal Reserve was pursuing a tight monetary policy. Regulations preventing banks from investing directly into industry diminished their traditional role as intermediaries, they then turned to assist the public in buying equities. Although the bull market of the 1920's is widely regarded as a pure bubble, virtually all contemporary observers and historians are willing to admit that at least some fraction of this spectacular rise in the market may be attributed to real factors. He notes that there was a belief that the new level of prices in the stock market was the product of economic fundamentals.

Even after the crash of 1929, Fisher of Yale retained his conviction that the rise in stock prices was justified and wrote "My own impression has been that the market went up principally because of sound, justified expectations of earnings, and only partly because of unreasoning and unintelligent mania for buying." (Fisher (1930))

Nonetheless, White argues that the 1929 stock boom was partly generated by the public's belief that dividends would be rising more rapidly than they actually did. The beginning of the bubble in the market may thus be traced back to the jumps in earnings that companies like General Motors experienced in early 1928. This created very optimistic expectations of future dividends. The exceedingly optimistic forecasts helped to get the bull market started, but they do not explain the full rise in prices. Even if the dividends had grown at the rate predicted, they would not have approached the increase in prices. A rapid recovery of earnings after the 1927

recession and a change in fundamentals may have initiated the boom, but fundamentals did not sustain it.

The ascent of the stock market was not justified by any forecast of dividends and the continued disappointment of unrealised dividends and the public statements of some managers did not slow down the rise in stock prices. This leaves the greater part of the boom to be explained and one favoured candidate is easy credit. Many contemporary observers and economic historians agree that the expansion of call loans or brokers' loans provided the means for the speculative mania to gather speed. Galbraith sees the ability to purchase stock on margin as a great speculative temptation and the volume of brokers' loans is a good index of the volume of speculation.

Even Irving Fisher, who believed that the market was, essentially sound, wrote the following: "Undoubtedly the contagion of the long bull market had encouraged unwise speculation. But the main trouble was that so much borrowed money was used." Kindleberger argues that the expansion of stock market credit was a key element in the generation of speculative mania.

White notes, however, that one problem presents itself to Galbraith, Kindleberger and others who have focused on the flow of funds to the stock market as a cause of the boom. He found that after 1928, the call rate the principal rate for brokers' loans started to increase more sharply than the discount rate, whereas they were directly related during 1926 and 1927. This suggests that it was the rising wave of speculation that attracted funds and not any independent credit creation.

The 1990's Stock Market Bubble: In the late 1990's, the U.S. economy experienced an asset-price bubble while enjoying a combination of low inflation and sustained real GDP growth driven by revolutionary advances in information technology. This experience demonstrates that if the economy has sound macroeconomic fundamentals, any turmoil affecting the financial sector, in particular asset markets, can have negligible implications for the real sector. The stock market driven by high technology companies started to boom in 1995 and reached a peak in March 2000 before collapsing, without any significant macro implication to the real sector. It only

mildly reduced investment and consumption. It eased monetary policy from July 1995 until November 1998 when it lowered the federal fund's rate by 125 basis points to mitigate any systemic risk the economy may have incurred due to the collapse of the hedge fund LTCM and the Russian default in 1998. It then took preemptive action by raising the fund's rate 175 base points between June 1999 and May 2000 to suppress any inflationary pressures that would have otherwise threatened the economy.

However, Greenspan (1999) argues that during the 1995-99 period, the US economy was experiencing lower and sustainable levels of inflation. He also contends that the revolution in information technology helped to produce an increase in labour productivity. This in turn lowered unit labour costs which, together with falling import prices, helped to contain any inflationary pressures. However, he further maintains that the real income growth in the form of higher sales of consumer goods, new homes, capital equipment and net exports was not matched by equal growth in the labour force, i.e., The labour market was tight in the sense that employment opportunities were growing in excess of the number of available workers.

He further argued that capital gains in the stock and housing markets increased consumer wealth and that this was perceived as an increase in their permanent income. This in turn created additional purchasing power without any additional increase in the production of goods or services. Consumer spending increased accordingly to grow twice as fast as disposable income. Also, investors perceived the rising growth in productivity as a good sign for long-term corporate earnings. This led to a rise in stock prices and the market value of assets held by households. The higher stock prices lowered the cost of equity capital and resulted in capital spending increases and investment. Hence an increase in aggregate demand components mainly consumption and investment in the goods market over productivity gains on the supply side of the economy. The tight labour market that was characterised by a shortage of labour put upward pressure on the price of labour and threatened higher inflation.

Monetary policy always operates with a significant lag as it usually takes 6-9 months to realise its effects through its standard interest rate channels on economic activities. In consequence, the Fed decided to adopt a pre-emptive tightening policy. This was done in order to stabilize the economy and balance its aggregate demand with its potential supply by raising the funds rate by 175 base points during the period June 1999 to May 2000.

Regarding the US stock market, and looking at P/E (the inverse of equity earnings yield, that measure the expected real return on equities) and equal earnings per share over the stock price will show that, if stock prices go up then earnings per share relative to stock price will go down and P/E will go up. Shiller and Campbell (2001) argue that while the observed P/E for the S&P 500 index in 2000 was 29.6, the average P/E was 14.5. However, Siegel (1998) argued that such an historical average of P/E corresponds to an historical average for expected real return of 7 percent. This expected requisite rate of return on stocks combined with a prospective dividend growth rate of 1% per year would give a warranted P/E of 14.3 ($0.01/0.07$), which is close to its average value.

By looking at US data from the *Economic Report of the President* it can be argued that the sharp rise in stock prices was, in part, justified by changes in fundamentals such as corporate profits, interest rates and dividend growth. Corporate profits grew rapidly over the 1990s but not as much as stock prices. It? increased sharply from 345bn in the year 1993 to 451.9bn in 2002 after taxes. At the same time, the yield on treasury bonds adjusted to inflation with ten-years maturity remaining relatively unchanged within the range of 4.61 to 6.57 percent. Furthermore, the dividends were growing mildly, except for a slight decline in the year 1999 worth \$20.3bn.

The Emergence of the Bubble: The bull market began in 1995 and continued until 1995 – 2000, with a cumulative total return of nearly 200 percent, or 24 percent per year on average. This rendered the bull market the strongest one since the 1930s. The excess return of stocks over bonds, i.e., The equity premium averaged about 7.3

percentage points. High technology sectors like Internet related stocks captured most of the stock gains.

During the same period under investigation, the technology-laden NASDAQ index grew at nearly the same rate as the global S&P 500, but in 1998-99, its growth rate of about 86 percent was four times as large as that of the S&P 500, which was about 20 percent. The average of Internet-related stocks increased about 160 percent per year during the same period and by the end of 1999 the market value of U.S. stocks was over \$17 trillion while it was less than \$7 trillion at the end of 1995. The importance of what is called the “New Economy” technology stocks, and particularly Internet stocks, showed spectacular gains in 1998-99. Market capitalisations of Internet companies increased from \$145bn in December 1997 to \$1.6 trillion in December 1999. Internet stocks alone accounted for about 23 percent of the total increase in stock market affluence over that period.

The Internet Bubble: In the more recent Internet bubble there were many similarities to railway mania and 1929 bubbles. The new economy and benefits of fresh technology were touted. As documented by Cooper, Dimitrov and Rau (2001), the simple addition of ‘dot-com’ to a company’s name was sufficient for it to become the object of speculation. Unusually long expansion through the 1990’s was taken as evidence that the business cycle had been tamed. Indeed, some people claimed that, in the long term, shares were a safer investment than bonds, a notion redolent of the vogue shortly previous to the 1929 crash¹⁹. The rise in technology-stocks was frequently justified by claims that the old rules of business no longer applied to these firms, a surprisingly familiar refrain. In particular, traditional valuation methods could not support the prices being paid for the stocks because few of the firms involved had ever paid a dividend. Companies with the most vague business plans were floated on stock exchanges at huge premiums to the underlying capital. Technology stocks generally reached remarkably high prices, e.g., Amazon.com was valued at US\$26 billion at the end of 1999, approximately 10 times the combined value of their

¹⁹ Chancellor (1999, p 194) provides a summary of the relevant work (EL Smith (1924), *Common stocks as long term investments*, McMillan, New York) and their effect on investors at the time.

traditional 'bricks and mortar' competitors, Borders and Barnes & Noble²⁰ (Ofek and Richardson (2003)).

The clearest measure of the bubble is given by the tech-laden NASDAQ stock index. Graphing the NASDAQ against the S&P 500 index shows that both grew at around the same rate from 1995 to late 1998. Figure 4.1 suggests that the bubble may have started around the beginning of 1999 and enjoyed its greatest growth from **November 1999** to the middle of March 2000, over which time the NASDAQ index grew by 70 percent²¹

The collapse of share prices from March 2000 was fairly rapid and, similar to 1929, there was no real and obvious trigger for the collapse²². By March 2001 the NASDAQ was once again level with the S&P index and has remained there since.



FIGURE 4.1 US SHARE PRICE INDICES, SOURCE: RBA

(See John Simon (2004, p.15)

²⁰ At the end of 2001 the difference had fallen to 15 per cent due to a fall in Amazon's market capitalisation to US\$4 billion, and a rise in the market capitalisation of Borders and Barnes and Noble.

²¹ Because the S&P 500 included a number of tech stocks, the bubble would have affected it too. Thus, this figure should not be seen as quantifying the size of the bubble in any way.

²² Ofek and Richardson (2003) suggest that the collapse was triggered by the expiration of lock-up clauses that allowed insiders to finally sell their stock.

We now approach the question of the nature of a bubble as one of classification. By considering enough examples presented in this chapter, it should be possible to identify the common features of all the episodes and thereby arriving at a practicable definition. To start with the primary factor that draws our attention to bubbles is their quintessence; high prices rise and how low they fall. All bubbles involve a rapid price rise and then fall. However, considering the 'bear trap' rally on the US market in 1929 or the NASDAQ in 2000, it is clear that the 'pop' does not necessarily occur all at once. Bubbles have their genesis in some fundamental change. This is commonly the development of some 'new' phenomenon. For railways, it was new transportation technology. For the technology stocks it was the Internet and computers. This 'new' element is also what frequently allows the bubble to grow to spectacular proportions the high level of uncertainty about the implications of new technology means that very high valuations can be entertained. Nonetheless, new technology is not a prerequisite for bubbles, and speculative attention can be turned to almost anything Kindelberger (2000: 41-43) provides a list that includes metallic coins, tulips, commodities, and foreign exchange among many others. Bubbles occur when the initial reason for investing becomes subsumed in a general demand for assets whose prices have risen in the past, regardless of the initial reason for the rise (John Simon (2004)).

Chapter 5

5.0 Conclusion and Recommendations

5.1 Conclusion

The purpose of this dissertation is to provide an investigation into the nature and presence of bubbles in the financial market. Our investigations started by examining and highlighting the causes of the dramatic rise and sudden falls prevalent in the technology industry during the 1990s and in the NASDAQ stock market in early 2000. The first analysis focuses on a familiar model of the PV test. see Shiller, (1981). It studies the relationship between actual price and fundamental value. We applied this test in terms of the simplest efficient markets model that defines market fundamentals to be the expected present value of dividends, discounted at a constant rate, and defines a rational bubble to be a self-confirming divergence of stock prices from market fundamentals in response to extraneous variables. We started with this test because the EMH is the foundation for most models used to explain the behaviour of asset prices. see Fama, (1970) among others. Our results show that the market was not efficient and that stock prices are driven away from Fundamentals. Nevertheless, it is difficult to apply the standard efficient market hypothesis or efficient markets theory to understand the stock market bubble that ended in 2000 and collapsed thereafter because, the Rational expectations theory is the basis for the efficient market hypothesis and efficient markets' theory. If a security's price does not reflect all the information about it, then there exist "unexploited profit opportunities": Someone can buy or sell the security to make a profit, driving the price toward equilibrium in so doing. In the strongest versions of these theories, where all profit opportunities have been exploited, all prices in financial markets are correct and reflect market fundamentals, such as future dividend streams in our test. Each financial investment is as good as any other, while a security's price reflects all information about its fundamental value. However, this theory did not reflect on our results, because some models in financial economics rely on the existence of traders who are unable to fully exploit available information. Somehow, these people fail to behave optimally. They are called "noise traders". When there are many noise traders, the market is more liquid in the sense of having frequent trades that allow people to

observe prices. On the other hand, the price of the stock reflects both the correct information as far as informed agents are concerned as well as distortions generated by noise traders. The more noise trading, the less information gets into prices, and therefore the less efficient the market is. In other words, our results prove that NASDAQ stock prices are rationally deviant from fundamental values. Our use of the word “rational” emphasizes the fact that the existence of the bubble is held to be consistent with rational expectations and constant expected returns independent of past information.

Here the stock price is equal to its fundamental value plus a rational bubble term. Because rates of return on assets with bubbles are governed by the same principles that determine returns on all assets, and because return is equal to dividend yield and capital gain it follows that part of the current value of an asset with a bubble reflects nothing more than the fact that the asset's value is expected to rise in the future, independent of dividends over any finite horizon. This definition implies that a high and growing price is unjustifiable and does not relate to earning capacity. This is a result of investors who buy with the sole purpose of selling quickly to other investors at a higher price. When these beliefs are self-fulfilling, we can define the bubble as a phenomenon driven by psychological factors i.e., a self-fulfilling prophecy. Furthermore, because investors buy and sell very quickly, and do not look at other factors determinate to the value of the stock such as the dividends and interest rate; they consequently create a big noise in the market, which reflects an inefficient situation in terms of information flow into the market. In this case only the demand and supply on a certain type of stock will determine its price. Bubbles are still the same, imply a self-fulfilling prophecy where the existence of abnormally high demands on certain stocks at a certain time will generate high prices. If this demand drops dramatically, it will cause the prices to crash. The higher noise-trader demand, the higher current prices are. Sharp increases and sudden crashes are generated by noise traders who do not respond to expected returns optimally forecasted. Say that they overreact to certain and uncertain news. In other words, they generate existents of uncertainty about the future of the current state of their investments. This type of uncertainty affects the beliefs of agents, for example, the agents believe that market prices will increase. They thus buy very quickly generating high prices, if not the price will decrease. They make quick sales that generate sharp decreases in price. The

uncertainty occurring when fundamentals are the same in all states is known as extrinsic uncertainty. Chapter 3 saw the introduction of the sunspot equilibrium or extrinsic uncertainty. The concept of sunspots is employed as a modeling device to study whether an economy is prone to self-fulfilling fluctuations. In that chapter we presented some of the foundational issues of sunspot equilibria. First, the simplest environment of finite economies as in the theory of Cass and Shell (1983), and Goenka and Shell (1997). Where, in standard general equilibrium theory allocations, prices may differ across the states of nature? Cass and Shell pose the following question: If preferences and endowments are identical across states, in an exchange economy, there can be an equilibrium in which allocations are different for at least one household? If the answer is yes then they say that sunspots matter. The result depends on the assumption that some agents are unable to participate in insurance markets. Our investigation then extended to economies with incomplete markets, as the theory by Cass (1989), among others demonstrated. Incomplete markets mean that the set of financial instruments is not rich enough to transfer wealth across all possible states of nature. Incomplete participation means that not all agents are able to participate in the securities markets. However, if the markets complete with participation, the economy is identical to a standard Arrow-Debreu exchange economy in which all equilibria are Pareto optimal. Sunspot equilibrium cannot be Pareto optimal since risk averse agents would prefer a safe allocation to a random one. Since all uncertainty is extrinsic; the safe allocation is feasible. It is therefore not possible for sunspot equilibrium to exist. We then extended the analysis to dynamic economies in which we covered the theories of Azariadis (1981) and Azariadis and Guesnerie (1986). This theory follows a stationary Markov chain, with two possible states a (sunspot) and b (no sunspot) Assume that for some reason, the agents of the economy believe that a perfect correlation between the price that clears the market and the state of the sunspot exists. Specifically, they believe that whenever the process is in state a , then the price is necessarily P_a ; whenever it is in state b , the price is necessarily p_b . When these beliefs are self-fulfilling, they define a rational equilibrium; if $P_a \neq P_b$. This is indeed sunspot equilibrium. However, as was discussed earlier, in determining sunspot equilibrium we could not surely clear the market price of tomorrow now, because the future price depends on expectations and sunspots as well as the possibility of an incomplete market. However, we can only

clear the market in the current period of time, and expect for future prices that are more likely to clear the market tomorrow. And when tomorrow comes, the prices might be deferent from that we expect them to be. For example, if we expect the stock price of the company 'Yahoo' to increase from 10 to 12, next month, and we clear the market today, based on this expectation of future prices. When next month comes, if our expectations were true then the sunspot equilibrium and the rational expectations are indeed rational bubbles. However, if our expectations of future prices were not true, then the new prices will determine the creation of equilibrium and these prices are indeed generated by irrational expectations. In this stage we were confident to say that, bubbles are distinguished from sunspot equilibria, defined as equilibria in which prices and allocations depend on the realization of random variables not related to the fundamental of preference, technology or information. However, Kindleberger (1987) defined the bubble as a sharp rise in the price of an asset or a range of assets in a continuous process, with the initial rise generating expectations of future rises, thereby attracting new buyers, generally speculators, interested in profits from trading in asset rather than its use or earning capacity". This definition implies that, in a bubble, the price of the asset deviates from its "fundamental value", and that a reversal of expectations and sharp decline in prices, a crash, would usually occur. However, bubbles may be rational to the extent that changes in asset prices may be self-fulfilling, or, to put it differently, "sunspots" may be continuously incorporated in market expectations. Generally speaking, bubbles are hard to spot because their fundamental value depends on the discounted expected future flow distributions (real flow distributions as earnings or dividends). All we observe are past distributions and prices. So, how can the past predict the future? There are two possible answers to this question: Firstly, nothing has changed and the past is a good guide to the future. Secondly, something has changed and the past is not a good guide to the future. If something has changed, then either, it is tastes that have changed and/or, technology. . Regarding changing tastes, Glassman (1999) says that stocks are no riskier than long maturity bonds. So the risk premium on stocks should equal the risk premium on bonds that he claimed were dropping. As the risk premium drops, the fundamental value of the stocks increases. In the case of technological changes many including Craine (1993), an increase in productivity results in an increase in the growth rate of earnings. If growth increases, the fundamental value of stock increases. However,

Shiller (1988) believes that nothing has changed. Shiller says low price dividends or earnings' ratios relative to the historical averages indicate a bubble.

There are a number of tests that have been proposed for exogenous rational bubbles (see chapter 4). One such test is that proposed by Tirole (1985) using the Diamond Model in the Overlapping Generations Model (OLG). If there is no bubble, prices and dividends will grow at the same rate. If price (P_t) grows faster than dividend (D_t), this may indicate the presence of a bubble (B_t). The existing evidence points to the need for more sophisticated tests for the case where there are periodically collapsing bubbles. Nevertheless, there are other types of bubbles called Intrinsic Bubbles. So far we have looked at bubbles, which are exogenous to fundamentals. In the case where there are alternative solutions to the Euler equation. On the other hand, intrinsic bubbles are distinguishable because they depend, in a non-linear deterministic way, on the fundamentals. They depend, for instance, on the level of real dividends. Therefore, if the fundamentals remain constant, so does the bubble element. If dividends are persistent, the bubble element will also persist. This can cause stock prices to over-react to changes in fundamentals (see Froot and Obstfeld (1991))

In summarizing the key points pertaining to rational bubbles be they exogenous or intrinsic, we note the following:

- Rational bubbles arise as a solution to the Euler equation in the absence of transversal conditions. They also culminate in Martingale Processes.
- Where a rational bubble exists, stock returns remain unpredictable and therefore we cannot use standard orthogonal tests to detect them.
- An exogenous bubble, which represents early bubble literature occurs independently to fundamentals. The models also only give their time path. In other words, the process generating bubbles is independent of the process generating fundamentals.
- A major problem is that it is very difficult to distinguish empirically between bubbles and other phenomena. This applies particularly to stochastic bubbles.

For instance, if a bubble bursts during the sample, it would result in asset prices, which rise, then drop. An analyst would not necessarily interpret such a pattern as indicating rejection of cointegration so the bubble would be undetected. A variety of

other phenomena could cause price behaviour similar to that caused by bubbles. It is difficult to devise tests that distinguish those from bubbles.

- Tests for the existence of rational bubbles, in general price level, equity market or the foreign exchange market are inconclusive. None of these presents any compelling evidence for the presence of rational bubbles.
- The theory of rational bubbles has an important weakness in that it provides no clue as to what circumstances initially give rise to bubbles or what events lead to their collapse.
- Intrinsic bubbles also satisfy the Euler equation but depend, in a non-linear deterministic way, on the fundamentals.

5.2 Recommendations

Although there are theoretical and empirical problems with rational bubbles, there is much to be learnt from studying them. At the very least we can see how it is possible to obtain large and persistent swings in prices with only small effects on expected returns in any one period. In the extreme case of rational bubbles, price movements are so persistent that they have no effect on expected returns at all. Moreover, these large swings may not be due only to 'irrational' behaviour, as is commonly implied. However, part of the reason for the failure to exploit bubbles seems to stem from greed. Investors who believe that assets are over-priced want to generate profits from the bubble. This is partly due to the difficulty associated with determining when a bubble will burst. Overvalued assets may become even more exorbitant. These overvaluations can stretch over years. I believe that the role of psychological behaviour and its impact on modern finance theory can no longer be ignored.

References

- Abel, N. Mankiw, L. Summers and R. Zeckhauser, (1989). "Assessing dynamic efficiency: theory and evidence". *Review of Economic Studies* 56: 1–20.
- Abreu, D and Markus K. Brunnermeier, (2003). "Bubbles and crashes". *Econometrica*, 71:173-204.
- Aggarwal, R. and D. Schirm (1995). *Global Portfolio Diversification: Risk Management: Risk Management, Market Microstructure and Implementation Issues*. San Diego: Academic Press. Inc.
- Allen, Franklin and Gary Gorton. (1991). "Rational Finite Bubbles". Working Paper No. 3707. *National Bureau for Economic Research, Cambridge*.
- Arrow, K. and Debreu, G. (1954). "Existence of an Equilibrium for a Competitive Economy". *Econometrica*. 22: 265-290.
- Aumann, R. (1974). "Cooperative Games with Coalition Structures". *International Journal of Game Theory*, 3: 217-237.
- Azariadis, C, and Guesnerie, R. (1982). "Prophéties Créatrices et Persistence des Théories". *Rev. Economique*, 33: 787-805.
- Azariadis, C, and Guesnerie, R. (1986). "Sunspots and Cycles". *Review of Economic Studies*, 53:725-736.
- Azariadis, C. (1981). "Self Fulfilling Prophecies". *Journal of Economic Theory*. 25: 380-96.
- Badar, (1997). "Lecture notes: Econ 8102 Microeconomic Theory II". *University of Minnesota*: 30-39 (Online)
<http://www.econ.umn.edu/~kemal/academic/Files/8102.pdf> 2, Oct 2004.
- Balasko, Y. (1983). "Extrinsic risk revisited". *Journal of Economic Theory*, 31: 203 - 210.
- Balasko, Y. (1990). "Equivariant general equilibrium theory". *Journal of Economic Theory* 52:18- 44.
- Balasko, Y. and K. Shell. (1981). "The Overlapping Generations Model, II: The Case of Pure Exchange With Money". *Journal of Economic Theory*. 24: 112-142.
- Balch, M .L. McFadden and S. Wu. (1974) *Essays on Economic Behavior Under Uncertainty*, eds., (North Holland). Coauthor, "Some Introductory Remarks on Behavior Under Uncertainty,".

- Barberis, N. (1998). "Markets: The Price may not be Right". In *Complete Finance Companion: Mastering Finance*. London: Pitman Publishing.
- Barro, R. (2000). "Is the Market too high or too low? Maybe a little of both" *Business Week Economic Viewpoint*; No. 3684: 32.
- Bekaert, G., and G. Wu. (2000). "Asymmetric Volatility and Risk in Equity Markets". *Review of Financial Studies*, 13: 1- 42.
- Bergantino, S. (1997). "Booms, Busts and babies: The Effect of Demographics on Housing and Stock Prices". MIT discussion paper.
- Bernheim, B. (1984). "Rationalizable strategic behaviour". *Econometrica*, 52:1007-1028.
- Bewley, T. (1972). "Existence of equilibria in economies with infinitely many commodities". *Journal of Economic Theory* 43: 514-540.
- Black, F. (1986). "Noise". *Journal of Finance*, 41: 529-543.
- Black, F., (1988). "An Equilibrium Model of the Crash". in S. Fischer (ed.), *NBER Macroeconomics Annual* MIT Press, Cambridge, Mass: 269-276.
- Blanchard, O. (1979). "Speculative Bubbles, Crashes and Rational Expectations". *Economics Letters*, 3: 387- 89.
- Blanchard, O. and M, Watson. (1982). "Bubbles, Rational Expectations, and Financial Markets". in Paul Wachtel, ed., *Crises in the Economic and the Financial Structure* (Lexington Books, Lexington): 295-315.
- Bordo, Michael D., (2003). "Stock Market Crashes, Productivity Boom Busts and Recessions: Some Historical Evidence". *Background Paper for the IMF WorldEconomic Outlook, April 2003*.
- Brennan, M. J., (1979). "The Pricing of Contingent Claims in Discrete Time Models". *Journal of Finance*. 34: 53- 68.
- Brunnermeier, M., and S. Nagel, (2002). "Hedge funds and the technology bubble". *Journal of Finance*, 59(5): 2013-2040.
- Buiter, Willem H. and Paolo A. Pesenti. (1990). "Rational Speculative Bubbles in an Exchange Rate Target Zone". Discussion Paper No. 479. *Centre for Economic Policy Research*.
- Bulow, J, and P, Klemperer. (1994). "Rational Frenzies and Crashes". *Journal of Political Economy* 102 (1): 1– 23.
- Calvo, G., (1978). "On the indeterminacy of interest rates and wages with perfect foresight". *Journal of Economic Theory* 19: 321-337.

- Campbell, J, A W Lo and A C McKinlay (1997). *The econometrics of financial Markets*. Princeton University Press: 258- 260.
- Campbell, J. and R. Shiller (1987). "Cointegration and tests of present value models". *Journal of Political Economy*. 95: 1062-1088.
- Campbell, J. and R. Shiller. (1987a). "Cointegration and tests of present value models". *Journal of Political Economy*, 95: 1062-1088.
- Campbell, J. and R. Shiller. (1987b). "Stock prices, earnings and expected dividends". *Journal of Finance*, 43 (3): 661-676.
- Campbell, J., and R. Shiller. (1988). "The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors". *Review of Financial Studies*, 1:195-228.
- Campbell, J., and R. Shiller. (1988b). "Stock Price, Earnings, and Expected Dividends". *Journal of Finance*, 43: 661-676.
- Canova, F., (1995). "VAR: Specification, Estimation, Testing and Forecasting, in Pesaran, H. and M. Wickens, eds.: *Handbook of Applied Econometrics*: 31- 65.
- Cass, D, M. Okuno and I. Zilcha. (1979). "The role of money in supporting the Pareto optimality of competitive equilibrium in consumption-loan type models". *Journal of Economic Theory* 60: 277- 305.
- Cass, D. and K. Shell. (1983). "Do sunspots matter?". *Journal of Political Economy*. 91:193 – 227.
- Cerchi, M. and A. Havenner. (1988). "Cointegration and stock prices: the random walk on Wall Street". *Journal of Economic Dynamics and Control*, 12: 333-346.
- Chancellor, E (1999). *Devil take the hindmost: a history of financial speculation*, Farrar, Straus and Giroux, New York.
- Chiappori, P and R. Guesnerie. (1991). "Sunspot Equilibria in Sequential Markets Models". in *Handbook of Mathematical Economics, Vol. IV*, (W. Hildenbrand and H. Sonnenschein Eds.)Amsterdam, Netherlands: Elsevier Science Publishers
- Clinton, B. (1996). "State of the Union Address." Before a Joint Session of the Congress, Washington, D.C., January 23, 1996.
- Cooper, MJ, O Dimitrov and PR Rau .(2001). "A rose.com by any other name". *Journal of Finance*, 56(6): 2371–2388.
- Copeland, T. and Weston, J. (1992). *Financial Theory and Corporate Policy*, 3 ed Addison Wesley Publishing Company, Chapter 6, 19 and 20.

- Cox, J., and S. Ross. (1976). "The Valuation of Options for Alternative Stochastic Processes". *Journal of Financial Economics*, 3: 145-166.
- Craine, R. (1993). "Rational Bubbles: A test". *Journal of Economic Dynamics and Control*, 17: 829- 846.
- Cuthbertson, K. (1996). "Quantitative Financial Economics: Stocks, Bonds, and Foreign Exchange". *New York: Working Paper*, No 3242
- Cutler, D, J. Poterba and L. Summers (1990). "Speculative Dynamics." *National Bureau of Economic Research Working Paper*, No 3242
- Cutler, D., J. Poterba, and L. Summers. (1990). "Speculative dynamics and the role of feedback traders". *American Economic Review*, 80: 63-68.
- David, P. A and G. Wright (1999), "Early Twentieth Century Growth Dynamics: An Inquiry into the Economic History of "Our Ignorance"". Stanford: SIEPR Discussion Paper No: 98-3.
- De Long, J., A. Shleifer, L. Summers, and R. Waldmann, (1990). "Noise Trader Risk in Financial Markets," *Journal of Political Economy*, 98: 703–738.
- De Long, J., Schleifer A., Summers L., Waldmann J. (1990a). "Positive Feedback Investment Strategies and Destabilizing Rational Speculation", *Journal of Finance*, 45: 379-96.
- Debreu, G. (1970). "Economies with a finite set of equilibria". *Econometrica*, 38: 387-392.
- Dezhbakhsh, H., and A. Demirguc-Kunt (1990). "On the Presence of Speculative Bubbles in Stock Prices". *Journal of Financial and Quantitative Analysis*, 25: 101-112.
- Diamond, P, (1965). "National Debt in a Neoclassical Growth Model," *American Economic Review*, 55: 1126 -1150.
- Diamond, P., and M. Rothschild. (1978). *Uncertainty in Economics*. Academic Press.
- Diba, B and H. Grossman. (1987). "On the Inception of Rational Bubbles," *Quarterly Journal of Economics* 102:697-700.
- Diba, B. and H. Grossman (1984). "Rational Bubbles in the Price of Gold". NBER Working Paper No. 1300.
- Diba, B. and H. Grossman. (1988). "Explosive rational bubbles in stock prices?". *American Economic Review*. 78: 520-530
- Dreman, D. (1993). "Bye-Bye to Beta (New Research Disputes the Validity of Stock Risk Analysis)". *Forbes*, March 30 1993, 149: 148.

- Duffie, J. and Huang, C. (1985). "Implementing Arrow-Debreu equilibria by continuous trading of few long-lived securities". *Econometrica* 53(6): 1337–1356.
- Epstein, L. and T. Wang. (1985). "Uncertainty, Risk-Neutral Measures and Security Price Booms and Crashes". *Journal of Economic Theory*, 67: 40-83.
- Evans, G. (1991). "Pitfalls in testing for explosive bubbles in asset prices". *American Economic Review*, 81: 922-930.
- Executive, Office of the President, Council of Economic Advisers. (2002). "*Economic Report of the President together with the Annual Report of the Council of Economic Advisers*". Washington, D.C: U.S. Government Printing Office, February 2002.
- Fama, E. (1965). "The Behavior of Stock Market Prices". *The Journal of Business*, 38: 34-105.
- Fama, E. (1970). "Efficient Capital Markets: A Review of Theory and Empirical Work". *Journal of Finance*, 25(2): 383-417.
- Fama, E. (1976). *Foundations of Finance*. New York: Basic Books.
- Fama, E. (1991). "Efficient capital markets: II". *The Journal of Finance* 46(5): 1575-1617.
- Fama, E., L. Fisher, M. Jensen and R. Roll (1969). "The Adjustment of Stock Prices to New Information". *International Economic Review*, 10: 1- 21.
- Fisher, Irving (1930). "The Stock Market Crash-And After" New York: Macmillan: 53.
- Flavin, M. (1983). "Excess Volatility in the Financial Markets: A Reassessment of the Empirical Evidence." *Journal of Political Economy*, 91(6): 929-956.
- Flood, R. and P. Garber, (1980). "Market Fundamentals versus Price-Level Bubbles: The First Tests," *Journal of Political Economy*, 88: 745-770.
- Flood, R. and R. Hodrick (1990), "On Testing for Speculative Bubbles". *Journal of Economic Perspectives*, 4(2): 85-101.
- Friedman, M and Anna J. Schwartz. (1963). *A Monetary History of the United States, 1867–1960*, Princeton: Princeton University Press.
- Froot, K, David S. and Jeremy C. Stein. (1992), "Herd On The Street: Informational Inefficiencies In A Market With Short-Term Speculation," *Journal of Finance*, 47(4): 1461-1484.
- Froot, K. and M. Obstfeld. (1991). "Intrinsic Bubbles: the Case of Stock Prices." *The American Economic Review* 81(5): 1189-1214.

- Galbraith, J, K., (1954). *The Great Crash 1929*, Boston: Houghton, Mifflin Company.
- Gale, D. (1973). "Pure Exchange Equilibrium of Dynamic of Dynamic Economic Models". *Journal of Economic Theory*. 5: 12-36.
- Garber, P.(1990), "Famous First Bubbles," *Journal of Economic Perspectives*, 4(2):35 54
- Geeman, J and R. Shiller, (2002). "One Simple Test of Samuelson's Dictum for the Stock Market" NBER Working paper 9348.
- Gilles, C. and S. LeRoy. (1992a). "Asset Price Bubbles." *The New Palmgrave Dictionary of Money and Finance*.
- Gilles, C. and S. LeRoy. (1992b). "Bubbles and Charges." *International Economic Review*, 29: 401-417.
- Glassman, J. (1999). "Stocks Are Volatile: It's a Fact of Investing." *The Washington Post* 1999, H.01.
- Goenka, A. and K. Shell. (1997). "Robustness of Sunspot Equilibria", *Journal Economic Theory* 10: 79- 98.
- Gordon, R.(2000). "Does the 'New Economy' Measure Up to the Great Inventions of the Past?," NBER Working Paper No. 7833.
- Graham, B and David L. Dodds (1934, 1940). *Security Analysis: Principles and Technique*, First and Second Editions, New York, McGraw-Hill Book Company, Inc.
- Grandmont, J. (1985). "On Endogenous Competitive Business Cycles". *Econometrica*, 53: 995- 1045.
- Greenspan, A. (1999). "New Challenges for Monetary Policy" the Federal Reserve Bank of Kansas City, August 1999.
- Grossman, G. and N. Yanagawa (1993). "Asset Bubbles and Endogenous Growth," *Journal of Monetary Economics*, 31: 3-19.
- Guesnerie, R. and J. Laffont. (1988). "Notes on sunspot equilibria in finite economies". in P. Champsaur et al (eds.), *Essays in Honor of E. Malinvaud, vol.I*, M.I.T. Press, 93 - 115.
- Guesnerie, R., (2001). *Assessing rational expectations: Sunspot multiplicity and economic fluctuations*. Cambridge and London: MIT Press: 8- 222.
- Hahn, F. (1982). *Money and Inflation*. Basil Blackwell

- Hamilton, J., Whiteman, C, (1985). "The Observable Implications of Self-fulfilling Speculative Price Bubbles"; *Journal of Monetary Economics*, 16: 353-373
- Hashimzade, N., (2003). "Probability of survival in a random exchange economy with dependent agents". *Economic Theory*, 21: 907– 912
- Hirota, S and S., Sunder. (2001). "Stock Market as a 'Beauty Contest': Investor Beliefs and Price Bubbles sans Dividend Anchors" (Online) : <http://www.rba.gov.au/PublicationsAndResearch/Conferences/2003/Simon.pdf> March, 10, 2004.
- Huang, K., Werner. (1999). "Asset Price Bubbles in Arrow-Debreu and Sequential Equilibrium". *forthcoming, Economic Theory*.
- Jensen, M. (1978). "Some Anomalous Evidence Regarding Market Efficiency," *Journal of Financial Economics*, 6: 95-102.
- John, Simon, (2004) "Three Australian Asset-price Bubbles". (online): www.rba.gov.au/PublicationsAndResearch/Conferences/2003/Simon.pdf 10, Oct 2004
- Jung, J and R. Shiller. (2002). "One Simple Test of Samuelson's Dictum for the Stock Market". NBER Working Paper No. 9348.
- Kaplan, R. and R. Roll, (1972). "Investor Evaluation of Accounting Information: Some Empirical Evidence". *Journal of Business*: 225- 257.
- Kasa, K. (1992). "Common stochastic trends in international stock markets". *Journal of Monetary Economics*. 29: 95-124.
- Kehoe, T. and D. Levine (1985). "Comparative Statics and Perfect Foresight in Infinite Horizon Economies". *Econometrica*. 53: 433-453.
- Keynes, J. (1936). *The General Theory of Interest, Employment and Money*. Macmillan, London.
- Kindleberger, C. (1978). *Manias, panics, and crashes*, New York, Basic Books Garber.
- Kindleberger, C. (1989). *Manias, Panics, and Crashes*. A History of Financial Crises. New York: Basic Books.
- Kindleberger, CP (2000), *Manias, panics and crashes: a history of financial crises*, John Wiley & Sons, New York.
- Kleidon, A., (1986). "Variance Bounds Tests and Stock Prices Valuation Models". *Journal of Political Economy*, 94(5), 953-1001.

- Lehman, B. (1991). "Asset Prices and Intrinsic Value" *Journal of Monetary Economics* 28: 485- 500.
- LeRoy, S. (1989). "Efficient Capital Markets and Martingales". *Journal of Economic Literature*, 27 (4): 1583-22.
- LeRoy, S., and R. Porter. (1981). "The present value relation: Tests based on implied variance bounds". *Econometrica*, 49: 555-574.
- Lucas, R. (1972). "Expectations and the neutrality of money". *Journal of Economic Theory*. 4:103–124.
- Mackay, C (1980), *Extraordinary popular delusions and the madness of crowds*, Harmony Books, New York. Originally published in 1841.
- Marsh, T. and R. Merton. (1986). "Dividend Variability and Variance Bounds Tests for the Rationality of Stock Market Prices". *American Economic Review*, 76(3): 483-503.
- Maskin, E. and J. Tirole (1987). "Correlated equilibria and sunspots". *Journal of Economic Theory*, 43: 364- 373.
- Mankiw, N, D. Romer, and M. Shapiro. (1985). "An Unbiased Reexamination of Stock Market Volatility". *Journal of Finance*, 40: 677-687.
- Mankiw, N. and D, Weil. (1989). "The Baby Boom, the Baby Bust, and the Housing Market". *Regional Science and Urban Economics* 19: 235-258.
- McQueen, G., and S. Thorley, (1994). "Bubbles, Stock Returns, and Duration Dependence". *Journal of Financial and Quantitative Analysis*, 29: 186-197.
- Meese, R. (1990). "Currency Fluctuations in the Post-Bretton Woods Era". *Journal of Economic Perspectives*, 4: 117-134.
- Mishkin, F. and White, E. N. (2002). "U.S. Stock Market Crashes and their aftermath: Implications for Monetary policy" in a conference on "Asset Price Bubbles: the Implications for Monetary, Regulatory, and International Policies" cosponsored by the Federal Reserve Bank of Chicago & the World Bank Group: 53-76.
- Muth, J. R. (1960). "Optimal Properties of Exponentially Weighted Forecasts". *Journal of the American Statistical Association*. 55: 229-305.
- Muth, J. R. (1961). "Rational Expectations and the Theory of Price Movements". *Econometrica*. 24: 315-335.
- Negroni, G. (2000b) "Eductive expectations coordination on a stationary sunspots equilibrium in an economy with heterogeneous agents". Catholic University of Milan, mimeo.

- Norden, S. and R. Vigfusson. (1996). "Can Regime-Switching Tests Detect Bubbles?" Working Paper August 1996 Bank of Canada.
- Norden, S. and Schaller, H.(1993). "The Predictability of Stock Market Regime: Evidence from the Toronto Stock Exchange". *Review of Economics and Statistics*, August: 505-10.
- Obstfeld, M. and K. Rogoff. (1983). "Speculative Hyperinflations in Maximizing Models: Can We Rule Them Out?" *Journal of Political Economy* 91:675-87.
- Obstfeld, M. and K. Rogoff. (1986). "Ruling Out Divergent Speculative Bubbles." *Journal of Monetary Economics* 17(3): 349-62.
- Ofek, E and R, Matthew. (2003). "DotCom Mania: The Rise and Fall of Internet Stock Prices." *Journal of Finance*, June, 58(3): 1113-1138
(Online)www.rba.gov.au/PublicationsAndResearch/Conferences/2003/Simon.pdf,10,October 2004).
- Ofek, E., and M.Richardson. (2001). "Dotcom mania: The rise and fall of Internet stock prices". *NBER Working Paper* 8630.
- Pearce, D. (1984). "Rationalizable Strategic Behavior and the Problem of Perfection". *Econometrica*, 52:1029-1050.
- Pratten, C. (1993). *The Stock Market*. Cambridge: Press Syndicate of the University of Cambridge.
- Rappoport, P and E. White. (1993). "Was There a Bubble in the 1929 Stock Market?" *Journal of Economic History* 53(3): 549-574.
- Rappoport, P. and E White. (1991). "Was there a bubble in the 1929 stock market?". *NBER Working Paper* No 3612.
- Rhee, C and W Rhee. (1991). "Fundamental Value and Investment: MicroData Evidence". *The Rochester Centre for Economic Research Working Paper* No.282.
- Roll, Richard (1988). "R2," *Journal of Finance*, 43 (2): 541-566.
- Romer, D. (1993). "Rational Asset-Price Movements Without News," *American Economic Review* 83: 1112-1130.
- Rosser, J. B, Jr. (1991). *From Catastrophe to Chaos: A General Theory of Economic Discontinuities*. Boston/Dordrecht: Kluwer Academic Publishers.
- Rosser, J.B., Jr. (1997). "Speculations on Nonlinear Speculative Bubbles". *Nonlinear Dynamics, Psychology, and Life Sciences*, 275-300.

- Rotterdam, School of Economics. (2003). "Shiller's variance-bound test". (Online).
<http://www.few.eur.nl/few/people/smart/m-economics/shiller.htm>, July,10 2004
- Samuelson, P. (1958). "An Exact Consumption-Loan Model of Interest with or without the Social Contrivance of Money". *Journal of Political Economy*. 66:467-482.
- Santoni, S., (1987). "The Great Bull Markets 1924-29 and 1982-87: Speculative Bubbles or Economic Fundamentals". *Federal Reserve Bank of St. Louis Review*, 96:16-29
- Santos, M., Woodford, M. (1997). "Rational asset pricing bubbles". *Econometrica* 65:19- 57.
- Saunders, E., (1993). "Stock Prices and Wall Street Weather" *American Economic Review* 83: 1337-1345.
- Saxton, V (2003). "Economic Repercussions Of The Stock Market Bubble" A Joint Economic Committee Study United States Congress July 2003 Joint. (online)
<http://www.house.gov/jec/growth/07-14-03.pdf> 10,oct, 2004.
- Scheinkman, J. (1980). "Notes on Asset Trading in an Overlapping Generations Economy". works paper, University of Chicago.
- Shell, K. (1971). "Notes on the Economics of Infinity". *Journal of Political Economy*, 79: 1002-1011.
- Shell, K. (1977). "Monnaie et allocation intertemporelle". (mimeo, CNRS S'eminare Roy-Malinvaud, Paris)
- Shiller, R "Online data ". (2004). Shiller home page. (Online).
<http://www.econ.yale.edu/~shiller/data.htm> October 10.
- Shiller, R. (1982). "Consumption, Asset Markets, and Macroeconomic Fluctuations". *Carnegie-Rochester Series on Public Policy* 17: 203–38.
- Shiller, R. (1981). "Do Stock Prices Move too Much to be Justified by Subsequent Changes in Dividends". *American Economic Review*. 71(3): 421-436.
- Shiller, R. (1984). "Stock Prices and Social Dynamics". *Brookings Papers on Economic Activity*. 2: 457-510.
- Shiller, R. (1989). *Market Volatility*. Cambridge: MIT Press.
- Shiller, R. (2000). "Measuring Bubble Expectations and Investor Confidence." *Journal of Psychology and Markets* 1(1): 49-60.
- Shiller, R. (2000). *Irrational Exuberance*. Princeton N.J: Princeton University Press.

- Shiller, R. (2000b). "Measuring Bubble Expectations and Investor Confidence". *Journal of Psychology and Markets*. 1(1): 49-60.
- Shiller, R. (2003). *The New Financial Order: Risk in the Twenty-first Century*. Princeton University Press: Princeton, NJ.
- Shiller, R. (2003). "From Efficient Market Theory to Behavioral Finance," *Journal of Economic Perspectives* 17 (1): 83-104
- Shleifer, A and L, Summers. (1990). "The noise trader approach to finance". *Journal of Economic Perspectives*, 4 (2): 19-33.
- Shleifer, A and R Vishny. (1997). "The Limits of Arbitrage," *Journal of Finance*, 52: 35- 55.
- Siegel, J (2003). "What is an asset price bubble? An operational definition", *European Financial Management*, 9(1): 11–24.
- Siegel, J. (1998). *Stocks for the Long Run*, 2nd Edition, McGraw-Hill.
- Spear, S. and S, Srivastava. (1986). "Markov rational expectations equilibria in an overlapping generations model". *Journal of Economic Theory*. 38: 35-62.
- Taylor, M. and I. Tonks. (1989). "The internationalisation of stock markets and the abolition of U.K. exchange control". *The Review of Economics and Statistics*, 71:332-336
- Thaler, R. (1998). "Giving Markets a Human Dimension". In *The Complete Finance Companion: Mastering Finance*. London: Pitman Publishing.
- Tirole, J. (1982). "On the Possibility of Speculation under Rational Expectations". *Econometrica* 50(5): 1163- 81.
- Tirole, J. (1985). "Asset Bubbles and Overlapping Generations". *Econometrica*, 53 (5): 1071-1100.
- Vuolteenaho, T. (2002). "What drives firm-level stock returns". *Journal of Finance*, 57: 233- 264.
- Wallace, N .(1980). "The overlapping generations model of fiat money". in *Models of Monetary Economies*, Eds, John Kareken and Neil Wallace, *Federal Reserve Bank of Minneapolis*: 49- 82.
- Weil, P. (1990). "On the Possibility of Price Decreasing Bubbles." *Econometrica* 58(6): 1467-74.
- West K. (1987). "A Specification Test for Speculative Bubbles", *Quarterly Journal of Economics*, 102, 553-80.

- West, K., (1988). "A Specification Test for Speculative Bubbles". *Quarterly Journal of Economics*, 102:553-580.
- White, E (1990). "The Stock Market Boom and Crash of 1929 Revisited," *Journal of Economic Perspectives*, 4(2): 67-84.
- White, E (1990). "Crashes and Panics: the lessons from history/ edited by Eugene N. White". New York University, 1990.
- Wright, R. (1987). "Market structure and competitive equilibrium in dynamic equilibrium models". *Journal of Economic Theory* 41:189-201.
- White, E, (1990). "When the Ticker Ran Late: The Stock Market Boom and Crash of 1929," in Eugene N. White (ed.), *Crashes and Panics: The Lessons from History*, New York: Dow Jones Irwin: 143–187.
- Zarnowitz, V. (1992). *Business Cycles: Theory, History, Indicators and Forecasting*, Chicago: University of Chicago Press.