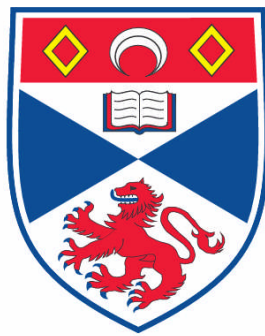


**MACROECONOMIC VARIABLES AND THE STOCK MARKET : AN
EMPIRICAL COMPARISON OF THE US AND JAPAN**

Andreas Humpe

**A Thesis Submitted for the Degree of PhD
at the
University of St. Andrews**



2008

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**Macroeconomic variables and the stock market.
An empirical comparison of the US and Japan.**

**A thesis submitted to the University of St Andrews
for the degree of Ph.D. in the Department of
Economics.**

2007

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Abstract

In this thesis, extensive research regarding the relationship between macroeconomic variables and the stock market is carried out. For this purpose the two largest stock markets in the world, namely the US and Japan, are chosen. As a proxy for the US stock market we use the S&P500 and for Japan the Nikkei225. Although there are many empirical investigations of the US stock market, Japan has lagged behind. Especially the severe boom and bust sequence in Japan is unique in the developed world in recent economic history and it is important to shed more light on the causes of this development. First, we investigate the long-run relationship between selected macroeconomic variables and the stock market in a cointegration framework. As expected, we can support existing findings in the US, whereas Japan does not follow the same relationships as the US. Further econometric analysis reveals a structural break in Japan in the early 1990s. Before that break, the long-run relationship is comparable to the US, whereas after the break this relationship breaks down. We believe that a liquidity trap in a deflationary environment might have caused the normal relationship to break down. Secondly, we increase the variable set and apply a non-linear estimation technique to investigate non-linear behaviour between macroeconomic variables and the stock market. We find the non-linear models to have better in and out of sample performance than the appropriate linear models. Thirdly, we test a particular non-linear model of noise traders that interact with arbitrage traders in the dividend yield for the US and Japanese stock market. A two-regime switching model is supported with an inner random or momentum regime and an outer mean reversion regime. Overall, we recommend investors and policymakers to be aware that a liquidity trap in a deflationary environment could also cause severe downturn in the US if appropriate measures are not implemented accordingly.

Declaration

I, Andreas Humpe, hereby certify that this thesis, which is approximately 80.000 words in length, has been written by me, that it is the record of work carried out by me and that it has not been submitted in any previous application for a higher degree.

15.09.2007 Andreas Humpe

I was admitted as a research student in October 2002 and as a candidate for the degree of PhD in October 2002; the higher study for which this is a record was carried out in the University of St Andrews between 2002 and 2007.

15.09. 2007 Andreas Humpe

I hereby certify that the candidate has fulfilled the conditions of the Resolution and Regulations appropriate for the degree of PhD in the University of St Andrews and that the candidate is qualified to submit this thesis in application for that degree.

15.09.2007 Dr. Peter Macmillan Dr. Arnab Bhattacharjee

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15.09.2007 Andreas Humpe

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Chapter 1

1.0 Introduction

A significant amount of literature now exists that investigates the relationship between stock market returns and a range of macroeconomic as well as financial variables across a number of different stock markets and over a range of different time horizons. Furthermore, existing financial economic theory provides a number of models that set a framework for the study of these relationships.

This thesis is an empirical analysis of the relationship between stock prices and various macroeconomic variables in the US and Japan. The empirical methods include cointegration analysis and smooth transition regression models.

In this thesis we will build upon the existing empirical as well as theoretical literature in order to increase our knowledge in this field. Most of the existing literature has investigated the US stock market or those of other market based financial systems. However, Japan represents the 3rd largest economy in the world by purchasing power parity (PPP)¹ and its stock market has the second largest market capitalisation of all stock markets around the world². In contrast to the US, there has been relatively little empirical research on the Japanese stock market and how it interacts with macroeconomic variables.

Furthermore, Japan experienced probably the most extreme boom and bust sequence in the developed world during recent times. In particular the 1980s were characterised by very high economic growth and astronomical asset prices, whereas the 1990s brought Japan into

¹ For instance a list published by the IMF or the World bank shows Japan as the 3rd largest economy in PPP terms. For a discussion see: [http://en.wikipedia.org/wiki/List_of_countries_by_GDP_\(PPP\)](http://en.wikipedia.org/wiki/List_of_countries_by_GDP_(PPP))

² For a discussion see: http://en.wikipedia.org/wiki/Tokyo_Stock_Exchange

deflation and economic recession with negative asset returns over the whole decade. For this reason it will be very interesting for us to investigate what has happened in Japan and contrast this with the US experience. In contrast to Japan, the US experienced a boom period during the 1990s. Moreover, Japanese economic growth was higher and inflation lower during the 1970s and 1980s compared to the US.

Overall the analysis will not only examine what might have caused the severe bull and bear market in Japan but also give recommendations for policymakers and investors. In the US, the economic development over the analysed period between 1965 and 2005 has been much smoother and we can support many existing empirical findings. However, for the US we will make recommendations as to how the experience of Japan can be avoided and what investors and policymakers can learn from Japan.

The structure of the thesis is as follows. In the remaining part of chapter 1 we will give an overview of the relevant recent economic history and institutional settings in the US and Japan. The historical review will reveal commonalities and differences between the US and Japan in their economic history since 1965. Although the 60s were comparable for both countries, the 70s and in particular the 80s were much more prosperous in Japan than in the US. However, the US economic development was very favourable during the 90s whereas Japan experienced severe economic downturn and deflation. Furthermore, the Japanese economy experienced a typical Keynesian liquidity trap during the 1990s. The liquidity trap is most often discussed in a Keynesian framework, where the economy is characterised by recession, high unemployment, low interest rates, low inflation or deflation. In such a case, investors are “trapped” into liquidity as they hold cash rather than other financial assets. The reason for that is that interest rates are so low that they can only increase and as a result asset prices are likely to fall. As a consequence, investors prefer to

hold cash over holding stocks or bonds (for further discussion see *inter alia* Pentecost 2000, Mankiw 2006). We therefore assume that a long-term equilibrium model for the US and Japan will highlight deviations from equilibrium during periods of economic boom and crisis³. This implies overreaction to economic news (for a discussion see DeBondt and Thaler 1985, 1987 and 1990). Beside the economic differences there are institutional differences as well. While the US is a market based financial system with a common law origin, Japan is a bank based system with civil law origin. Furthermore, the Japanese stock market is more dominated by institutional investors and has a larger share of cyclical industries than the US. Because of the historical and institutional differences we might expect the Japanese stock market to be more sensitive to macroeconomic shocks and probably less efficient. The higher sensitivity might be due to the higher cyclicity and capital intensity of the Japanese economy whereas the lower efficiency level might be due to lower securities disclosure regulations in Japan compared to the US.

Chapter 2 will give an overview of asset-pricing theory in finance and will summarise the existing literature on the topic. Therefore, the chapter will lay out the theoretical foundation of our empirical investigation and carve out the area of research within the existing literature. In the literature we will already find differences and commonalities among empirical facts in the US and Japan. In particular previous academic research on stock market efficiency will hopefully give us a better understanding of possible differences in stock market efficiency due to the institutional differences in both countries as will be explained in chapter 1.1.2.

³ This assumes that our model is correct and that there exists a long-term equilibrium. However, we are aware that the deviations could also be caused by differences between expectations and the ex post measurement of our variables.

In chapter 3 we start the empirical investigation by analysing the long-term equilibrium in a cointegration framework in the US and Japan. In the US, we support existing findings that the US stock market (in our case S&P500) forms a long-term equilibrium vector with industrial production, consumer prices, interest rates and to a lesser degree money supply. Furthermore, the expected signs of the relationships are supported. Industrial production has a positive effect, whereas interest rates and consumer prices have negative impacts.

However, the same findings cannot be found for Japan and we have reason to believe that something unusual has happened to Japan. Further econometric analysis shows a structural break in Japan during the early 1990s. When looking at the equilibrium relationship before and after the break, we find evidence that before 1993, Japan had a similar relationship as the US, whereas after 1993 this relationship breaks down. The post 1993 relationship points to a stock market (Nikkei225) driven more strongly by money and inflation. We argue this may have happened because of the severe downturn characterised by deflation and the occurrence of a liquidity trap as will be explained in chapter 1.1.1. Therefore, we add to the literature by reporting a structural break in the long-run relationship between macroeconomic variables and the Nikkei225 in Japan. Furthermore, we are the first to analyse the impact of a liquidity trap in a deflationary environment on the stock market.

The US has not experienced such an environment in recent history but we suggest to investors and policymakers that a liquidity trap combined with deflation could potentially cause a comparable effect on the US stock market. In particular in the 2001-2003 period the US was close to deflation. However a liquidity trap was avoided because individuals as well as companies were able to restructure fast and continue investing. Generally we find larger coefficients between the stock market and macroeconomic variables in Japan. The

higher cyclicity of the Japanese economy, as will be explained in chapter 1.1.2, is probably the most likely reason for this finding.

Chapter 4 expands the analysis by increasing the variable set and investigating non-linear behaviour between macroeconomic variables and the stock market. An important innovation in our work is the inclusion of a leading indicator, namely the G7 OECD leading indicator. It has been used in the literature to forecast economic growth and we think it would also be useful in predicting stock returns. We find that in both countries this indicator has a positive relationship with stock returns.

In the US we support a positive relationship between the risk-spread between corporate bond yields and government bond yields and future stock returns, whereas money supply has a negative impact on returns. As an export-oriented country, Japan shows a positive relationship between the YENUSD exchange rate and the Nikkei225. However, we find the relationship between the Nikkei225 and the 10 year bond yield in Japan to be positive between 1993 and 2004. This is unexpected but might also be the result of the severe downturn and deflation as will be explained in chapter 1.1.1. Finally, we find some evidence that the in and out of sample forecasting performance of the non-linear model are superior to the corresponding linear ones.

Chapter 5 tests a particular non-linear model of noise traders and arbitrage investors in the dividend yield in the US and Japanese stock market. As a proxy for the US stock market we use the S&P500 and for Japan the Nikkei225. The inner regime is characterised by momentum or random walk behaviour whereas the outer regime shows mean reversion

behaviour⁴. However, we find the inner regime in Japan to be much smaller than in the US and therefore the window of opportunity for momentum traders to survive is greater in the US. This supports findings in the existing literature that momentum profits are possible in the US but not in Japan. Furthermore, the result might be due to the different ownership structure in both countries as will be explained in chapter 1.1.2.

Finally chapter 6 summarises the findings and concludes with recommendations for policymakers, investors and further research.

1.1. The US and Japanese stock markets

In this chapter we will give an overview of the institutional and historical commonalities as well as differences in the US and Japan. As a first step we will summarise the main developments in economic history since 1965 in the US and Japan. The historical events identify several differences between the US and Japanese economic development and bring up most of the issues we will address in our empirical analysis. Secondly, we will give a broad overview of institutional differences in the US and Japan. Once again, we find some differences in the institutional setting in both countries that raise additional questions which have to be addressed in the empirical investigation of the thesis. However, for some issues we might already find answers in the literature review chapter or at least get a good idea about most likely findings due to earlier academic research.

⁴ An inner and outer regime is defined by a smooth transition regression model (LSTAR2). The inner regime is close to the mean of the transition variable (in our case the dividend-yield) whereas the outer regime is further away from the mean of the transition variable. In chapter 5 we test for different behaviour of the dividend yield in the inner and outer regime (close to and further away from its' mean). We expect a momentum or random walk in the inner regime (close to the long-term mean) where the coefficient on the lagged dividend-yield is zero or greater and mean reversion behaviour in the outer regime where the coefficient on the lagged dividend-yields is smaller than one. Assuming that stock prices and dividends (fundamentals) build a long-term equilibrium (and are cointegrated), the dividend-yield should be stationary. As a result the long-term mean of the dividend yield corresponds to the long-term fair value (equilibrium) and large deviations from that fair value should attract fundamental investors that will force the dividend-yield back to its' long-term mean (mean reversion in the outer regime). In the inner regime, the market is close to its' fair value and the dividend-yield fluctuates randomly.

1.1.1 Historical developments in the US and Japan

The US and Japanese stock markets have a long history. In the US, the origins of Wall Street date back to 1790 (Geisst 2004) whereas the Tokyo Stock Exchange (TSE) was established in 1878⁵. On 9th of August 1945 the TSE was closed and reorganised after the atomic bombing of Nagasaki. The new Tokyo Stock Exchange reopened again on the 16th of May 1949. Overall, the stock markets in the US and Japan are well established stock exchanges where institutional and private investors could actively trade securities over a long period. Therefore, stock market participants in the US and Japan possibly have a comparable degree of experience. The Japanese stock market is an established exchange and therefore comparable to the US stock market.

Economic development over the last 40 years has been very different in the US and Japan. After World War II (WWII) both countries enjoyed high economic growth. At the same time, inflation and interest rates were relatively low, whereas money supply was ample. Unsurprisingly stock market returns were high during the 50s and 60s in the US and Japan.

However, in the beginning of the 1970s severe and seemingly persistent macroeconomic problems emerged. In 1971 the Bretton Woods international monetary system collapsed and rapidly increasing inflation between 1972 and 1973 ended in a deep worldwide recession between 1974 and 1975. In the US interest rates increased sharply and the stock market performed very poorly during the 70s. The high inflation was partly driven by increased wages due to influential labour unions and higher energy prices (for a discussion see Bruno and Sachs 1985). In Japan the 70s were not as devastating as in the US.

⁵ See the Tokyo Stock Exchange home page for details: <http://www.tse.or.jp/english/about/history.html>

Although inflation was very high in Japan as well, industrial production, money supply and stock market returns were more robust than in the US. Real interest rates were even negative for most of the 1970s in Japan (for an overview see table 1 in chapter 3.11 on page 170). As a result the relative-performance of the Japanese economy and stock market were relatively good during this period.

In the 1980s the US recovered from the severe stagflation of the 1970s and inflation and nominal interest rates decreased to more normal levels again. However, real growth was relatively low and real interest rates on average increased during that period. While the 1980s can be described as a back to normal period in the US, the Japanese economy and asset markets literally went through the roof. Japan enjoyed low inflation and real interest rates in combination with high economic growth and ample money supply.

The heyday of the US stock market arrived during the 1990s, notably driven by the high tech and internet boom during that period. The economic environment during the 1990s was quite favourable with low inflation and real interest rates in combination with high economic growth and decent money supply. In contrast to the US, Japan suffered from prolonged deflation during the 1990s partly caused by a massive asset price deflation. Furthermore, real economic growth was very low and real interest rates stayed positive due to deflation and the lower bound of zero on nominal interest rates. In particular during the early 1990s the Bank of Japan (BoJ) was very reluctant to fight the early indications of deflationary pressures and kept money supply tight. However, in the second half of the 1990s the BoJ changed course but arguably this was too late and the economy ended in a prolonged downturn with a deep recession, high unemployment, falling asset prices and deflation. Although the BoJ increased money supply and lowered interest rates in the second part of the 1990s, the Japanese banks could not hand out new loans due to solvency

restrictions and a typical Keynesian liquidity trap unfolded (for a discussion see Weberpals 1997, Krugman 1998, Svensson 2003 and also Turner 2003). In particular this liquidity trap could have impacted the relationship between macroeconomic variables and the stock market. On the one hand the close to zero interest rate and high money supply could have supported financial markets. On the other hand, the liquidity trap might have triggered a loss of confidence in monetary policy and economic stability, with negative consequences for the stock market. Therefore, we expect to find a change in the sign or significance of monetary variables during the period of the liquidity trap.

The period 2000 until 2005 brought about a significant stock market downturn in the US between March 2000 and March 2003, whereas the market recovered afterwards and continued doing so till today. The market was hit by the recession of 2001 and the terrorist attacks in New York of 2001. In contrast to the BoJ in the early 1990s, the Federal Reserve (FED) reacted very quickly to the stock market downturn and the potential risk of deflation and prolonged recession beginning in 2001. Policy rates were lowered to an unprecedented post war level of 1% in 2003 and money supply was increased at the same time to stimulate borrowing and to make corporate restructuring easier. This probably prevented a situation similar to Japan a decade earlier and economic growth and prosperity returned relatively quickly. Japan followed the US into recession in 2001 and the stock market fell even further from the already depressed levels. Economic growth has improved since 2000 compared to the 1990s but deflation has been persistent. The stock market fell to a low in 2003 but has recovered since. Overall, the different economic history and in particular the occurrence of a liquidity trap in Japan, gives us reason to expect different relationships between the stock market and macroeconomic variables.

Economic history shows that there were two distinct periods of economic boom and crisis in the US and Japan. Although both countries had a good period during the 50s and 60s, in the 70s the US and Japan developed quite differently. In particular the 80s and 90s were very different in both countries. While Japan could enjoy euphoric growth during the 80s, the US recovered from the severe downturn during the 70s. By contrast, the 1990s were boom years in the US whereas Japan suffered from severe recession and deflation. Finally both countries experienced a recession in 2001 with a stock market downturn in 2002/2003. However, since 2003 the US and Japan have recovered from the recession.

As the economic environment has been very different during the mentioned sub periods, risk aversion may have changed accordingly. A change in risk aversion could possibly explain the large fluctuation in the US and Japanese stock market during the boom and bust periods. In order to visualise fluctuations around an equilibrium relationship between macroeconomic variables and the stock market in chapter 3, we motivate several macro variables via a dividend discount model and then use these variables to estimate an equilibrium relationship by cointegration methodology.

After presenting the theoretical underpinnings in chapter 2, we will model a long-term equilibrium relationship between industrial production, 10-year bond yields, consumer prices as well as money supply and the stock market in the US and Japan between 1965 and 2005. As a proxy for the US stock market we use the S&P500 and for Japan the Nikkei225. We expect to find an equilibrium vector that clearly shows the booms and busts in the US and Japanese economy⁶. Therefore we believe that the Japanese boom during the 80s and the US boom during the 90s may exhibit a positive deviation from the long-term

⁶ We assume a long-term equilibrium relationship between the selected variables and the stock market. Furthermore, we interpret deviations from equilibrium as changes in risk aversion caused by the business cycle. However, deviations from the equilibrium could also be driven by differences between future expectations and the current situation or a wrong stock market model.

equilibrium. Furthermore, the severe recessions during the 70s in both countries and the 90s in Japan should appear as negative deviations from long-term equilibrium. We also believe that the positive deviations from equilibrium are driven by a fall in risk aversion due to favourable economic developments whereas the negative deviations are caused by an increase in risk aversion due to recessions and economic crisis. In Japan, we think that the occurrence of a liquidity bubble could have changed the relationship between macroeconomic variables and the stock market. We suspect that the liquidity trap has triggered a loss of confidence in monetary policy and economic stability. Furthermore, the onset of deflation and close to zero nominal interest rate could change the relationship between consumer prices, interest rates as well as money supply and the stock market. For instance, most researchers have found that an increase in inflation is bad news for the stock market. However, during deflationary periods an increase in inflation may be good news. Similarly an increase in interest rates at the close to zero interest rate level might be seen as a positive development. If the low interest rates are caused by a severe crisis, an increase of interest rates can be associated with and improvement in economic conditions and that would be positive for the stock market. This is one of the major issues that has not been answered in earlier research and we will address it in the cointegration analysis.

As an alternative to the long-term equilibrium model, we will investigate a non-linear model between macroeconomic variables and the stock market in chapter 4. In contrast to the cointegration approach we will build a model that differentiates between positive and negative stock market returns or large and small stock market returns. Therefore the model predicts that the relationship between macroeconomic variables and the stock market is different in rising and falling stock markets or during large and small stock market changes. The motivation of these models is via behavioural finance theories which will be

discussed in chapter 4 as well. Hence, the non-linear model in chapter 4 is an alternative explanation to the long-term equilibrium approach in chapter 3.

1.1.2 Institutional settings in the US and Japan

The legal origin of the US and Japanese stock market are different. The US has a common law origin, whereas the Japanese legal system is based on a civil law origin⁷. The origin of the legal system plays an important role in investor protection and property protection. For instance Roe (2006) reports higher securities disclosure regulations and lower labour regulations in the US compared to Japan. Furthermore, the study shows much higher budgets for financial regulations in common law countries compared to civil law countries. The author concludes that investor protection in common law countries like the US is higher than in civil law countries like Japan. This could impact stock market efficiency because lower securities disclosure regulation and lower investor protection in civil law countries like Japan increase the likelihood of stock market manipulation. Although we will not address market efficiency in our empirical analysis directly, we expect to find an answer to whether there are differences in market efficiency in the US and Japan in the empirical literature review in chapter 2. Furthermore, we will investigate a specific non-linear model of interactions between noise traders and fundamental traders in chapter 5. In this framework we define noise traders as momentum traders and the existence of momentum profits could indicate the level of market efficiency. We expect that the empirical literature together with the results in chapter 5 should give us a reasonable understanding about differences in market efficiency in the US and Japan.

⁷ The main difference between civil and common law is that civil law is based on abstract rules which judges must apply to the individual case, whereas common law draws abstract rules from specific cases. For a discussion see: [http://en.wikipedia.org/wiki/Civil_law_\(legal_system\)](http://en.wikipedia.org/wiki/Civil_law_(legal_system))

In addition to the different legal origin, the US has a market based financial system whereas Japan has a bank based system. In a bank based system, banks play the key role in allocating capital, overseeing corporate investment decisions and collecting savings. In market based financial systems these duties are shared by banks and security markets. As a result, corporate control is mainly conducted by banks in a banking based system whereas the same task is shared by banks and securities markets in a market based system (Demirguc-Kunt and Levine 2000). In bank based systems, banks tend to be the largest creditors and largest share holders at the same time. As creditors, banks are mainly interested in their own capital protection and encourage conservative corporate management. Furthermore, the banking relationship with firms is very strong and banks often have a board representative. This bank dominance could result in information asymmetries that potentially have an impact on market efficiency. Due to the civil law origin and the bank based system, we expect the Japanese stock market could be less efficient than the US stock market. Therefore it will be interesting to see whether the literature on market efficiency together with the model of noise and fundamental traders in chapter 5 can reveal significant differences between the US and Japanese stock market.

Probably because of the differences in the legal and financial system, the US and Japan have a different share ownership structure as well. The share-ownership of Japanese households is below 5% (Altunbas, Kara and van Rixtel 2007), whereas the US share-ownership of private investors is around 34% (Bogle 2005). This means that in contrast to the US stock market, the Japanese stock market is almost completely dominated by institutional investors. As institutional investors are constrained by regulations and probably internal restrictions, the typical investor behaviour might differ from private investors and this could impact the stock market behaviour in the US and Japan. For private investors it is likely to be more difficult than for large institutional investors to

collect large amounts of information and process the information properly. As a result information asymmetries between private and institutional investors are quite likely. Assuming that noise traders are smaller and therefore less informed investors, large information asymmetries may make it more difficult for noise traders to survive. Therefore, we might expect that the noise trader regime in the non-linear model between noise traders and fundamental traders in chapter 5 to be smaller in Japan than the US.

Although the Bank of Japan (BoJ) has been set up as an independent central bank, it has often been criticised for not being very independent in reality. For instance Alesina and Summers (1993) as well as Cukierman (1992) have reported that the BoJ is less independent than the Federal Reserve Bank (FED) in the US. Therefore, the BoJ is seen as more subject to government control (Pollard 1993). An independent central bank that supports economic growth and price stability fosters trust in the economy and might encourage real and financial investments. A lack of central bank independence could worry investors. Especially during periods of economic overheating or recessions, investors might overreact to economic news. For instance, investors could be concerned that a less independent central bank might not fight inflation hard enough during economic booms due to political interests. Alesina and Summers (1993) found evidence that central bank independence lowers inflation and inflation volatility. Furthermore monetary easing during economic recessions might also be less supportive because of political influences. Possibly due to the less independent central bank of Japan, the stock market appears more sensitive to economic news in Japan than in the US. We therefore expect generally higher coefficients in Japan compared to the US in our empirical analysis. In particular the cointegration analysis in chapter 3 and the non-linear model in chapter 4 should give a clear answer to this question.

The industry structure of the Japanese economy is more export driven than the US economy. In the OECD Economic Outlook (2006) the exports as share of GDP are estimated to be 14% for Japan and 10% for the US. Although the export share of GDP of both countries is relatively low compared to countries like Germany or France that have an export share to GDP of 41% and 26% respectively. As a result, Japan should be more sensitive to changes in global output than the US economy and international macroeconomic variables might be more important for the stock market development in Japan than in the US. In the non-linear model in chapter 4 we include an international output variable and the exchange rate as we expect Japan to be more sensitive to international developments than the US.

Furthermore, the manufacturing share to GDP is larger in Japan than in the US. In Japan the manufacturing share to GDP peaked in 1970 at 35% and declined to 21% in 2000 (for a discussion see Hitomi 2004). In contrast to Japan, the manufacturing share to GDP has been relatively stable in the US at around 17% since 1965 (for a discussion see The Facts about Modern Manufacturing published by the National Association of Manufacturers in the US in 2006). The higher manufacturing share in Japan might imply a higher cyclicity of the Japanese economy compared to the US. This could also mean that the stock market in Japan is more cyclical and sensitive to industrial output changes. Finally the stock market composition is different in the US and Japan. While the Nikkei 225 in Japan has more than 50% of its market capitalisation in cyclical consumer and industrial stocks, the S&P 500 in the US has 40% of its market capitalisation in non-cyclical consumer and financial shares⁸. As a result, the Japanese stock market should be more dependent on industrial and cyclical factors whereas the US might be more sensitive to interest rates and

⁸ Own calculations using the S&P500 and Nikkei 225 stocks and their weightings in the index.

monetary developments due to its large dependence on the financial sector⁹. These issues will be addressed in the chapter 3 and 4. In chapter 3 we will examine the coefficient of industrial production, interest rates, money supply as well as consumer prices on stock prices in the US and Japan. As a result we will be able to compare the size and sign of the coefficients in the US and Japan. In chapter 4 we will include risk factors such as the risk and term-premium. As these variables move along with the business cycle, we might find that Japanese stock prices are more sensitive to the business cycle than the US. On the other hand, banking profits are partly linked to transforming short-term deposits of clients into longer-term deposits by the bank and earning a term premium. Therefore, the higher share of financial corporations in the S&P 500 compared to the Nikkei 225 could result in higher sensitivity of the US stock market to the term premium.

1.2. Hypothesis and Objectives

Due to the considerations in chapter 1.1.1 and 1.1.2 we will investigate the following hypothesis and objectives in our empirical analysis. First of all, we hypothesise a unique long-term equilibrium relationship between stock prices and a selected set of macroeconomic variables. Furthermore we hypothesise that the relationship in the US and Japan should be comparable because both markets should obey the same fundamental processes. However, due to the higher cyclicity of the Japanese economy we expect higher sensitivities between the macroeconomic variables and the stock market in Japan. Furthermore, we hypothesise that the occurrence of a liquidity trap in Japan could have modified the relationship between the selected variables and the stock market. Hence, the

⁹ We have calculated the annualised earnings volatility of the S&P500 Financial and S&P500 Industrial sector. We find the S&P500 Industrial sector to have slightly higher volatility than the S&P500 Financial sector. This supports the idea that the industrial sector earnings are more cyclical than financial sector earnings. As a result we could find larger coefficients in Japan compared to the US because industrial stocks have a higher share in the Nikkei225 (Japan) whereas financial stocks have a higher weight in the S&P500 (US).

objective in chapter 3 is to verify the long-term equilibrium relationship and compare Japanese with US results.

In chapter 4 of the thesis we hypothesise that both markets show non-linear behaviour between macroeconomic variables and the stock market. The motivation of non-linear behaviour in financial markets will be based on behavioural finance theories. Furthermore, we hypothesise that the non-linear models better describe the in and out of sample data than a comparable linear model does. We hypothesise that in Japan international variables are more important than in the US because Japan is more export-oriented than the US. Therefore our objective is to estimate non-linear models for the US and Japan in order to compare them with each other as well as with the linear alternatives.

In chapter 5 of the thesis we hypothesise a two-regime switching model between a momentum or noise process and a mean reversion regime for the dividend yield in the US and Japanese stock market. Therefore, our objective is to estimate a two-regime switching model with noise or momentum traders who interact with arbitrage or fundamental traders. Since the literature suggests momentum profits in the US stock market only, we hypothesise the noise or momentum regime to be smaller or even non-existent in Japan. The reason for that difference might be due to the differences in the legal origins, institutional ownership and a bank based Japanese financial system compared to the market based US system.

In chapter 6 our final objective is to give recommendations for private investors, institutional investors and policymakers to ensure the best possible outcome for the economy and economic prosperity.

Chapter 2

2.0 Theoretical and Empirical asset pricing

In the following chapter the theoretical and empirical asset-pricing literature is summarised in order to give a broad overview of the topic. Furthermore, the empirical facts in the US and Japanese stock market are compared and commonalities and differences in those markets are reported. In this context, one of the main objectives is to find reported differences in terms of market anomalies that hint to differences in market efficiency in the US and Japanese stock market. Finally, this chapter will identify the area of the empirical investigation that follows in the next chapters. The theoretical and empirical findings will be the basis for motivating the variables for the empirical investigations in chapter 3, chapter 4 and chapter 5 of this thesis.

2.1 Introduction

This chapter will provide a general overview of the main asset-pricing models and also provide an overview of the existing empirical findings of these models applied to real world data for the US and Japan. Thus, this chapter will introduce the reader to the theoretical foundations of asset-pricing as they have developed. Furthermore, the empirical evidence will be highlighted with an emphasis on the differences and commonalities in the US and Japanese stock market. As a result, this chapter will already anticipate some empirical facts for those different equity markets as well as lay out the theoretical foundations for the empirical chapters that will follow.

It should be noted that the aim of this review is not to provide a complete account of the vast literature on asset-pricing, but rather give an introduction to this area with a focus on

empirical findings in the US and Japan. This is of importance as it will enable us to put the empirical investigation of later chapters into some perspective.

The outline of the chapter is as follows. In chapter 2.2 we will introduce the origins of modern financial economics and the efficient market hypothesis as a corner stone of that field. Chapter 2.2.1 will summarise the early tests of market efficiency that have revealed many market anomalies. In particular we will find that most of those market anomalies have been reported in the US, but many have also been recently supported in Japan. One notable exception are momentum profits, which have been found to exist in the US but not in Japan. Chapter 2.3 will give a short review of portfolio selection and choice under uncertainty, as this builds the foundation for the following chapter, 2.4, where a detailed overview of relevant asset-pricing models is given. More precisely, the theory of the consumption based asset-pricing, capital asset-pricing, intertemporal capital asset-pricing, arbitrage pricing, multifactor, present value and rational bubble models is summarised, along with an empirical analysis of these models, where the emphasis will be upon a comparison of findings in the US and Japan. Finally chapter 2.5 gives a short summary of the chapter.

It should be noted that we will cover behavioural finance theory in the non-linear chapters 4 and 5 as it starts by looking at anomalies in human behaviour and then tries to build a theory that fits the facts. Therefore, behavioural finance theory is a descriptive theory and forms models inductively, compared to deductive theories that are formed from axioms (Thaler 1994a, 1994b).

2.2 The early days of asset pricing

It is generally accepted that the French mathematician Louis Bachelier (1900) was the father of financial econometrics (Campbell, Lo and MacKinlay 1997; Mandelbrot 2005). He wrote his doctoral dissertation “Théorie de la Spéculation” on the price behaviour of financial assets that traded on the French stock market in 1900. In his thesis Bachelier built upon the early theories of probability developed by Blaise Pascal and Pierre de Fermat in 1654. Those can be traced back to the seventeenth century where a gambler’s dispute led to the creation of the mathematical theory of probability. Blaise Pascal and Pierre de Fermat built the foundation of probability theory by solving a fair game that consisted in throwing a pair of dice 24 times. The proposed problem was to decide whether or not to bet money on the occurrence of at least one "double six" during the 24 throws. This general theory of probability was further developed by Jakob Bernoulli (1654-1705) to the so called indicator random variable that became the prerequisite for the development of the random walk theory in finance (for further discussion see Campbell, Lo and MacKinlay 1997, Daston 1995 and Grinstead and Snell 1997). Early empirical research of the random walk hypothesis of share prices was based on the analysis of sequences, runs and reversals of stock returns (for a discussion see Cowles and Jones 1937 and Kemp and Reid 1971).

In 1965 Samuelson wrote an article with the title: “Proof that Properly Anticipated Prices Fluctuate Randomly” where he investigates the random characteristics of financial price data (Samuelson 1965). If it is assumed that a security price P_t at time t is the rational expected value V conditioned on the information I_t available at time t , we get:

$$P_t = E[V|I_t] = E_t V . \quad (2.2.1)$$

Further, the same relationship holds one period later:

$$P_{t+1} = E[V|I_{t+1}] = E_{t+1}V. \quad (2.2.2)$$

Thus, the expectation of change in the price over the next period is given by:

$$E_t[P_{t+1} - P_t] = E_t[E_{t+1}[V] - E_t[V]] = 0. \quad (2.2.3)$$

This is because by the Law of Iterated Expectations (Samuelson 1965; LeRoy 1989):

$$I_t \subset I_{t+1}, \text{ hence } E_t[E_{t+1}[V]] = E_t[V]. \quad (2.2.4)$$

Thus given information set I_t , realised changes in prices are not forecastable. This leads to the idea that market prices instantaneously and fully reflect all relevant available information and is known as the efficient market hypothesis (Fama 1970). Furthermore, the information set can be divided into three different types of information. First, the weak form information set only includes the history of prices or returns. Second, the semi-strong form of information set contains all publicly available information. Third, the strong form information set includes all information that is known, whether or not it is publicly available (Roberts 1967, Fama 1970). Jensen (1978) has further added to the definition of the efficient market hypothesis that prices reflect available information only to the extent that the marginal benefits of exploiting information exceed the cost of doing so.

2.2.1 Empirical tests of the efficient market hypothesis

One of the first empirical tests of the weak efficient market hypothesis was based on testing technical trading rules. If all information that is contained in past share prices is immediately priced into current share prices, no trading rule constructed by past price observation should be able to generate superior trading profits. Technical trading rules provide buy and sell signals for individual stocks or the aggregate stock market, and are solely based on past stock price observations. Alexander (1961) as well as Fama and Blume (1966) have applied so called $k\%$ filter rules as a test of the EMH. Here a stock is bought when it rises $k\%$ above its previous low, and held until it falls $k\%$ below its previous high. Then one goes short and holds this position until $k\%$ above the next low, to cover short and go long again. However, the authors found that after accounting for transaction costs, this trading strategy does not produce superior profits compared to a buy and hold strategy (see also Jensen and Benington 1970). This observation has been seen as strong evidence in favour of the weak form efficient market hypothesis, because the use of historical stock prices has not been able to generate above average returns.

However, more recent papers have found that some trading rules can produce superior profits. For example, Brock, Lakonishok and LeBaron (1992) show that a double-moving average rule applied to US equity prices between 1897 and 1986 generated above average returns of 17% per year. A double moving average consists of two different averages of the past stock price. For instance, the long-term moving-average might be the last 200 days average stock price, whereas the short-term moving-average might be the last 40 days average stock price. The trading rule recommends, to hold a stock as long as the short-term

moving-average is greater than the long-term moving-average, and to be short the stock as long as the short-term moving-average is smaller than the long-term moving average¹⁰.

There have been many other studies that find evidence against the weak form efficient market hypothesis by applying technical trading rules. For other stock market studies against weak efficiency see inter alia Cootner (1962), Levy (1967a), Levy (1967b), Dryden (1970a), Dryden (1970b), Akemann and Keller (1977), Brush and Boles (1983) and Brush (1986).

Early research on technical trading rules has used historical data to find patterns in stock prices and hence develop profitable (ex-post) trading rules. This methodology finds the best possible outcome and fits the possible trading rules to the historical data. As a result, technical trading rules that have been profitable ex-post might not produce profits when applied to real time data.

Furthermore, trading rules can cause high trading costs¹¹ or increase the risk in terms of higher volatility of the portfolio. As Park and Irwin (2004) have pointed out, modern technical trading rules have therefore been more focused on parameter optimization, out of sample tests, risk and cost adjustment as well as data snooping problems. The authors have distinguished those different approaches into the following sub groups.

Firstly, general or standard studies that have tested various trading rules while including risk and cost adjustment in the analysis (see inter alia Farrell and Olszewski 1993, Silber 1994, Goodacre, Bosher and Dove 1999, Kwan, Lam, So and Yu 2000, Taylor 2000,

¹⁰ We will discuss the empirical evidence regarding this model more fully below (when we discuss the empirical evidence of EMH tests in Japan).

¹¹ Trading rules that generate high turnover cause high trading costs as the portfolio has to be changed frequently and an investor has to pay buy and sell commissions.

Goodacre and Kohn-Spreyer 2001 as well as Skouras 2001). Generally many of those studies have found trading rules that have generated above market returns after accounting for trading costs or higher volatility of the portfolio. These findings contradict weak market efficiency (for further discussion of stock market examples see Taylor 2000).

Secondly, in model based bootstrapped analysis, where bootstrap methodology is applied to check the significance of trading profits (see inter alia Bessembinder and Chan 1995, Hudson, Dempsey and Keasey 1996, Mills 1997, Bessembinder and Chan 1998, Day and Wang 2002, Kwon and Kish 2002 as well as Fang and Xu 2003). In contrast to other studies that have used bootstrap methodology and that we will discuss later, model based bootstrap has analysed the same trading rules of moving averages and trading range break-outs. This methodology generates bootstrapped distributions of different trading rules, given historical stock prices, and can therefore test the statistical significance of trading profits. Overall, the results of model based bootstrapped analysis vary enormously. Generally, trading rules in established markets like the US and Japan could not generate above market returns whereas some emerging markets did show above market returns (for further discussion of the US and Japan see Ito 1999).

Thirdly, genetic programming techniques have been used to test a variety of trading strategies (see inter alia Allen and Karjalainen 1999, Wang 2000, Korczak and Roger 2002, Ready 2002 as well as Neely 2003). Genetic programming is a computer intensive search procedure. The principle is based on a Darwinian system of survival of the fittest. It starts by creating a random trading rule and then this trading rule can change and evolve over time. Successful trading rules that can generate high performance get selected, whereas poorly performing trading rules are dropped. The result shows the trading rules with the highest survival power over time. The empirical analysis of trading rules

generated by genetic programming has been very poor. Generally, genetic programming does not generate above market returns in out-of-sample forecasting. To my knowledge, genetic programming has not been applied to the Japanese stock market.

Fourthly, reality check approaches and techniques have also been applied to technical trading rules (see inter alia Sullivan, Timmermann and White 1999, Sullivan as well as Timmermann and White 2003). Reality check postulates that the re-use of data can result in satisfactory outcomes due to chance. The idea is that many data sets have been used that often that the reported trading rule results are due to chance (for a discussion see Lo and MacKinlay 1990). For instance, White (2000) suggests a bootstrap reality check methodology where the sample is used to generate bootstrapped distributions to test the significance of trading rules.

Fifthly, a long-standing method in practical asset management, chart pattern analysis, has also been investigated empirically (see inter alia Lo, Mamaysky and Wang 2000, Leigh, Paz and Purvis 2002, Leigh, Modami, Purvis and Roberts 2002, Dawson and Steely 2003 as well as Zhou and Dong 2004). Chart pattern analysis postulates the re-occurrence of price patterns that indicate future price moves. For instance, trend lines that build a lower or upper trend to an extended price move are expected to forecast the future price trend. The above mentioned researchers have found mixed results of chart pattern analysis. For instance, Levy (1971) and Osler (1998) have not found any profitable chart pattern in the US stock market, whereas Caginalp and Laurent (1998) have found a profitable chart pattern in US stocks.

Finally, nonlinear estimation methods have also been implemented and tested accordingly to verify the success of technical trading rules (see inter alia Gencay 1998a, Gencay 1998b

as well as Gencay and Stengos 1998). Non-linear estimation methods are usually based on artificial intelligence to find trading rules. Studies on trading rules generated by nonlinear estimation methods for the stock market have generally found above market returns (for further discussion see Gencay and Stengos 1998 and Fernandez-Rodriguez, Gonzalez-Martel and Sosvilla-Rivero 2000). For a general discussion of technical trading rules discussed above and the efficient market hypothesis see Park and Irwin 2004.

There is a limited amount of research that looks at the profitability of trading rules on the Japanese stock market. One is that by Bessembinder and Chan (1995) who find moving average rules produce superior trading profits in Japan. This result is comparable to earlier findings for the US by Brock, Lakonishok and LeBaron (1992) as well as Bessembinder and Chan (1998). The two studies by Bessembinder and Chan use the same methodology and test the same trading rules¹² in different markets. Instead of comparing the portfolio return generated by the trading rules with the market return, the authors calculate “break even” transaction costs. The “break even” transaction costs are the round-trip transaction costs which would just eliminate gains from technical trading. In fact, the authors find “break even” transaction costs of 0,57% for both the US and Japan, however for different time horizons. In contrast, Ratner and Leal (1998) use bootstrapping simulation and find after accounting for trading costs only one technical trading rule that has produced superior trading profits in Japan. Similar results have also been found for the US stock market (for a discussion see Ito 1999 and Brock, Lakonishok and LeBaron 1992). Genetic programming, chart pattern analysis and nonlinear estimation methods are reasonably new techniques and a reasonable comparison of the US and Japan is not possible. Although the bulk of research applies to the US stock market and research of the Japanese stock market

¹² The authors apply moving averages and range break out rules.

has lagged far behind, there seems to be no evidence of significant differences in trading rules and their profitability in the US and Japan.

Generally, some authors have suggested that the profitability of trading rules depends on the efficiency of equity markets. Therefore trading rules in well established stock markets are unlikely to be very profitable. In particular it has been argued that some emerging markets that are not well developed show higher trading rule profits than developed markets (for a discussion see Cai, Cai and Keasey 2005). As we cannot find significant differences in the profitability of technical trading rules in the US and Japan, we expect both markets to have a similar level of market efficiency. This is not as expected in chapter 1.1.2 where we thought that the differences in the legal origin and the financial system would imply that the Japanese stock market is less efficient than the US market.

There appears to be only one trading rule where US and Japanese results differ. Price momentum strategies (momentum is defined as stock price performance) where one buys the best performing stocks over a certain period against the market or against the worst performing stocks over the same period, have been reported to generate superior returns in the US (see inter alia Jagadeesh and Titman 1993, Chan, Jegadeesh and Lakonishok 1996, Chan, Hameed and Tong 2000 as well as Jagadeesh and Titman 2001), but do not yield above market returns in Japan (for a discussion see Chui, Titman and Wei 2000). The authors suggest that the different ownership structure in Japan compared to the US might be responsible for the lack of momentum profits in Japan. It appears that the share-ownership of Japanese households is below 5% (Altunbas, Kara and van Rixtel 2007), whereas the US share-ownership of private investors is around 34% (Bogle 2005). This means that in contrast to the US stock market the Japanese stock market is almost completely dominated by institutional investors. As institutional investors are constraint by

regulations and probably internal restrictions¹³, the typical investor behaviour might differ from private investors and this could impact the stock market behaviour in the US and Japan. For private investors it will be more difficult than for large institutional investors to collect large amounts of information and process the information properly. Therefore, it is likely that private investors base their investment decision more on historical price information than on sophisticated fundamental models. This could result in more price momentum behaviour of private investors compared to institutional investors.

Overall, the ownership structure could impact the stock market behaviour due to different investment behaviour of institutional and private investors. As a result, the very different ownership structure in the US and Japan could be the reason for the different momentum effects in both markets. However, it is not clear whether private investors create momentum effects or momentum investors could only survive in the US due to lower market efficiency. The findings in the literature support that the larger share of private investors in the US are responsible for momentum effects. Another argument for the lack of momentum profits in the Japanese stock market that has been reported by Chui, Titman and Wei (2000) is the different origin of the legal system. The authors find strong evidence that countries with civil law origin like Japan show no momentum profits, whereas countries with common law origin like the US show strong momentum profits. It has been argued that the absence of momentum trading in civil law countries like Japan might be explained by the greater risk of stock price manipulation. For instance Roe (2006) reports higher securities disclosure regulations and lower labour regulations in the US compared to Japan. Furthermore, the study shows much higher budgets for financial regulations in common law countries compared to civil law countries. As a result, investor protection in common law countries like the US is higher than in civil law countries like Japan. Chui,

¹³ Internal restrictions could arise from limitations of individual stock position size or risk driven investment decisions due to e.g. value at risk restrictions.

Titman and Wei (2000) suggest that stock price manipulation is more likely in civil law countries due to lower security regulations compared to common law countries. The authors argue that market manipulation can offset the momentum effect if manipulators induce negative serial correlation in stock returns. This happens when insider buy a share before positive information is released and then manipulate prices to push the prices up further. At this higher level, they can sell the shares with a profit but will bring the share price down again. As a result, the subsequent share price decline happens in less than 6 month after the initial run-up (caused by insider buying) and will therefore lower the momentum effect (i.e. insider trading cancels out momentum effect).

Overall, there is still a vivid debate on technical trading rules and the empirical studies are extensive. However, there is no clear outcome in favour or against the weak form efficient market hypothesis in the stock market. Although many studies have found evidence of superior trading profits by applying technical trading rules, the critics will point to data snooping and the probability of picking up something spurious due to over-extensive research (see inter alia White 2000 as well as Sullivan, Timmermann and White 1999). Not least the relatively easy availability of price data, and that at least “weak market efficiency” is a cornerstone of modern finance has made technical trading rule tests very popular among researchers.

Early empirical tests of semi-strong market efficiency have been based on earnings announcements and other company reports (Ball and Brown 1968, Foster, Ohlson and Shevlin 1984). It was discovered that stock prices under react to earnings news (Jones and Litzenberger 1970, Bernard and Thomas 1989, 1990, Ball 1992, Bernard 1993). This means that after positive earnings surprises stocks tend to drift up and tend to drift down after negative earnings surprises (Vieru, Perttunen and Schadewitz 2005). This earnings

announcement effect has been reported for the US, as well as the Japanese stock market (Herrmann, Inoue, Thomas 2001, Jones and Litzenberger 1970, Bernard and Thomas 1989, 1990, Ball 1992, Bernard 1993). Further evidence against the semi-strong efficient market hypothesis was based on so called calendar effects. For example Rozeff and Kinney (1976) reported that between 1904 and 1976 the average return on shares listed on the New York Stock Exchange (NYSE) is 3,06% higher in January than in the other eleven month. For a discussion of other calendar effects see Ariel (1987), Ariel (1990), Lakonishok and Schmidt (1988), French (1980), Gibbons and Hess (1981) and Harris (1986, 1989). Even so there are not many papers on calendar effects in the Japanese stock market, for instance Kato and Shallheim (1985) find a strong January and June effect in Japan whereas Jaffe and Westerfield (1985) find a weekend effect in Japanese returns. The January effect in Japan that has been reported by Kato and Shallheim (1985) shows an excess return of 2.5% in January¹⁴ and is comparable to the January effect in the US that has been reported by Rozeff and Kinney (1976). Furthermore, Hansen and Lunde (2003) also support calendar effects in the Japanese stock market. Overall, most calendar effects have been reported in the US, but there is also evidence in favour of calendar effects in Japan.

Researchers have found some fundamental factors to have predictable power in the cross section of US stock market returns. Basu (1977) showed that stocks with low price to earnings ratios earned significantly higher returns than stocks with high price to earnings ratios. This low price to earnings effect has been supported by many other empirical investigations (see inter alia Nicholson 1960, Chan, Hamao and Lakonishok 1991, Dreman 1998, Lakonishok, Shleifer and Vishny 1994). Banz (1981) discovered the small firm effect where positive excess returns can be generated by investing in stocks with low market capitalisation. Another important factor return that has been reported in empirical

¹⁴ The excess return in January reported by Kato and Shallheim is 5,23% higher than in the other eleven month.

research is the price to book factor where companies with low price to book ratio outperform the general market (see inter alia Rosenberg, Reid and Lanstein 1985, Chan, Hamao and Lakonishok 1991, Fama and French 1992).

Although most of the empirical analysis has been done in the US stock market, the price to earnings, price to book and size effect have also be found in Japan (for a discussion see Chan, Hamao and Lakonishok 1991, Claessens, Dasgupta and Glen 1995). For instance, Haugen and Baker (1996) find a comparable size of the price to book effect in the US and Japan whereas the price to earnings effect is stronger in the US between 1985 and 1993.

We will not discuss evidence on the strong form of the EMH here since lack of data availability means very little work has been done in this area. However, there is anecdotal evidence of people who made large profits by using illegal information¹⁵.

As we will focus on macroeconomic variables and the stock market, technical trading rules will not be investigated in this thesis. However, empirical research on trading rules in the US and Japan reveals some differences that might be attributed to the ownership structure and the origin of the legal system in the US and Japan (Chui, Titman and Wei 2000). In particular, the authors find weak evidence that stocks held by foreign investors in Japan exhibit more momentum than stock that are not held by foreign investors. This could be caused by cultural and institutional differences. However, they find strong evidence that countries with common law origin like the US show strong momentum, whereas countries with civil law origin like Japan show no momentum effects. It has been argued that the absence of momentum trading in civil law countries like Japan might be explained by the

¹⁵ For instance the case of Ivan Boesky in the USA and Geoffrey Collier in the UK illustrate that abnormal profits can be generated by using illegal information. On the contrary, the risk-return relationship might not be favourable as the user of illegal information has the risk of being caught and sent to prison.

greater risk of stock price manipulation. Our macroeconomic investigation of the stock market shows differences between the US and Japan, the ownership structure and the legal system possibly playing a role.

However, overall it should be mentioned that although there is evidence of stock market predictability, this does not necessarily mean that stock markets are not efficient. As Pesaran (2005) has pointed out: “Only under risk neutrality, where marginal utility was constant, the equilibrium condition implied the non-predictability of excess returns”. This means that stock market predictability and stock market efficiency would only be equal under risk neutrality and constant marginal utility.

2.2.2. Summary

In this section we have given a brief overview of the origins of modern financial econometrics and the efficient market hypothesis. Furthermore, we have shown many early tests of market efficiency that have revealed stock market anomalies. Although most of those market anomalies have been reported in the US, many have also been supported in Japan. Therefore, we have found evidence in the literature that technical trading rules like double moving average rules have produced superior profits in the US and Japan. In addition, there is good evidence in the literature in favour of the earnings announcement effect, size effect, calendar effects and valuation ratio effects, like the price to book or price to earnings effect for both countries, the US and Japan. Generally, most findings are comparable and give us a hint that both stock markets have the same level of efficiency. As discussed in chapter 1.1.2, there are institutional differences between the US and Japan but the above evidence indicates that those differences have no major effect on the stock

market efficiency. This is contrary to what we have expected in chapter 1. For this reason we would not expect those markets to behave in a much different way when it comes to speediness of response to news. This implies that if we do find major differences between the US and Japan, it is likely that those differences are due to economic development and not institutional differences or market efficiency.

However, there is one notable exception of trading rules that have not been supported in Japan, namely momentum profits. As those momentum profits have not been found in Japan, this implies that simple trend followers will find it very difficult to survive in Japan whereas the same stock market players have had a good survival power in the US. For this reason, we would expect the window of opportunity for momentum players to be much smaller or non-existent in Japan, whereas it should exist in the US. We will investigate this issue further in section 5 where we test a model of noise traders and informed traders applied to the dividend yield in the US and Japan.

2.3 Portfolio selection and asset pricing

In this section we will give a short review of portfolio selection and choice under uncertainty, as this builds the foundation for the relevant asset-pricing models. Then a detailed overview of relevant asset-pricing models is given. More precisely, the theory of the consumption based asset-pricing, capital asset-pricing, intertemporal capital asset-pricing, arbitrage pricing, multifactor, present value and rational bubble models are summarised. We also summarise and contrast the empirical findings of those models, where the emphasis will be upon a comparison of the US and Japan. However, we will not cover behavioural finance theory in this section, but in the non-linear chapters 3 and 4 as it starts with looking at anomalies in human behaviour and then tries to build a theory that

fits the stylised facts. Therefore, behavioural finance theory is a descriptive theory and forms models inductively compared to deductive theories that are formed from axioms (Thaler 1994a, 1994b).

2.3.1 Choice under uncertainty and the consumption of risk and return

When two investment opportunities have the same expected rate of return, most investors would choose the less risky one. Such an investor is called risk averse, whereas an investor who does not care about the risk and would be indifferent as to the two investments is called risk neutral. The third possibility is an investor seeking risk and thus preferring the more risky of the two investments. The underlying explanation why most investors are risk averse is that they have diminishing marginal utility of wealth due to concave utility functions defined on individual's wealth. As one's wealth increases, utility or satisfaction increases as well, but at a diminishing rate. Thus, at a given level of wealth, a one unit increase in wealth increases utility by less than a one unit decrease in wealth decreases utility. Essentially, additional or marginal increments to wealth increase utility by successively smaller amounts. Therefore concave utility functions explain why a risk averse investor chooses the less risky asset when two assets offer the same expected return.

Assume that the first investment opportunity gives a certain return of r_f whereas the alternative gives a 50% probability of getting a return of $r_f + x$ and a probability of 50% of getting a return of $r_f - x$. Thus the expected return of both investments is the same, namely r_f . However, the concave utility function shows, that the 50% outcome $r_f - x$ has a larger utility loss as the 50% chance of $r_f + x$ has utility gain. So the expected return is the same but the expected utility is smaller than the certain outcome. It is important to note, that this is the definition of decision making under uncertainty and outcomes can only be associated

with probabilities. Thus expected returns are the probability weighted outcomes of return and are not certain (for a discussion see Blake 2000).

The major problem with this definition of risk aversion in terms of the utility of wealth and the expected utility of wealth is that utility or expected utility is not observable or objectively measurable. Hence the utility of one investor is not directly comparable with the utility of another investor. To get around this problem, the utility function is modified and instead of the level of wealth invested in the risky asset, the difference between the wealth in the risky asset at the end of a period is compared to the wealth at the beginning of that period. Therefore a second order Taylor's expansion of the expected return on the portfolio may be taken in order to give an approximation of expected utility which depends on the expected return of the portfolio and the variance of the return of the portfolio. The advantage of this formulation is that both, return and variance of return, is easily measurable and can approximate expected utility of an investor.

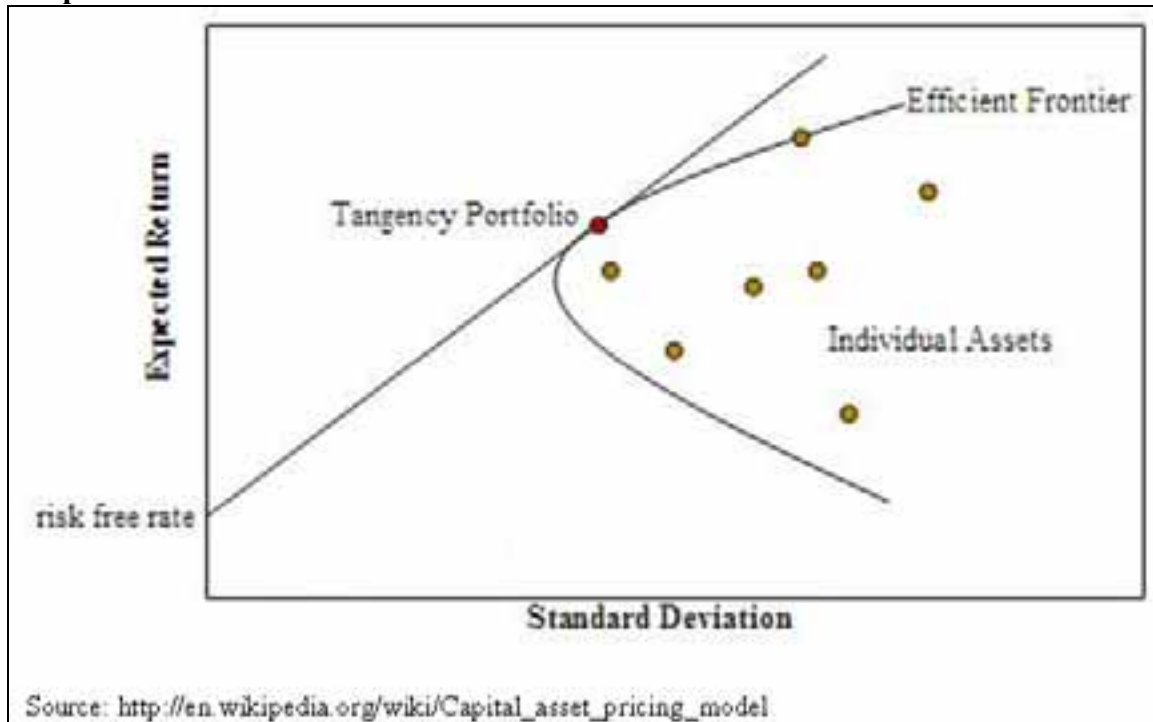
The intuition is that the higher the variance of return, the greater the risk associated with this return. This definition of utility according to return and variance of return leads to the investor's choice between risk and return. Thus, on the basis of these utility curves, sets of indifference curves can be found. Indifference curves satisfy the property that expected utility, here defined as trade-off between risk and return, is constant along them. This means that there is a different indifferent curve for every utility level. Concave utility functions, produced by risk aversion, give rise to convex indifferent curves, defined by mean return and standard deviation. The slope of the indifferent curves depends on the coefficient of absolute risk aversion and very high risk aversion gives rise to very convex indifferent curves. Thus, the greater the risk aversion, the greater the trade-off between consuming risk and return. The preferred measure of portfolio risk is the standard deviation

of the portfolio return, instead of variance, since it is measured in the same units as return (for a discussion see Blake 2000).

On the production side of portfolios under uncertainty, the risk return characteristic of a portfolio depends on the risk and return of the individual securities in the portfolio and the proportion of each security held. This leads to the idea of diversification or the process of combining securities in a portfolio with the aim of reducing total risk but without sacrificing portfolio return. The naive intuition of diversification is not to put all eggs into one basket whereas the statistical definition of diversification is based on the correlation between different securities.

Markowitz (1959) has shown that combining securities with less than perfectly positively correlated returns can reduce risk without sacrificing return. Assuming there are n assets in the economy, one can construct portfolios using some or all of these assets. So given all the combinations of different assets and different weightings of these assets, the set of every possible portfolio gives the economy's portfolio opportunity set. On the upper outer line of this opportunity set, the so called efficient portfolios can be found and are defined by the lowest expected standard deviation for a given level of expected return. The other combinations of assets do not build an efficient portfolio, since either at the same expected risk, one can find a portfolio with higher expected return, or for a given expected return exists a portfolio with lower expected risk. The following diagram illustrates the efficient frontier.

Graph 1: Efficient Frontier



The portfolio an investor would choose is given by the point of tangency between the investor's indifference curve and the efficient set of risky portfolios. Extending this model by the possibility of risk less lending and borrowing, the tangency between the risk less asset and the risky assets efficient set gives the capital market line. Portfolios along the capital market line are derived from borrowing and lending at the risk-less rate of interest in the capital market and investing in the market portfolio. The slope of the capital market line shows the rate at which risk and return can be traded off against each other.

2.4 Asset pricing

In this section theoretical and empirical facts concerning the consumption based asset-pricing, capital asset-pricing, intertemporal capital asset-pricing, arbitrage pricing, multifactor, present value and rational bubble models are summarised. The objective is to summarise and contrast the empirical findings in the US and Japan.

2.4.1 Consumption based model

For the technical content on theoretical asset pricing we will mainly follow Cochrane's 2001 book about asset-pricing. On a theoretical basis it seems to make sense to start with the consumption based capital asset pricing model (C-CAPM), even so on a historical and empirical basis the capital asset pricing model (CAPM) comes first. For this reason, we will start to explain the C-CAPM, CAPM and then the intertemporal capital asset-pricing model (I-CAPM) in this chapter. However, in the empirical literature review we will start with the CAPM and then follow with I-CAPM and C-CAPM as empirical history suggests.

The basic decision an investor has to make is how much to consume and how much to save in different assets. The first order condition of this is again described by the marginal utility of consumption. Hence, the marginal utility of consuming less today and buying more of an asset instead, should equal the marginal utility gain of having more of the asset's payoff in the future. So the asset price should be equal to the value of the discounted asset's payoffs, given the investor's marginal utility as the discount rate. Discount rates and hence interest rates are related to marginal utility growth and therefore the expected future consumption. Thus a high real interest rate would allow agents saving more today in order to consume more in the future. The interesting thing to note is that risk corrections to asset prices are determined by the covariance between consumption or marginal utility and the asset's payoffs. To put it very simply, an asset that does well during recessions when people possibly suffer from lower income should be more expensive than an asset that does very poorly during recessions and is less desirable (Cochrane, 2001). So the more risky asset should trade at a discount in order to compensate for the higher risk and this discount is determined by the co-variance between the asset's payoffs and consumption. Investor's behaviour can be modelled with a convenient utility function of current over future values of consumption in form of:

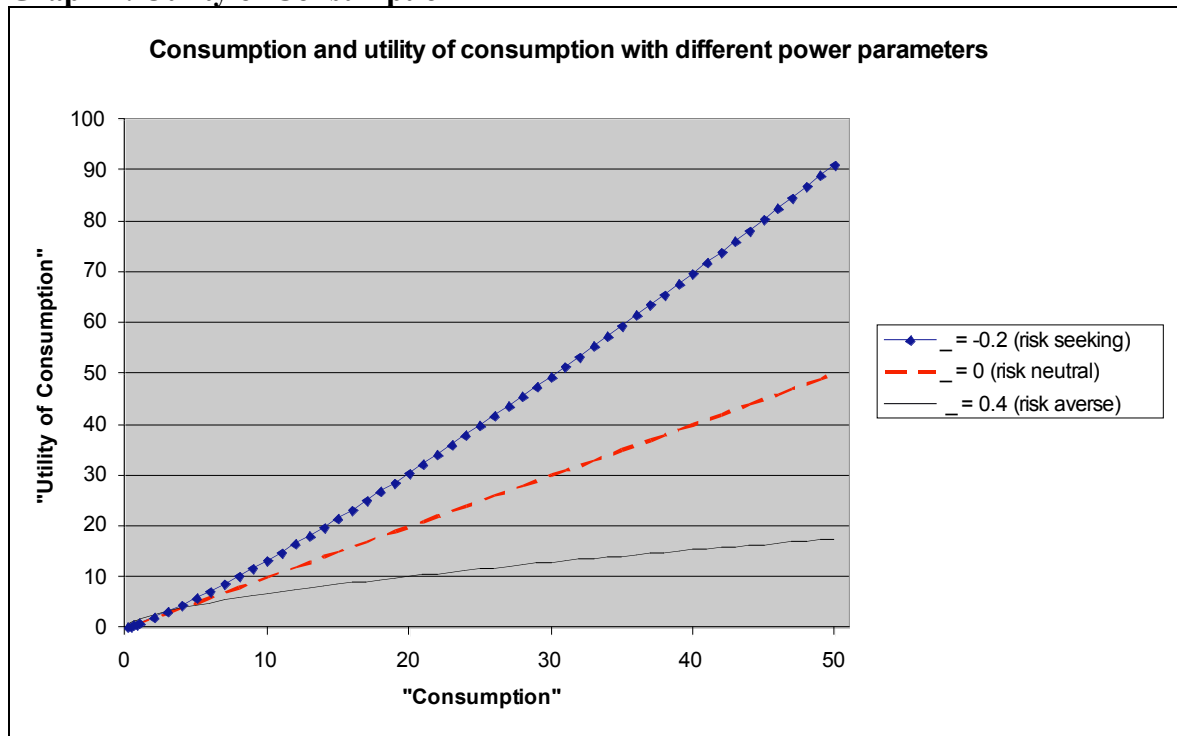
$$U(c_t, c_{t+1}) = u(c_t) + \beta E_t [u(c_{t+1})] \quad (2.4.1)$$

where “U” is total utility, $u(c_t)$ and $u(c_{t+1})$ are time t and $t+1$ utility functions, c_t is consumption at time t while c_{t+1} equals consumption at time $t+1$. The “ β ” is the subjective discount factor and captures investors’ impatience. E_t refers to expected at time t . In a two period model, total expected utility is the sum of the utility of consumption today plus the expected utility of consumption in the next period discounted by the subjective discount rate. The form of the utility function is usually described by:

$$u(c_t) = \frac{1}{1-\gamma} c_t^{1-\gamma}. \quad (2.4.2)$$

The power parameter γ indicates the relative risk aversion. In case γ equals to zero, the utility function becomes linear and therefore shows no risk aversion. A power parameter γ that is greater than zero reflects risk aversion (see diagram below).

Graph 2: Utility of Consumption



If an investor can buy and sell an asset's payoff x_{t+1} at a price p , given the original consumption level “ e ” and amount of the asset that is going to be bought or sold denoted ξ , we get.

$$\max_{\xi} u(c_t) + E_t [\beta u(c_{t+1})] \quad \text{with the constraints } c_t = e_t - p_t \xi \quad \text{and } c_{t+1} = e_{t+1} + x_{t+1} \xi.$$

The first order condition for an optimal consumption and portfolio choice is derived by applying the above constraints into the objective and setting the derivative with respect to ξ equal to zero:

$$p_t u'(c_t) = E_t [\beta u'(c_{t+1}) x_{t+1}] \quad (2.4.3)$$

or as an alternative:

$$p_t = E_t \left[\beta \frac{u'(c_{t+1})}{u'(c_t)} x_{t+1} \right]. \quad (2.4.4)$$

Given this condition, the investor buys or sells the asset until the condition holds. That is the marginal loss of buying another unit of the asset equals the marginal gain of increased discounted expected utility from extra payoff at $t+1$. So given the investor's consumption choice c_t , c_{t+1} as well as the payoff x_{t+1} and the investor's specific utility function, the expected market price can be determined. This is simply the first order condition for optimal consumption and portfolio formation. A reduction in real consumption by one dollar today, reduces the consumption today, but results in an expected return on the asset that has been bought instead. As a result, the return on the asset that has been bought, gives the possibility of higher consumption in the next period. Therefore, the expected utility of consumption for the next period increases by the extra return of the asset that has been bought by reducing consumption in the former period. This extra consumption in the next period must then be discounted to get the utility of the extra consumption in the next period for today. In the basic consumption based pricing equation, the stochastic discount factor m_{t+1} is defined as:

$$m_{t+1} = \beta \frac{u'(c_{t+1})}{u'(c_t)} . \quad (2.4.5)$$

The stochastic discount factor or marginal rate of substitution m_{t+1} is the rate at which an investor is willing to substitute consumption at time $t+1$ for consumption at time t . Therefore, the asset price p_t depends on the expected stochastic discount factor and the expected asset payoff:

$$p_t = E_t(m_{t+1} x_{t+1}) \quad (2.4.6)$$

Assume now a certain world. The asset price p_t depends now on the expected asset payoff discounted by the risk free rate (i.e $p_t = \frac{1}{R_t} x_{t+1}$ where R_t represents a so called gross risk free rate). Hence, without uncertainty the stochastic discount factor depends on the risk free rate only:

$$E_t m_{t+1} = \frac{1}{R_f} \quad (2.4.7)$$

For a specific risky asset, the discount rate has to be represented by an asset specific risk adjusted discount factor $\frac{1}{R_i}$. The risk free rate is related to the discount rate:

$$\beta \frac{u'(c_{t+1})}{u'(c_t)} = \frac{1}{R_f} . \quad (2.4.8)$$

Hence we can re-formulate this to:

$$R_f = \frac{1}{\beta} \left(\frac{u'(c_{t+1})}{u'(c_t)} \right) . \quad (2.4.9)$$

Under power utility we get the following equation:

$$R^f = \frac{1}{\beta} \left(\frac{c_{t+1}}{c_t} \right)^\gamma . \quad (2.4.10)$$

The log risk-free rate r_t^f and the subjective discount factor δ are defined as:

$$r_t^f = \ln R_t^f \quad ; \quad \beta = e^{-\delta}.$$

The first difference operator is denoted by Δ :

$$\Delta \ln c_{t+1} = \ln c_{t+1} - \ln c_t.$$

We can write:

$$R_t^f = 1 / E_t \left[\beta \left(\frac{c_{t+1}}{c_t} \right)^{-\gamma} \right]. \quad (2.4.11)$$

A standard statistical result is that if Z is lognormal, then $\ln Z \sim N(\mu_{\ln Z}, \sigma_{\ln Z}^2)$ and:

$$E(e^z) = e^{E(z) + (1/2)\sigma^2(z)}.$$

Assuming a lognormal distribution for consumption growth and power utility, we get:

$$R_t^f = \left[e^{-\delta} e^{-\gamma E_t(\Delta \ln c_{t+1}) + (\gamma^2/2)\sigma_t^2(\Delta \ln c_{t+1})^{-1}} \right]. \quad (2.4.12)$$

Taking the logarithms gets:

$$r_t^f = \delta + \gamma E_t(\Delta \ln c_{t+1}) - \frac{\gamma^2}{2} \sigma_t^2 \frac{2}{t} (\Delta \ln c_{t+1}). \quad (2.4.13)$$

So real interest rates are high when people's impatience δ or $\frac{1}{\beta}$ is high. When people are

impatient and discount future consumption heavily, savings can only be encouraged by high real interest rates. Obviously if everybody wants to consume now, it needs high interest rates to make people save today and consume later. This means, high interest rates lower consumption growth of today, and increase savings in order to raise future consumption growth. Thus real interest rates impact upon intertemporal substitution. Given a larger power parameter γ , real interest rates are more sensitive to consumption growth. A highly curved utility function makes the investor care more about sticking to a certain consumption profile over time and hence makes him less willing to change consumption in response to changes in the interest rate. Higher expected consumption growth requires a higher real interest rate, because a higher power parameter γ implies less willingness to

deviate from a smooth consumption path over time. Precautionary saving is captured by σ^2 . Hence with higher consumption volatility, people are more worried about low future states of consumption and make precautionary savings in order to overcompensate possible future shortfalls. As a result, real interest rates are driven lower (for further discussion see Cuthbertson and Nitzsche 2004).

In order to derive the C-CAPM model we note, intuitively that an asset that has a high correlation with consumption growth should trade at a lower price than an asset that has a lower correlation with consumption growth.

When we define the covariance $\text{cov}(m, x) = E(mx) - E(m)E(x)$, we can write:

$$p_t = E(mx) \quad \text{or} \quad p_t = E(m)E(x) + \text{cov}(m, x). \quad (2.4.14)$$

Using the risk-free rate equation $R^f = 1 / E(m)$, we get:

$$p_t = \frac{E(x)}{R^f} + \text{cov}(m, x). \quad (2.4.15)$$

Thus the term $\frac{E(x)}{R^f}$ is the standard discounted value formula that would apply in a risk-neutral world, whereas the term $\text{cov}(m, x)$ is a risk adjustment. Therefore, asset returns that co-vary positively with consumption will have to offer a high expected return, in order that investors are willing to hold the asset. Such an asset pays off when consumption is high, and consumers are already “happy” and so the higher return gives them little additional utility. In contrast, asset returns that co-vary negatively with consumption provide insurance against “hard” times and will be willingly held, even if they promise a low expected return (see Cuthbertson and Nitzsche 2004).

For individual securities this means:

$$p_t = \frac{E(x)}{R^f} + \frac{\text{cov}[\beta u'(c_{t+1}), x_{t+1}]}{u'(c_t)}. \quad (2.4.16)$$

This shows that the co-variance between the pay off x_{t+1} with consumption determines if an asset trades at a high or low price. Since investors want to have a smooth consumption growth path, they prefer assets with payoffs that do not positively co-vary heavily with consumption. Assuming a special situation, where the price of a risky asset is equal to one and the payoff is expressed as a payoff, we can write:

$$1 = E(mR^i), \quad (2.4.17)$$

with m being the stochastic discount factor and R^i the asset return. The idea of asset-pricing under C-CAPM is that even if expected returns can vary across time and assets, expected discounted returns should always be the same. In the co-variance decomposition we get:

$$1 = E(m)E(R^i) + \text{cov}(m, R^i), \quad (2.4.18)$$

and introducing the risk free rate assumption $R^f = 1 / E(m)$, we get:

$$E(R^i) - R^f = -R^f \text{cov}(m, R^i), \quad (2.4.19)$$

and hence:

$$E(R^i) - R^f = -\frac{\text{cov}[u'(c_{t+1}), R_{t+1}^i]}{E[u'(c_{t+1})]}. \quad (2.4.20)$$

Thus the C-CAPM model predicts that all assets have an expected return of the risk-free rate plus a risk adjustment. Assets with returns that heavily co-vary positively with consumption make consumption more volatile. For that reason these assets must trade at a lower price in order to have higher expected returns in order to convince investors to hold them. On the other hand, an extreme example is an insurance contract, which generally has a very low or even negative expected rate of return, but co-varies negatively with

consumption. Thus you get money when you crash your car and really need the funds to buy a new one (Cochrane 2001).

A payoff can be split into a part that is correlated with the discount factor and the remaining part that is not correlated with the discount factor. The correlated part represents the systematic risk and the uncorrelated part the idiosyncratic risk. As a result, the idiosyncratic component of any payoff is that part uncorrelated with m and only the systematic component of a payoff accounts for its price.

The expected return equation can be expressed as follows:

$$E(R^i) = R^f + \left(\frac{\text{cov}(R^i, m)}{\text{var}(m)} \right) \left(- \frac{\text{var}(m)}{E(m)} \right) \quad (2.4.21)$$

or in beta representation with $\beta_{i,m}$ being the regression coefficient of the Return R^i on m :

$$E(R^i) = R^f + \beta_{i,m} \lambda_m. \quad (2.4.22)$$

This is a beta pricing model where each expected return should be proportional to the regression coefficient, or beta, in a regression of that return on the discount factor m . The coefficient λ_m is the same for all assets ($i=1, \dots, I$), while $\beta_{i,m}$ varies from asset to asset. Here the price of risk is λ_m and the quantity of risk is given by $\beta_{i,m}$. The price of risk λ_m depends

on the volatility of the discount factor. Assuming power utility $m = \beta(c_{t+1} / c_t)^{-\gamma}$ we can

take a Taylor expansion $E(R^i) = R^f + \left(\frac{\text{cov}(R^i, m)}{\text{var}(m)} \right) \left(- \frac{\text{var}(m)}{E(m)} \right)$, in order to get feasible

variables such as consumption growth instead of marginal utility. After some algebra it is possible to show:

$$E(R^i) = R^f + \beta_{i,\Delta c} \lambda_{\Delta c} \text{ with } \lambda_{\Delta c} = \gamma \text{var}(\Delta c) \quad (2.4.23)$$

(see Cochrane 2001 for more details).

So the expected return should linearly increase with the beta on consumption growth and $\lambda_{\Delta c}$ is the factor risk premium that depends upon risk aversion and the volatility of consumption (Cochrane 2001). The empirical evidence of the consumption based asset pricing model in the stock market will be discussed in section 2.4.4 of this chapter.

2.4.2 Capital Asset Pricing Model (CAPM)

For the technical content of the CAPM definition we will mainly follow Blake (2000). The Capital Asset Pricing Model (CAPM) was developed by Sharpe (1964) as well as Lintner (1965) and is a single factor equilibrium model for asset pricing. The model is based on utility maximisation as well as a given portfolio opportunity set. Thus equilibrium asset prices are determined by the supply and demand for assets. Assuming an individual investor v with the following utility function:

$$\bar{u}_v = \bar{u}_v(\bar{r}_{pv}, \bar{\sigma}_{pv}^2), \quad (2.4.24)$$

where the utility depends on the expected return of the investor's portfolio \bar{r}_{pv} and the variance of the return on the investor's portfolio $\bar{\sigma}_{pv}^2$.

$$\bar{r}_{pv} = \left(\frac{1}{\varphi_v} \right) \left(\sum_{i=1}^N \varpi_{iv} \bar{r}_i - \varpi_{n+1,v} r_f \right), \quad (2.4.25)$$

with φ_v being the investor's wealth in proportion to total wealth and ϖ_{iv} is the investor's weight in security i while \bar{r}_i is the expected return of security i . The risk free rate is r_f while ϖ_{N+1} is riskless debt.

$$\bar{\sigma}_{pv}^2 = \left(\frac{1}{\varphi_v} \right)^2 \left(\sum_{i=1}^N \sum_{j=1}^N \varpi_{iv} \varpi_{jv} \sigma_{ij} \right), \quad (2.4.26)$$

where σ_{ij} is the co-variance between security i and security j . The budget constrain of investor v is given by:

$$\left(\frac{1}{\varphi_v} \right) \left(\sum_{i=1}^N \varpi_{iv} - \varpi_{N+1,v} \right) = 1. \quad (2.4.27)$$

The investor v has the aim to maximise the utility function $\bar{u}_v = \bar{u}_v(\bar{r}_{pv}, \bar{\sigma}_{pv}^2)$ given the

$$\text{budget constrain } \left(\frac{1}{\varphi_v} \right) \left(\sum_{i=1}^N \varpi_{iv} - \varpi_{N+1,v} \right) = 1.$$

The first order condition for a maximum with the Lagrange multiplier λ_v for investor v is

described by:

$$\frac{\partial \bar{u}_v}{\partial \bar{r}_{pv}} \diamond \frac{\partial \bar{r}_{pv}}{\partial \varpi_{iv}} + \frac{\partial \bar{u}_v}{\partial \sigma_{pv}^2} \diamond \frac{\partial \sigma_{pv}^2}{\partial \varpi_{iv}} + \lambda_v \left(\frac{1}{\varphi_v} \right) = \frac{\partial \bar{u}_v}{\partial \bar{r}_{pv}} \left(\frac{1}{\varphi_v} \right) \bar{r}_i + \frac{\partial \bar{u}_v}{\partial \sigma_{pv}^2} \left[2 \left(1 / \varphi_v \right)^2 \sum_{j=1}^N \varpi_{jv} \sigma_{ij} \right] + \lambda_v \left(\frac{1}{\varphi_v} \right) = 0$$

as well as:

$$\frac{\partial \bar{u}_v}{\partial \bar{r}_{pv}} \diamond \frac{\partial \bar{r}_{pv}}{\partial \varpi_{N+1,v}} + \frac{\partial \bar{u}_v}{\partial \sigma_{pv}^2} \diamond \frac{\partial \sigma_{pv}^2}{\partial \varpi_{N+1,v}} - \lambda_v \left(\frac{1}{\varphi_v} \right) = \frac{\partial \bar{u}_v}{\partial \bar{r}_{pv}} \left[- \left(1 / \varphi_v \right) r_f \right] - \lambda_v \left(\frac{1}{\varphi_v} \right) = 0$$

and substituting the second equation into the first, so that λ_v is eliminated:

$$\frac{\partial \bar{u}_v}{\partial \bar{r}_{pv}} (\bar{r}_i - \bar{r}_f) + \frac{\partial \bar{u}_v}{\partial \sigma_{pv}^2} \left[2 \left(\frac{1}{\varphi_v} \right)^2 \sum_{j=1}^N \varpi_{jv} \sigma_{il} \right] = 0, \quad i = 1, \dots, N. \quad (2.4.28)$$

This equilibrium relationship must hold for all investors and all securities. Thus this

relationship must also hold for pairs of securities and using security i and k , we get:

$$\frac{\frac{\partial \bar{u}_v}{\partial \bar{r}_{pv}} (\bar{r}_i - \bar{r}_f) - \frac{\partial \bar{u}_v}{\partial \sigma_{pv}^2} \left[2 \left(\frac{1}{\varphi_v} \right)^2 \sum_{j=1}^N \varpi_{jv} \sigma_{ij} \right]}{\frac{\partial \bar{u}_v}{\partial \bar{r}_{pv}} (\bar{r}_k - \bar{r}_f) - \frac{\partial \bar{u}_v}{\partial \sigma_{pv}^2} \left[2 \left(\frac{1}{\varphi_v} \right)^2 \sum_{j=1}^N \varpi_{jv} \sigma_{kj} \right]} = 1, \quad (2.4.29)$$

or simply:

$$\frac{\bar{r}_i - \bar{r}_f}{\sum_{j=1}^N \varpi_{jv} \sigma_{ij}} = \frac{\bar{r}_k - \bar{r}_f}{\sum_{j=1}^N \varpi_{jv} \sigma_{kj}}, \quad (2.4.30)$$

In market equilibrium, the following is true for all securities:

$$\sum_{v=1}^V \varpi_{jv} = \theta_j, \quad j = 1, \dots, N. \quad (2.4.31)$$

Thus we get:

$$\frac{\bar{r}_i - r_f}{\sum_{j=1}^N \theta_j \sigma_{ij}} = \frac{\bar{r}_k - r_f}{\sum_{j=1}^N \theta_j \sigma_{kj}} = \pi, \quad (2.4.32)$$

with π being a common ratio for all securities. Summing up all securities and multiplying the nominator and denominator by θ_k gives:

$$\frac{\sum_{k=1}^N (\bar{r}_k \theta_k - r_f \theta_k)}{\sum_{k=1}^N \sum_{j=1}^N \theta_k \theta_j \sigma_{kj}} = \frac{\bar{r}_m - r_f}{\sigma_m^2} = \pi, \quad (2.4.33)$$

with \bar{r}_m being the expected return on the market portfolio and σ_m^2 being the variance of the return on the market portfolio. Substitution of the last two equations gives us the capital asset pricing model:

$$\bar{r}_i = r_f + \frac{\bar{r}_m - r_f}{\sigma_m^2} \frac{\sigma_{im}}{\sigma_m} = r_f + (\bar{r}_m - r_f) \beta_i, \quad (2.4.34)$$

with the co-variance of the returns on the i_{th} security with the market being:

$$\sigma_{im} = \sum_{j=1}^N \theta_j \sigma_{ij}, \quad (2.4.35)$$

and the beta of i_{th} security given by covariance between i_{th} security and market divided by variance of the market:

$$\beta_i = \frac{\sigma_{im}}{\sigma_m^2}. \quad (2.4.36)$$

This approach defines the quantity of risk by the amount of undiversifiable or systematic market risk. Thus in equilibrium an investor does not get paid for taking on any “non-systematic” risk because it can be easily diversified away.

The CAPM is a special case of the C-CAPM model that has been explained earlier already. The CAPM can be derived from the C-CAPM by assuming that the market portfolio of all risky assets is perfectly negatively correlated with the marginal utility of consumption. Therefore, the CAPM assumes that investors are only concerned about their investment portfolio and neglect how returns on that portfolio might depend on the economic development. For instance, during recessions labour income could suffer and an investor would be willing to hold an asset with low expected return if it pays off in recessions. In such a case, the C-CAPM incorporates the negative correlation between consumption growth and the assets' payoff (see Cuthbertson and Nitzsche 2004 for further discussion).

2.4.3 Intertemporal Capital Asset Pricing Model (ICAPM)

For the technical content of the ICAPM definition we will follow Cochrane (2001). Using the consumption based framework explained earlier, the ICAPM is a linear factor model where the factors or state variables forecast changes in the distribution of future returns or income. This model was first introduced by Merton (1973). Although in theory the C-CAPM can answer many asset-pricing questions, the empirical evidence is rather poor (we will discuss this later). For that reason, researches have tried to link other factors to the discount factor. The ICAPM generates linear discount factors. Those factors are based on state variables for the investor's consumption portfolio decision:

$$m_{t+1} = a + b' f_{t+1} . \quad (2.4.37)$$

Where f are factors, a and b parameters whereas m is the stochastic discount factor. The idea is that the discount factor m does not only depend upon consumption but other factors. This can also be expressed as a multiple beta model in the form:

$$E(R_{t+1}) = \gamma + \beta' \lambda . \quad (2.4.38)$$

Here γ and λ represent free parameters whereas β are multiple regression coefficients of returns R on the factors f . However, the remaining question is what should one use for factors? In general, factor pricing model seek variables that approximate aggregate marginal utility growth. This can be expressed by:

$$\beta \frac{u'(c_{t+1})}{u'(c_t)} \approx a + b' f_{t+1}. \quad (2.4.39)$$

Therefore, the idea is to find factors that are relevant for the performance of investors' portfolios. Such factors must indicate special states of the world where portfolio returns might be very poor and investors concerned about their payoffs. Hence, investors are willing to sacrifice some overall expected return if an asset does well during "hard times". The factors that should be incorporated in ICAPM are variables that indicate when "hard times" happened. These often include macro economic variables that may tell us something more about "other" states of the world that influence utility. For instance, consumption is related to interest rates, GDP growth, inflation and other macro-economic variables. Those macro variables can therefore measure the state of the economy.

How well the investor can do in his maximisation problem is given by the state variables. Current wealth is an apparent state variable whereas additional state variables describe the conditional distribution of asset returns that the agent will face in the future or are given by shifts in the investment opportunity set. Optimal consumption is therefore a function of the state variables and this fact can be used to substitute out consumption, in order to get:

$$m_{t+1} = \beta \frac{u'[g(z_{t+1})]}{u'[g(z_t)]}. \quad (2.4.40)$$

A simple linearization can be used to derive that the state variables z_{t+1} are factors. As an alternative, the value function depends on the state variables and hence:

$$V(W_{t+1}, z_{t+1}), \quad (2.4.41)$$

and thus:

$$m_{t+1} = \beta \frac{V_w(W_{t+1}, z_{t+1})}{V_w(W_t, z_t)}. \quad (2.4.42)$$

Since the value of a unit of money must be the same in any use, we have:

$$u'(c_t) = V_w(W_t, z_t). \quad (2.4.43)$$

A Taylor approximation can be used to obtain a linear relation and using Stein's lemma¹⁶

while assuming normality, we get in continuous time:

$$\Lambda_t = e^{-\delta t} V_w(W_t, z_t), \quad (2.4.44)$$

so that:

$$\frac{d\Lambda_t}{\Lambda_t} = -\delta dt + \frac{W_t V_{ww}(W_t, z_t)}{V_w(W_t, z_t)} \frac{dW_t}{W_t} + \frac{V_{wz}(W_t, z_t)}{V_w(W_t, z_t)} dz_t + (\text{second derivatives term}). \quad (2.4.45)$$

The elasticity of marginal value with respect to wealth or the coefficient of relative risk aversion, is defined as:

$$rra_t \equiv -\frac{W V_{ww}(W_t, z_t)}{V_w(W_t, z_t)}. \quad (2.4.46)$$

This captures the investor's reluctance to take money or wealth bets. In order to get ICAPM in relating expected returns to the co-variance of returns with wealth and other state variables, we derive:

$$E \frac{dp_t^i}{p_t^i} + \frac{D_t^i}{p_t^i} dt - r_t^f dt = raa_t E \left(\frac{dW_t}{W_t} \frac{dp_t^i}{p_t^i} \right) - \frac{V_{wz,t}}{V_{w,t}} E \left(dz_t \frac{dp_t^i}{p_t^i} \right). \quad (2.4.47)$$

The ICAPM can than also be expressed as:

¹⁶ Applying Stein's lemma it can be shown that if X and Y are jointly normally distributed random variables and function h: R→R is differentiable with E(|h'(Y)|) < ∞, then Cov(X, h(Y)) = E(h'(Y))Cov(X, Y).

$$E_t(R_{t+1}^i) - R_t^f \approx rra_t \text{cov}_t(R_{t+1}^i, \Delta W_{t+1}/W_t) + \lambda_{zt} \text{cov}_t(R_{t+1}^i, \Delta z_{t+1}). \quad (2.4.48)$$

The expression rra_t is called the coefficient of relative risk aversion and shows the elasticity of marginal value with respect to wealth. Covariance can be substituted by the wealth portfolio in place of covariance with wealth and thus shocks to the two are the same. For the other factors dz , factor-mimicking portfolios can be used (Cochrane, 2001).

Many empirical papers that have motivated the independent variables by ICAPM justify their choice of the theoretical model with the proposition that the C-CAPM does not work. However, the ICAPM and the C-CAPM are not alternative models but rather the ICAPM is a special case of the C-CAPM. In both models the discount factor is described by $m_{t+1} = \beta u'(c_{t+1})/u'(c_t)$. The ICAPM only makes assumptions that allow substituting consumption by other factors. Hence, if one believes that the C-CAPM is fundamentally wrong, the ICAPM must be wrong as well. The only consistent motivation of the ICAPM is the view that the quality of the consumption data is disappointing. As a result, state variables that might be good approximation of consumption could be used in the ICAPM. Furthermore, we can look at past consumption and identify factors that impact sources of income.

2.4.4 Empirical evidence on Capital Asset Pricing Models.

As explained earlier, the CAPM predicts that the risk of a stock should be measured relative to a broad “market portfolio” that generally can include not only traded assets, but also consumer durables, real estate, and human capital (Fama and French 2003). However, in empirical tests the market portfolio has usually been limited to, for example common stocks in a particular market. Thus the lack of success of any empirical test of the CAPM

could be due to a failure of the theory or a result of an inappropriate choice of the market portfolio. Early cross section tests of the Sharpe and Linter CAPM model have focused on the intercept and slope between market beta and expected return. Thus the cross section of average asset returns is regressed on the estimates of asset betas. CAPM predicts that the estimated intercept of this regression should be equal to the risk free interest rate and the coefficient on beta equal the expected return on the market in excess of the risk-free interest rate. As a first step, it is assumed that β_i is constant over the sample period and a first-pass time-series regression of each asset i is calculated:

$$R_{it} - R_{ft} = \alpha_i + \beta_{iM} (R_{Mt} - R_{ft}) . \quad (2.4.49)$$

In a second step, the estimates of β_i of the individual securities are used in a second-pass cross-section regression:

$$\bar{R}_i = \lambda_0 + \lambda_1 \hat{\beta}_i + v_i . \quad (2.4.50)$$

In this equation, \bar{R}_i is the sample average return of an individual securities on k securities that is then regressed on the estimated $\hat{\beta}_i$'s on k securities from the first-pass time-series regression. The CAPM predicts that $\lambda_0 = \bar{R}_f$ as well as $\lambda_1 = \bar{R}_M - \bar{R}_f > 0$.

However, it became apparent that those cross-section estimates suffer from inaccurate betas on individual assets and a common source of fluctuation in regression residuals due to e.g. industry effects. Therefore, early research on the CAPM has used portfolios instead of individual securities (see inter alia Blume 1970, Friend and Blume 1970, Black, Jensen and Scholes 1972). It became common practice to sort securities on beta when performing the CAPM on portfolios. Hence the first portfolio contains securities with the highest beta, whereas the last portfolio contains the securities with the lowest beta. As an alternative, portfolios have been sorted by size or price to book (for a discussion see Cuthbertson and Nitzsche 2004). However, although early tests of the Sharpe Lintner CAPM show a positive relationship between beta and average return, the estimated relationship is too flat

and the intercept is greater than the average risk-free rate (for a discussion see inter alia Douglas 1968, Black, Jensen and Scholes 1972, Miller and Scholes 1972, Blume and Friend 1973, Fama and MacBeth 1973 as well as Fama and French 1992).

As an alternative to the cross section estimate, Jensen (1969) suggests the possibility of a time series regression test. The Sharpe Lintner CAPM predicts that the average excess return of an asset is entirely explained by its average realized CAPM risk premium (that is beta times the average value of market risk minus the risk free interest rate). An empirical test can now be performed on the time series regression of this relationship. This incorporates that “Jensen’s alpha”, the intercept in the following time series regression:

$$R_{it} - R_{ft} = \alpha_i + \beta_{iM}(R_{Mt} - R_{ft}) + \varepsilon_{it}, \quad (2.4.51)$$

is equal to zero for each asset. However, also the time series tests show that the relationship between beta and average return is too flat (see inter alias Friend and Blume 1970, Black, Jensen and Scholes 1972, Stambaugh 1982). Furthermore, the empirical tests find that the intercepts of excess returns on excess market returns are negative for assets with high betas and positive for assets with low betas. The Sharpe-Lintner version of the CAPM however predicts that the market portfolio is mean variance efficient. Thus differences in expected return across securities should be completely explained by differences in market beta and no other variables should add to the explanation of expected returns (Fama and French 2003). However, Fama and MacBeth (1973) include the squared betas and residual variances from regressions of returns on the market return (for a discussion see Fama and French 2004). In their paper they do not find evidence that those two variables add significant explanatory power and the findings are consistent with the hypothesis that their market proxy is on the minimum variance frontier.

However, since the late 1970s empirical papers even challenged the Black version of the CAPM and evidence amounted that much of the variation in expected returns is not related to market beta. The Black version of the CAPM assumes the absence of a risk-free asset. Therefore the expected return on the zero-beta portfolio is an unknown parameter because it cannot be observed. The Black CAPM unconstrained model is given by:

$$R_{it} = \alpha_i + \beta_{iM} R_{Mt} + \varepsilon_{it} \quad (2.4.52)$$

$$E[\varepsilon_t] = 0 \quad (2.4.53)$$

$$E[\varepsilon_t \varepsilon_t'] = \Sigma \quad (2.4.54)$$

$$E[R_{Mt}] = \mu_m \quad (2.4.55)$$

$$E[(R_{Mt}, \varepsilon_t)'] = \sigma_M^2 \quad (2.4.56)$$

$$Cov[R_{Mt}, \varepsilon_t] = 0 \quad (2.4.57)$$

Furthermore, the expected zero-beta portfolio return is given by γ . As a result, the Black version of the CAPM can be tested by the following equation:

$$\alpha_i = (1 - \beta_{iM})\gamma. \quad (2.4.58)$$

As a result, only beta should have predictive power for future asset returns. However, researchers found other factors to have predictive power for future asset returns that cannot be explained by beta. Those factors have been the price earnings ratio (see inter alias Basu 1977, Nicholson 1960, Chan, Hamao and Lakonishok 1991, Dreman 1998, Lakonishok, Shleifer and Vishny 1994), price to book ratio (see inter alias Rosenberg, Reid and Lanstein 1985, Chan, Hamao and Lakonishok 1991, Fama and French 1992), leverage effect (see inter alias Bhandari 1988) and the size effect (see inter alias Banz 1981, Basu 1983, Reinganum 1981).

Overall, the empirical evidence on time series and cross section investigations of the CAPM suggests that the standard market proxies seem to be on the minimum variance

frontier as the Black version of the CAPM predicts. However, the more specific predictions of the Sharpe Lintner CAPM that the premium per unit of beta is the expected return minus the risk free interest rate has been generally rejected (for a discussion see Fama and French 2004). These findings have been supported in Japan (see inter alia Chen, Hamao and Lakonishok 1991, Capaul, Rowley and Sharpe 1993).

The Intertemporal Capital Asset Pricing Model (ICAPM) of Merton (1973) has been used to include macroeconomic risk factors to asset pricing models. In order to qualify as a ICAPM factor, the variable must describe the time variation of the investment opportunity set over time and investors must be sufficiently concerned about it to be willing to hedge its effects. Such factors must indicate special states of the world where portfolio returns might be very poor and investors concerned about their payoffs. Hence, investors are willing to sacrifice some overall expected return if an asset does well during “hard times”. The factors often include macro economic variables that may tell us something more about “other” states of the world that influence utility. For instance, consumption is related to interest rates, GDP growth, inflation and other macro-economic variables. Those macro variables can therefore measure the state of the economy. In general, authors have found that macroeconomic surprises do effect stock prices (see inter alia Connolly and Wang 2000, Bomfim 2003, Boyd, Hu and Jagannathan 2004, Bernanke and Kuttner 2005). Furthermore, empirical research has found significant predictors of the equity risk premium. For instance Campbell and Shiller (1988a, 1988b) and Fama and French (1988) found the market dividend yield; Fama and French (1989), the term spread and the junk bond yield spread as well as Kothari and Shanken (1997), the book to market ratio to predict the equity risk premium. Thus tests of intertemporal asset pricing models have supported the view that macroeconomic variables affect stock prices. We will also investigate macroeconomic variables and the stock market in the empirical chapters that

follow. In contrast to the intertemporal asset pricing applications we will first try to establish a long term relationship between macroeconomic variables such as industrial production or inflation by applying a cointegration approach. In a second step we will then allow for risk measures to explore forecastability of stock market returns.

Finally, researchers have tested the consumption based asset-pricing model (C-CAPM). For instance Hansen and Singleton (1982, 1983) have investigated a consumption based model with a representative investor that has time separable power utility of consumption. However, the findings show that this model cannot simultaneously explain the time variation of interest rates and the cross section of average returns on stocks and bonds (for a discussion see Campbell and Cochrane 2000). Also Wheatley (1988) rejects the C-CAPM for an international data set. While the C-CAPM has generally been rejected for the US, Hamori (1992) finds evidence in favour of the C-CAPM in Japan. Others have relaxed some of the assumptions and included money as a state variable (see inter alias Singleton 1985, Marshall 1990, Finn, Hoffman and Schlagenhauf 1990 and Hamori 1991), whereas some emphasized the role of time non separable preferences (see inter alias Dunn and Singleton 1986, Eichenbaum and Hansen 1990, Ferson and Constantinides 1990). Normally γ has a dual role in the standard power utility function. On the one hand, a larger γ makes individuals to smooth consumption over time. On the other hand, a higher γ also makes individuals to have a similar level of consumption in different states of the world. As a result, γ is the coefficient of relative risk aversion and reciprocal of the intertemporal elasticity of substitution (Cuthbertson and Nitzsche 2004). Epstein and Zin (1989, 1991) have proposed a utility function that separates risk aversion and intertemporal elasticity of substitution into two different coefficients. Overall, the empirical evidence on C-CAPM is quite weak. However, the strong theoretical foundation still makes it a very favourable model. In our empirical investigation we will not build upon the C-CAPM because of the

empirical difficulties involved. Furthermore, consumption tends to be highly correlated with industrial production or other output variables. For this reason, in a cointegration or regression approach, the use of an output variable in combination with consumption often results in co-linearity.

2.4.5 Arbitrage Pricing Theory (APT)

For the technical content of the APT theory we mainly follow Blake (2000). Ross (1976) was the initiator of the arbitrage pricing theory (APT) as an alternative for the CAPM due to the increasing dissatisfaction with CAPM on theoretical and empirical grounds. The capital asset pricing model, as a single factor model, based on the linear relationship between expected return and risk, measured as beta, depends on the mean standard deviation efficiency of the market portfolio. Thus the CAPM was derived from the first principles of expected utility theory and was consistent with the accepted empirical view that there exists a common variability in asset prices (for a discussion see chapter 2.4.2). However, Ross (1976) argued that the assumption of underlying expected utility theory made no use of this common variability, but instead CAPM made the distinction between diversifiable and non-diversifiable risk. This distinction is a result of a linear generating process such as the market model where the common variation in returns is because of a single factor and the actual returns deviate from this common factor by an additional random disturbance. Therefore it is assumed that part of the returns is random whereas the other part is systematic. However, the random return component can be diversified away and an investor gets only paid for the systematic risk. So the alternative APT model maintains many of the intuitive results of the CAPM and is based on a linear return generating process as a first principle, but employs no utility assumption except from monotonicity and concavity for greed and risk aversion. By comparison the CAPM needs a

utility function that is based on mean and standard deviation. The APT is rather based on the statistical characterisation that stocks tend to move together. In particular similar types of stocks (e.g. same industry or similar price to book ratio) show a common factor in price movements. Ross (1976) starting point was assuming that individuals believe that security returns are determined by a K-factor generating process:

$$r_i = \bar{r}_i + \sum_{j=1}^K \delta_j \beta_{ij} + \varepsilon_i, \quad (2.4.59)$$

where r_i gives the actual return on the i_{th} security, δ_j is the zero mean j_{th} factor common to all security returns, \bar{r}_i shows the expected return on the i_{th} security and the coefficient β_{ij} measures the response or loading of the i_{th} return with the j_{th} common factor. The δ_j are the common or systematic components of risk while the ε_i are the unsystematic components of risk for the i_{th} security. The basis was arbitrage conditions to restrict the returns in this return generating process. Thus an individual investor has the possibility of investing in the set of all constructible arbitrage portfolios, that is, the set of new portfolios of securities, which differ from his existing portfolio but use no additional wealth. This implies that any additional purchases of assets must be financed by the sale of others (Blake, 2000). As a result, we have net zero additional investments because in order to buy more assets some other assets must be sold to finance the purchase. This means for all arbitrage portfolios:

$$\sum_{i=1}^N \Delta x_i = 0, \quad (2.4.60)$$

in the portfolio with N assets where the change in the holding of the i_{th} asset being Δx_i . By modifying the current portfolio, the change in the portfolio return follows:

$$\Delta r_p = \sum_{i=1}^N r_i \Delta x_i = \sum_{i=1}^N \bar{r}_i \Delta x_i + \sum_{j=1}^K \delta_j \beta_{ij} \Delta x_i + \sum_{i=1}^N \varepsilon_i \Delta x_i. \quad (2.4.61)$$

Assuming that the arbitrage portfolios are well diversified, and then each Δx_i will be of order $1/N$ for a portfolio with N assets, so that the unsystematic risk can be diversified

away and the last term of the equation will be negligible. On top of that, if the individual manages to choose Δx_i so that the arbitrage portfolio has no systematic risk either, we get:

$$\sum_{i=1}^N \beta_{ij} \Delta x_i = 0, \quad (2.4.62)$$

for all j , and the change in return by changing the portfolio is given by:

$$\Delta r_p = \sum_{i=1}^N \bar{r}_i \Delta x_i. \quad (2.4.63)$$

However, in equilibrium portfolios that cost nothing by using no new resources and do not embody systematic nor unsystematic risk must ultimately generate a certain return equal to zero.

$$\Delta r_p = \sum_{i=1}^N \bar{r}_i \Delta x_i = 0, \quad (2.4.64)$$

otherwise arbitrarily large positive net wealth positions could be accumulated without cost or risk (Blake 2000). Thus no portfolio is in equilibrium if it can be improved without incurring additional risk or using additional resources. Since the equation:

$$\Delta r_p = \sum_{i=1}^N \bar{r}_i \Delta x_i = 0 \quad (2.4.65)$$

must hold for all Δx_i and satisfying:

$$\sum_{i=1}^N \Delta x_i = 0 \quad (2.4.66)$$

as well as:

$$\sum_{i=1}^N \beta_{ij} \Delta x_i = 0, \quad (2.4.67)$$

then it must be the case that the \bar{r}_i are spanned by the unit constant, and the β_{ij} and constant weights $\gamma_0, \gamma_1, \dots, \gamma_k$:

$$\bar{r}_i = \gamma_0 + \sum_{j=1}^K \gamma_j \beta_{ij}. \quad (2.4.68)$$

If there is no riskless security or a zero beta security, then from above $\beta_{0j} = 0$ so that:

$$r_f = \gamma_0 , \quad (2.4.69)$$

and thus:

$$\bar{r}_i = r_f + \sum_{j=1}^K \gamma_j \beta_{ij} , \quad (2.4.70)$$

that is to say, a linear relationship between expected returns and the common factor loadings β_{ij} . The loadings β_{ij} are given by:

$$\beta_{ij} = \frac{Cov(r_i, \delta_j)}{Var(\delta_j)} , \quad (2.4.71)$$

where:

$Cov(r_i, \delta_j)$ = covariance between the return on the i_{th} security and the j_{th} factor, and

$Var(\delta_j)$ = variance of the j_{th} factor.

The empirical evidence of Arbitrage Pricing Theory in the stock market will be discussed in the following chapter.

2.4.6 Empirical evidence of Arbitrage Pricing Theory

Arbitrage Pricing Theory (APT) has been empirically tested by inter alias Roll and Ross (1980), Chen, Roll and Ross (1986), Connor and Korajczyk (1986) as well as Lehmann and Modest (1988). For instance, Hamao (1988) has investigated APT in the Japanese market with industrial production, inflation, investor confidence, interest rates, foreign exchange and the oil price as factors. As Cochrane (2001) has pointed out, APT and the so-called Intertemporal Capital Asset Pricing Model (ICAPM) have often been confused with each other. Thus a major difference between APT and ICAPM for empirical work is the motivation of the factors. The ICAPM motivates the selection of the factors by looking at

state variables that describe the conditional distribution of future asset returns, whereas the APT motivates the factors by the co-variance matrix of returns in order to find portfolios that characterize common movements. For this reason it is difficult to make a clear cut between APT and ICAPM models in the empirical literature. For instance, one of the original papers on APT by Chen, Roll and Ross (1986) used industrial production and inflation as main factors. However, they do not present a factor decomposition of the asset returns, or a time series regression (For a discussion see Cochrane 2001). Thus a reader could easily classify the paper as a macroeconomic factor model or an ICAPM. In contrast, Fama and French (1993) use portfolios of assets sorted on size and price to book as factors to proxy state variables. A reader might easily categorize the paper as an APT model while the authors describe it as an ICAPM (Cochrane 2001). In the very diverse empirical literature on APT, there are papers that find macroeconomic variables such as inflation or industrial production to be significant for stock returns (see inter alia Chen, Roll and Ross 1986 as well as Burmeister and Wall 1986) whereas the same or others find portfolio characteristics such as price to book or size to explain stock returns (see inter alia Rosenberg, Reid and Lanstein 1985, Chan, Hamao and Lakonishok 1991 and Fama and French 1992). Generally, researches have not reported major differences between empirical APT investigations in the USA (see inter alia Roll and Ross 1980, Chen 1983, Chen, Roll and Ross 1986) and Japan (see inter alia Hamao 1988, Chan, Hamao and Lakonishok 1991 and Haugen and Baker 1996). For instance, Haugen and Baker find a book to price coefficient of 0,14 for the US and 0,12 for Japan. In their sample, that spans 1985 until 1993, the coefficient of cash-flow to price and earnings to price are higher in the US than Japan but have the same sign.

In the empirical investigation of this thesis we will also use macroeconomic variables to explain aggregate stock market movements. In contrast to most of the above mentioned

papers, we will not use a co-variance matrix to motivate our macroeconomic variables but a present value framework. Furthermore, most APT papers have investigated the cross section of return and we will focus on the aggregate stock market. However, many APT papers have found macroeconomic variables such as industrial production, inflation or interest rates to explain stock market movements and this will give us the opportunity to discuss as well as compare our findings with the APT literature.

2.4.7 Multi factor model

On theoretical grounds, there is not too much to say about multi-factor models per se since those have been invented because the single factor model CAPM did not satisfy empirical investigations and many other additional factors beside the market factor have been found to be important in explaining security returns. So generally speaking many multi-factor models have been motivated by empirical research rather than theoretical asset-pricing. Those models commonly take the form of:

$$r_{it} = \gamma_i + \sum_{j=1}^K \beta_{ij} F_{jt} + \varepsilon_{it} , \quad (2.4.72)$$

with F_{jt} are K factors that have a systematic effect on every security and β_{ij} measures the return sensitivity of the factor j on the security i . Any security specific return component that is not systematic on the i_{th} asset is contained in ε_{it} .

As any model that contains more than one variable is technically speaking a multifactor model, it is not very useful to list every empirical paper that has used more than one factor to price an asset. However, there are two particular models that became famous for being multifactor models, namely Fama and French's three factor model (Fama and French 1993) and Barra. Fama and French (1993) found that the market factor, size factor and

price to book factor can explain most of the variability of monthly stock returns. Barra named after Barr Rosenberg Associates (former professor of finance at the University of California at Berkeley) identified 68 factors that could influence stock market returns (for a discussion see Blake 2000).

All other relevant empirical multifactor models have been or will be covered by APT, ICAPM, CCAPM, DDM or DCF in order to avoid unnecessary replication.

2.4.8 Present Value Statement

Now we will look at the present value model of dividends or earnings. For the technical content we partly follow Blake (2000).

Assuming an investor buys a security and holds it for one year only, the asset price can be expressed by:

$$P_0 = \frac{E(d_1)}{1+r} + \frac{E(P_1)}{1+r} \quad (2.4.73)$$

Where P_0 is the fair price of the stock and $E(d_1)$ is expected annual dividend per share at the end of the one year period. Furthermore $E(P_1)$ is the expected price of the share at the end of the one year period whereas $E(\)$ denotes the expectations based on all current information. Finally r is the market determined discount rate or cost of capital. The equation should hold under rational expectations and full information. Thus the return on the stock includes an income element (d_1) as well as a capital gain element ($P_1 - P_0$). Assuming a constant discount rate r , the higher the income element, the lower the capital gain element has to be (Blake 2000).

Assuming now that the investor holds the security for another one year period, we have:

$$E(P_1) = \frac{E(d_2)}{1+r} + \frac{E(P_2)}{1+r} \quad (2.4.74)$$

By substitution we get:

$$P_0 = \frac{E(d_1)}{1+r} + \frac{E(d_2)}{(1+r)^2} + \frac{E(P_2)}{(1+r)^2} = \sum_{t=1}^T \frac{E(d_t)}{(1+r)^t} + \frac{E(P_T)}{(1+r)^T} \quad (2.4.78)$$

Here d_t refers to the dividend in year t . Clearly as $T \rightarrow \infty$, the last term on the right hand side, which is the expected discounted value of the stock price in T periods from the present, approaches zero and we get:

$$P_0 = \sum_{t=1}^{\infty} \frac{E(d_t)}{(1+r)^t} \quad (2.4.79)$$

Thus we obtain a formula expressing the stock price as the expected present value of future dividends into infinity, discounted at a constant rate. Furthermore, it is assumed that the stock price does not grow at a rate greater or equal to the discount rate. Otherwise, we would not get a discounted stock price value anymore and the expected stock price would approach an infinite value when t approaches infinity. However, the above equation is an unrealistic special case that only provides some useful idea what might occur when dividends are expected to grow over time. Given a constant growth rate, we can derive the so called “Gordon growth model” (Gordon, 1962) for the price of a stock with a constant discount rate r and dividend growth rate g , where $g < r$.

$$P_0 = \frac{E(d_{t+1})}{r-g} = \frac{(1+g)d_t}{r-g} \quad (2.4.80)$$

The Gordon growth model illustrates that, if the discount rate is close to the rate of dividend growth then the stock price is very sensitive to changes in the discount rate. It is important to note that this formulation does not account for stock re-purchases that change

the dividends per share. Generally, the hypothesis that the expected stock return is constant through time, known as martingale model of stock prices, does not mean that stock prices must follow a martingale. A martingale for the price requires that:

$$E(P_{t+1}) = P_t, \quad (2.4.81)$$

However, the present value statement states that:

$$E(P_{t+1}) = (1 + r)P_t - E(D_{t+1}). \quad (2.4.82)$$

Thus the expected stock price in the next period does not equal the stock price today as would be entailed by the martingale model of stock prices. In contrast, the future stock price is equal to one plus the constant required return times the current stock price minus an adjustment factor for the dividend payments. To get a martingale, a portfolio including all reinvested dividends must be constructed (for further discussion see Campbell, Lo and MacKinlay, 1997). The number of shares at time t is equal to N , so we get:

$$N_{t+1} = N_t \left(1 + \frac{D_{t+1}}{P_{t+1}} \right). \quad (2.4.83)$$

Thus the value of the portfolio at time t , discounted to time 0 at the discount rate r is given by:

$$M_t = \frac{N_t P_t}{(1 + r)^t}. \quad (2.4.84)$$

Hence M_t follows a martingale. However, even so the stock price is not a martingale, it will follow a linear process with a unit root if the dividend follows a linear process with a unit root as well. Thus the expected value formula relates two unit root process for P_t and D_t . By subtracting a multiple of the dividend from both sides of the present value formula:

$$P_t = P_{Dt} \equiv E_t \left[\sum_{i=1}^{\infty} \left(\frac{1}{1+r} \right)^i D_{t+i} \right] \quad (2.4.85)$$

we can get:

$$P_t - \frac{D_t}{r} = \left(\frac{1}{r} \right) E_t \left[\sum_{i=0}^{\infty} \left(\frac{1}{1+r} \right)^i \Delta D_{t+1+i} \right]. \quad (2.4.86)$$

This now relates the difference between the stock price and $1/r$ times the dividend to the expectation of the discounted value of future changes in dividends. Furthermore, this process should be stationary if changes in dividends are stationary (Campbell, Lo and MacKinlay, 1997). In this case, even so the dividend process and the stock price are not stationary, there exists a linear combination of prices and dividends that is stationary and this implies cointegration between dividends and prices.

As an alternative, the share valuation can be modelled on the expected earnings of a firm instead of dividends. So that the expected earnings are discounted exactly the same way as the stream of expected dividends, using the same discount rate, because the discount rate is true for the risk class of the corporate activities of the overall company. However, a firm's reported earnings are normally larger than the firm's dividends. As a consequence, this would imply that the valuation based on earnings would yield a higher fair value than on dividends. Obviously, this cannot be the case because the two valuation methods must for consistency reasons lead to the same fair price. So in order to avoid any inconsistency, economic earnings are used rather than reported earnings. Economic earnings are an appropriate measure for earnings in order to evaluate shares (Blake, 2000). The economic

earnings of a company are defined by the maximum amount of real resources that can be withdrawn from the corporate earnings, and used for real consumption without hazarding the ability of the company to deliver real consumption in the future. Thus economic earnings are defined as reported earnings plus external funds minus net investments. The external funds are constrained by the fact that the present value of new external funds must sum up to zero over the lifetime of the firm. For instance the firm must ultimately pay back any borrowings, because otherwise the firm would essentially not have a budget constraint. Hence reported earnings plus new external funds equals dividends plus net investments. For that reason dividends are a constant proportion of share wealth and are set at exactly the level necessary to enable the share wealth to deliver the same dividend in the future. Thus dividends plus investments equals reported earnings plus new external funds. Given that the present value of new external funds must be zero over the lifetime of the company, dividends and economic income must be the same. As a result, if earnings are defined correctly, then there is no difference between the dividend valuation model and the earnings valuation model (Blake 2000). It should be mentioned that nowadays many companies prefer share buy-backs instead of dividend payments. Share buy-backs decrease the equity and therefore also the number of shares outstanding of a company. As a result the earnings or cash flows per share increase as the number of shares decrease. This effect has to be taken into account as well when looking at an earnings or dividend discount model. For this reason it has been argued that the dividend yield is lower today because many companies prefer share buy-backs over dividend payments. Obviously, adjusted for share buy-backs, the dividend yield would be higher.

The present value model of dividends or earnings can also be used to motivate macroeconomic variables that might drive share prices. The idea is to find macroeconomic variables that impact corporate earnings, growth rates or the discount rate. As can be seen

in equation 2.4.79 and 2.4.80, the current stock price should be a function of expected dividends or earnings, the growth rate and the discount rate. Hence, any macroeconomic variable that is correlated with corporate earnings, growth rates or the discount rate might be helpful in predicting stock prices.

In periods of high economic growth (e.g. measured by real GDP or real industrial production) the corporate sector in aggregate will be able to increase sales and generate higher turnover. Furthermore, economies of scale may generate higher profitability and higher profits due to increased turnover. As a result, corporate profits and cash flows should be linked to economic growth. In the present value model, future profits or cash flows are discounted to derive a current firm value. Hence, in a macroeconomic framework industrial production can be used as a proxy for aggregate corporate cash flows or profits.

High inflation could lead to a tight monetary policy with low money supply growth and higher interest rates. Such a policy is likely to increase the discount rate and the cost of capital and has a negative effect on stock prices. Inflation influences the risk-free rate and discount rate thus determining the value of future cash flows. In the present value model corporate cash flows are discounted by the discount rate (usually by a short-term market rate). If interest rates increase, the cost of capital and the discount rate will increase as well. As a result, the current value of future cash flows falls. Furthermore, high inflation can cause uncertainty about future prices and trigger precautionary savings. Higher precautionary savings will impact consumption and hence corporate sales growth.

The money supply $M1$ might also be related to future inflation uncertainty and policy response. High money supply can lead to higher inflation and policy makers often increase interest rates to slow demand and decrease inflation pressure (for a discussion see Urlich

and Wachtel (1981) as well as Rogalski and Vinso (1977)). As discussed above, in the present value model corporate cash flows are discounted by the discount rate. If interest rates increase, the cost of capital and the discount rate will increase as well. As a result, the current value of future cash flows falls.

The short interest rate directly changes the discount rate in the valuation model and thus influences current and future values of corporate cash flows. As a result, the current value of future cash flows falls when the discount rates increases. Furthermore, the cost of capital increases with higher interest rates as well. Hence, corporate costs increase and profits might fall in response.

2.4.9 Empirical evidence on the Present Value Model

The dividend discount model, as a specific present value model, has been very popular in empirical research as it is a cornerstone of financial theory and fundamentally appealing. For instance, Campbell and Shiller (1987, 1988b), Lee (1995), Sung and Urrutia (1995), Timmermann (1995), and Crowder and Wohar (1998) have estimated the present value relation of the aggregate S&P500 price level with its dividend stream over time. Most authors have applied cointegration methodology to test for a long-term equilibrium relationship between share prices and dividends. In general those authors do find a long term relationship between aggregate stock prices and the underlying dividend stream over time. Nasseh and Strauss (2004) estimate the long-term relationship between dividends and share prices for individual securities in the S&P100. They apply a panel cointegration approach and support a positive relationship between dividends and share prices over time.

To my knowledge, there has not been any empirical investigation of the present value model in Japan comparable to the research in the US (like the above mentioned papers of Campbell and Shiller (1987, 1988b), Lee (1995), Sung and Urrutia (1995), Timmermann (1995), and Crowder and Wohar (1998)).

However, cointegration of earnings and prices also implies that price earnings ratios are stationary over time. This has often been used to test for bubbles in the stock market. As this will be discussed in the next chapter, we will not cover it here.

Furthermore, many researchers have used the discounted dividend (DDM) or discounted cash flow model (DCF) as a basis to motivate macroeconomic variables for a multifactor model. The idea is to consider macroeconomic variables that are likely to impact corporate cash flows, earnings, dividends or the discount rate of those income streams. In our empirical part we will follow this line as well and use the discounted cash flow (DCF) model to motivate macroeconomic factors. However, most multifactor models that use macroeconomic variables are classified as APT, intertemporal (ICAPM), or simply “multifactor” models in the empirical literature. For this reason, we will not repeat the entire multifactor model based empirical papers that have at some stage used the DCF or DDM model to motivate some macroeconomic variables. Instead, we will give an in depth discussion of the relevant empirical papers when we motivate the macroeconomic variables for our study. As mentioned earlier, many empirical papers do not make clear what theoretical models have been used to motivate the macro-variables whereas others get confused with ICAPM and APT.

2.4.10 Rational bubbles

For the technical content on rational bubbles, we have mainly been following Campbell, Lo and MacKinlay (1997).

The dividend discount model (DDM) was based on the assumption that the expected discounted stock price at the end of the time horizon, ex dividends, will converge to zero when the time horizon increases to infinity. Therefore, the present value of a stock is given by the discounted value of future dividends. When the convergence assumption is relaxed, there are many solutions for:

$$P_0 = E_t \left[\frac{P_{t+1} + D_{t+1}}{1 + R} \right]. \quad (2.4.87)$$

Such a solution can be written as:

$$P_t = P_{Dt} + B_t. \quad (2.4.88)$$

The additional bubble term B_t shows up in the equation as it is expected to be present in the following period with an expected value $(1+R)$ times the current value:

$$B_t = E_t \left[\frac{B_{t+1}}{1 + R} \right]. \quad (2.4.89)$$

The term B_t has often been referred to as rational bubble whereas P_{Dt} is the corresponding fundamental value of the stock. The reason why it is called “rational” bubble is because the presence of B_t is entirely consistent with rational expectations and constant expected returns. To make an example, Blanchard and Watson (1982) suggest a bubble of the form:

$$B_{t+1} = \begin{cases} \left(\frac{1+R}{\pi} \right) B_t + \xi_{t+1}, & \text{with probability } \pi; \\ \xi_{t+1}, & \text{with probability } 1-\pi. \end{cases} \quad (2.4.90)$$

For the shock ξ_{t+1} satisfying $E_t \xi_{t+1} = 0$, the restriction $B_t = E_t \left[\frac{B_{t+1}}{1 + R} \right]$ is fulfilled. In the

Blanchard and Watson case, the bubble has a constant probability, $1-\pi$, bursting in any

period. In any period where it does not burst, it grows with the rate $\frac{1+R}{\pi} - 1$, faster than R , in order to compensate for the probability that the bubble will burst.

On theoretical grounds there have been arguments brought forward that rule out rational bubbles. For instance, in partial equilibrium, there can never be a negative bubble on an asset that has limited liability. This is because if a negative bubble would exist, it would ultimately imply a negative asset price at some point in time, and this in turn would be inconsistent with limited liability. Furthermore, if a rational bubble exists today, it must have existed since asset-trading began. As a result, within an asset-pricing model, a bubble on a limited liability asset cannot start. The reason is that if the bubble ever equals 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, it can only have a zero expectation if it is zero in the future with probability one (Diba and Grossman, 1988a). Another argument is that a bubble cannot exist if there is any upper limit on the price of an asset. Thus a stock price bubble could be constrained by issuing stock in response to price increases. Furthermore, also general equilibrium conditions put a limit on the possibility of rational bubbles. For instance, Tirole (1982) has pointed out that bubbles cannot exist in a model with a finite number of infinite-lived rational agents. The argument is that there is an arbitrage opportunity given by infinite-lived agents selling short in a positive bubble, invest some of the proceeds to pay the dividend stream, and still have positive wealth left over. Tirole (1985) has also investigated the chance of bubbles with the Diamond (1965) overlapping generation model. His model allows for an infinite number of finite-lived agents. However, Tirole shows that even in such a case, a bubble cannot exist when the interest rate is greater than the growth of the economy. This is because the bubble would eventually become

infinitely large, relative to the wealth of the economy and would therefore violate some agent's budget constraint. As a result, bubbles can only exist in dynamically inefficient overlapping generations economies with overaccumulated private capital that drives the interest rate down below the growth rate of the economy (Campbell, Lo and MacKinlay (1997)).

Froot and Obstfeld (1991) propose a different kind of bubble where the bubble is tied to the level of dividends. They propose a bubble term that follows $B(D_t) = cD_t^\lambda$. This bubble process depends completely on the level of dividends and is therefore not independent of the fundamental process. In cases where such a process exists, stock prices will be more sensitive to dividend changes than in a linear pricing model. In general an intrinsic bubble relates the bubble to the fundamental process by assuming that the bubble depends exclusively on the fundamental process (Salge 1997). So the intrinsic bubble is tied to fundamentals but exaggerates changes in fundamentals.

2.4.11 Empirical evidence on rational bubbles

One of the first indirect tests for rational bubbles in the stock market have been variance bounds tests developed by Shiller (1981) and LeRoy and Porter (1981). Generally these papers are tests of the DDM. However, one reason for rejecting the DDM could be the existence of a bubble. Shiller's underlying idea is based on the present value model of dividends and assumes that all investors take the same view of the future. Furthermore, it is assumed that all investors form the same expectations of future dividends and future dividends are discounted by a constant discount factor in the future. Thus if we had data on expected future dividends and the future discount factor, we could work out the present value of expected future dividends discounted by the future discount factor and compare

this with the current stock price. However, at the present time t , we do not know what the expected future dividend by investors would have been. Shiller (1981) proposed a simple way of getting around his problem. Assume we have actual dividends from 1900 onwards and that we have the share price at some point in the future (e.g. 2000). It is further assumed that the discount rate is known, for example 0.94 for annual data. Then using the present value model of dividends one can calculate what the stock price in 1900 would have been if investors had forecasted dividends correctly between 1900 and 2000 plus a terminal value for the period after 2000. However, in 1900 the present value of the terminal value after 2000 would have been very small and in empirical studies researchers have often used the stock price at the end of the sample as the terminal value (for a discussion see Gurkaynak 2005 and Cuthbertson 2000). This price is called the perfect foresight stock price in 1900. By then moving one year ahead, one can construct a time series of the perfect foresight stock price since 1900. Comparing the actual share price series with the perfect foresight share price series, we get the forecast errors of dividends. The forecast errors should sum up to a value close to zero. Furthermore, the ex post rational price is supposed to be at least as variable as the observed price because the observed price must be based on expected dividends and does therefore not include the variation introduced by future forecast errors, which the ex-post price must include. This relationship ultimately places an upper bound on the variance of the observed price series. Variance bounds test now verify if actual stock price volatility is justified by its rational expected future value of dividends volatility. The following relationship can be tested:

$$VR = \text{var}(P_t^*) / \text{var}(P_t) \geq 1 \quad \text{and} \quad SDR = \sigma(P_t^*) / \sigma(P_t) \geq 1. \quad (2.4.91)$$

Assuming an efficient market, rational expectations and a constant discount factor, the variance of the perfect foresight price P_t^* should exceed that of the actual price P_t . Shiller (1981) shows that actual price volatility exceeds the bound imposed by the variance of ex-post rational price heavily. In the original research by Shiller (1981) and Grossman and

Shiller (1981), the authors use the evidence of excess volatility as a critique of the present value model in general.

However, Tirole (1985) and Blanchard and Watson (1982) suggest that the variance bound may be violated due to the existence of bubbles. Overall, variance bounce tests are tests of the present value model, and a rejection may be due to the restrictive assumptions of the model. Campbell and Shiller (1988a, 1988b), use a log linear approximation to the dividend/price ratio in order to estimate a VAR model that allows for time-variation in the discount rate. This is also a test of the DDM and the model predicts that in the absence of a bubble, the dividend/price ratio will be stationary even if dividends and prices have unit roots. The log stock return $\log(R_{t+1})$ is defined as follows:

$$\log(R_{t+1}) \equiv \log(P_{t+1} + D_{t+1}) - \log(P_t) \quad (2.4.92)$$

$$\log(R_{t+1}) = \log(P_{t+1}) - \log(P_t) + \log(1 + \exp(\log(D_{t+1}) - \log(P_{t+1}))). \quad (2.4.93)$$

The last term of the above equation is a nonlinear function of the log dividend-price ratio and a first order Taylor expansion can be taken (Campbell, Lo and MacKinlay 1997):

$$\log(R_{t+1}) \approx k + \rho \log(P_{t+1}) + (1 - \rho) \log(D_{t+1}) - \log(P_t). \quad (2.4.94)$$

Here ρ and k are parameters of linearization defined by $\rho \equiv 1/(1 + \exp(\log(D) - \log(P)))$.

With the average log price ratio $\overline{(\log(D) - \log(P))}$ and $k \equiv -\log(\rho) - (1 - \rho)\log(1/\rho - 1)$.

When $\rho = 1/(1 + D/P)$, the dividend-price ratio is constant. However, Campbell and Shiller (1988a, 1988b) find that even when the constant discount factor assumption is relaxed, there is still excessive variance in the dividend/price ratio. Cochrane (1992) tests whether there exists a discount rate process that can explain the dividend/price volatility. In case no discount rate process can generate the observed dividend/price behaviour, a bubble can be concluded (Gurkaynak 2005). Therefore, the methodology is an indirect test for bubbles.

Cochrane (1992) does find a time-varying discount rate process that fits the data and concludes that no bubble is required to explain the dividend/price behaviour.

One of the problems with variance bounds tests is that the validity of the standard model and bubbles are related but have different underlying assumptions. Therefore, when one is testing for a bubble, a bubble should at least be in the set of alternatives when the test rejects the standard model. Otherwise there might be many possible reasons for rejecting the DDM that are not necessarily caused by a bubble. West (1987) proposed a two-step test of rational bubbles to solve that problem. The test is based on calculating a particular parameter in the dividend discount model by two ways. Under the assumption of no bubbles, the two estimates of the particular parameter should be statistically equal. The discount factor δ in the Euler equation can be estimated by:

$$P_t = \delta(P_{t+1} + D_{t+1}) + \varepsilon_{t+1} \quad (2.4.95)$$

Now assuming an AR(1) process for dividends:

$$D_t = \alpha D_{t-1} + v_t \quad |\alpha| < 1 \quad (2.4.96)$$

Under the null hypothesis of no-bubble:

$$P_t = \psi D_t + \varepsilon_{t+1} \quad \text{where } \psi = \delta\alpha/(1-\delta\alpha). \quad (2.4.97)$$

Furthermore, an indirect estimate of ψ , denoted $\hat{\psi}$ can be obtained from the regression estimates of δ in:

$$P_t = \delta(P_{t+1} + D_{t+1}) + \varepsilon_{t+1} \quad (2.4.98)$$

and α in:

$$D_t = \alpha D_{t-1} + v_t \quad |\alpha| < 1. \quad (2.4.99)$$

The direct estimate of ψ denoted $\hat{\psi}^*$ is then estimated by regressing P_t on D_t in:

$$P_t = \psi D_t + \varepsilon_{t+1}. \quad (2.4.100)$$

Finally, under the null hypothesis of no bubbles, the direct and indirect estimate of ψ should be equal. If a bubble is present, we get:

$$P_t = P_t^f + B_t = \psi D_t + B_t. \quad (2.4.101)$$

Here P_t^f is the fundamental price whereas B_t is the bubble component. Thus the regression of P_t on D_t now contains an omitted variable B_t and the estimate of ψ will be inconsistent as well as biased upward if the covariance(D_t, B_t) is greater zero. However, the Euler equation and the dividend forecasting equation still provide consistent estimators of the parameters and hence in the presence of a bubble the two different estimates of ψ will be statistically different. In his investigation West (1987) has used stock market data of the S&P500 between 1871 and 1980 and finds a substantive difference between the two sets of estimates. Hence, he rejects the null hypothesis of no bubbles in the data set. Dezbakhsh and Demirguc-Kunt (1990) criticize West's econometric methodology and point out that his tests have size distortion in small samples. Also Flood, Hodrick, and Kaplan (1994) criticize West's approach and argue that in his framework, the Euler equation is derived and tested for in two consecutive periods but it should also hold in its more general form to price long-lived assets. Therefore, the relationship should hold for any two periods, the stoical error in the estimation may be small for consecutive periods, but for periods further apart it might accumulate and become very large.

Another way of testing for bubbles is via integration or cointegration based tests. Diba and Grossman (1987, 1988a) point out that rational bubbles cannot start, and if a bubble exists now, it must always have existed. This is because of the lack of arbitrage opportunities and impossibility of a negative price due to limited liability. The Diba and Grossman (1988b) test gives room for unobserved fundamentals and implements some structure on which deviations from fundamentals in the data may be attributed to the presence of bubbles. They specify the market fundamental price to be the discounted value of future dividends

plus fundamentals that are unobservable to the econometrician. Under the assumption that the unobservable fundamentals are not more non-stationary than the dividend stream, the value of the market fundamentals will be as stationary as the dividends. If there is no bubble and dividends are stationary in levels, stock prices will be equal to market fundamentals and should also be stationary in levels. So in general, if dividends are stationary in n^{th} differences, stock prices should also be stationary in n^{th} differences (Gurkaynak 2005). This relationship breaks down in the presence of bubbles, as Diba and Grossman (1988b) point out that the bubble process is non-stationary regardless of how many differences are taken. This property can be tested econometrically. Therefore, a way to test for the existence of a bubble in the data, is to see whether stock prices are stationary when differenced the number of times that are required to make dividends stationary. This also imposes an equilibrium relationship between stock prices and dividends. Under the null hypothesis of no bubbles, given that the unobservable fundamentals are stationary, dividends and stock prices should be cointegrated. Diba and Grossman (1988a) do find dividends and stock prices to be integrated in levels, but stationary in differences. Furthermore, they find strong evidence for cointegration between stock prices and dividends and interpret these findings as indicating that a stock price bubble is not present in the data. Evans (1991) points out that in the case of periodically collapsing bubbles, under certain conditions, Diba and Grossman's test fails to recognise bubbles. This led to research in expanding and collapsing periods of the bubble where different regimes could be modelled as a Markovian process (for a discussion see inter alia Hall, Psaradakis, and Sola 1999, van Norden and Vigfusson 1998, van Norden 1996, Driffill and Sola 1998). Froot and Obstfeld's (1991) propose a different kind of bubble where the bubble is tied to the level of dividends. They propose a bubble term that follows:

$$B(D_t) = cD_t^\lambda. \quad (2.4.102)$$

This bubble process depends completely on the level of dividends and is therefore not independent of the fundamental process. In case such a process exists, stock prices will be more sensitive to dividend changes than justified by a linear pricing model. Therefore, under the null hypothesis of no bubbles, prices are a linear function of dividends and the price/dividend ratio is approximately a constant. On the other hand, intrinsic bubbles impart nonlinearity into the relationship between stock prices and dividends. Froot and Obstfeld (1991) investigation shows that there exists a nonlinear relationship between stock prices and dividends, but this is interpreted as a sign of bubbles only because the model is assumed to be linear.

Overall, bubble tests have not solved the question whether bubbles really exist or not. However, those tests have shown some of the limitations of standard preset value models and where those models fail. For instance, variance bounds tests have shown that prices are too volatile to be explained by a linear relationship with dividends. Furthermore, the idea of intrinsic and collapsing bubbles led to the idea of regime-switching fundamentals as an explanation. In general, less restrictive fundamental models of stock prices that for instance allow for time varying discount rates, risk aversion or structural breaks, allow the fundamental part of the model to fit the data better and give therefore less room for a bubble. In a way, the bubble has been a catch-all for price movements that could not be explained by the fundamental model (Gurkaynak 2005).

In our empirical investigation we will start with the idea of a present value model. However, the model will be relaxed in many ways and we will build a multifactor model around the idea of discounted cash flows, dividends and earnings. We will try to identify macroeconomic variables that determine cash flows, dividends and earnings as well as

discount rates. Furthermore, we will not follow the route of bubbles but rather allow for nonlinearity in the second part of the empirical investigation.

2.5 Summary

In this section we have given an empirical and theoretical overview of asset pricing theory. We have started with many early tests of market efficiency that have revealed stock market anomalies. Although most of those market anomalies have been reported in the US, many have also been supported in Japan. Therefore, we have found evidence in the literature in favour of technical trading rules, the earnings announcement effect, size effect, calendar effects and valuation ratio effects, like the price to book or price to earnings effect for both countries, the US and Japan. Generally, most findings are comparable and give us a hint that both stock markets have the same level of efficiency. As discussed in chapter 1.1.2, there are institutional differences between the US and Japan but the above evidence indicates that those differences have no major effect on the stock market efficiency. This is contrary to what we have expected in chapter 1. For this reason we would not expect those markets to behave in a much different way when it comes to speediness of response to news. This implies that if we do find major differences between the US and Japan, it is likely that those differences are due to economic development and not institutional differences or market efficiency. However, there is one notable exception of trading rules that have not been supported in Japan, namely momentum profits. As those momentum profits have not been found in Japan, this implies that simple trend followers will find it very difficult to survive in Japan whereas the same stock market players have had a good survival power in the US. For this reason, we would expect the window of opportunity for momentum players to be much smaller or non-existing in Japan, whereas it should exist in

the US. We will refer to this issue in section 5 where we test a model of noise traders and informed traders applied to the dividend yield in the US and Japan.

Secondly the consumption based asset pricing model was outlined. This model starts with the basic decision an investor has to make. How much to consume and how much to save in the different assets. The model predicts that the marginal utility of consuming less today and buying more of the asset instead, should equal the marginal utility gain of having more of the asset's payoff in the future. So the asset price should be equal to the value of the discounted asset's payoffs, given the investor's marginal utility for the discount rate. Discount rates and hence interest rates are related to marginal utility growth and therefore the expected future consumption. Thus a high real interest rate would imply agents save more today in order to consume more in the future. The interesting thing to note is that risk corrections to asset prices are determined by the co-variance between consumption or marginal utility and the asset's payoffs. To put it very simply, an asset that does well during recessions when people possibly suffer from lower income should be more expensive than an asset that does very poorly during recessions and is less desirable (Cochrane, 2001). So the more risky asset should trade at a discount in order to compensate for the higher risk and this discount is determined by the co-variance between the asset's payoffs and consumption.

In general, empirical research has however not been able to support the predictions of the consumption based asset pricing model. Only, Hamori (1992) finds evidence in favour of the C-CAPM in Japan. Others have relaxed some of the assumptions and include money while others emphasized the role of time non-separable preferences. Overall, the empirical evidence on C-CAPM is quite weak, especially in the US. However, the strong theoretical foundation and intuitive appeal still makes it a very widely used model.

Thirdly, we have outlined the Capital Asset Pricing model. This model is a single factor equilibrium model and predicts that the expected return of an individual security is a function of the risk-free rate, the expected return of the market portfolio and the beta factor of the individual security.

However, the empirical evidence has been relatively weak as well. Even so early papers have found a positive relationship between a security's beta and the average return, the estimated relationship is too flat and the intercept has been found to be greater than the average risk-free rate. Generally, researchers have not found significant differences between empirical CAPM investigations in the USA and Japan.

Fourthly, the Intertemporal Asset Pricing model is a linear factor model with wealth and state variables that forecast changes in the distribution of future returns or income. This model generates linear discount factors in which the factors are state variables for the investor's consumption portfolio decision.

The empirical evidence on intertemporal pricing is more supportive than for consumption and capital asset pricing. This might also be due to the fact that many more variables are included in the regression. However, state variables such as the dividend yield, price to book ratio, the term spread as well as the risk spread have been found to have explanatory power for stock prices. Furthermore, many have included macroeconomic factors such as industrial production, inflation and interest rates. These factors have also been found to have explanatory power for stock market returns. Generally, research has not reported significant differences between empirical ICAPM investigations in the USA and Japan.

Fifthly, Arbitrage pricing theory (APT) also allows for multiple factors. As Cochrane (2001) has pointed out, APT and the Intertemporal Capital Asset Pricing Model (ICAPM) have often been confused with each other. Thus a major difference between APT and ICAPM for empirical work is the motivation of the factors. The ICAPM motivates the selection of the factors by looking at state variables that describe the conditional distribution of future asset returns, while the APT motivates the factors by the co-variance matrix of returns in order to find portfolios that characterize common movements. For this reason it is difficult to make a clear cut between APT and ICAPM models in the empirical literature.

As a result, the empirical evidence of many papers that have been quoted as APT are comparable with other papers that have been quoted as ICAPM models. In the very diverse empirical literature on APT, there are papers that find macroeconomic variables such as inflation or industrial production to be significant for stock returns whereas the same or other papers find portfolio characteristics such as price to book or size to explain stock returns as well. Generally, researches have not reported significant differences between empirical APT investigations in the USA and Japan.

Sixthly, the present value model has been explained. This model predicts that the price of an asset should be equal to the expected discounted future cash flows the asset will deliver. Thus it has been proposed that over the long-term, fundamental values and stock prices should build an equilibrium relationship. In particular, earnings, cash flows and dividends discounted at the appropriate discount rate should build long-term equilibrium with stock prices over time.

Empirically many papers have tried to model a long-term equilibrium between dividends or earnings and stock prices. Even so most empirical papers have concluded that there might exist a long-term relationship, the evidence is not clear and some have found evidence against a long-term equilibrium. In this respect, to my knowledge there is no paper that has found dividends or earnings being cointegrated with stock prices in Japan.

Others, have used the discounted value model to motivate macroeconomic variables that are likely to influence corporate cash flows or the discount rate. Usually, those papers have argued that GDP, industrial production, interest rates, inflation and money supply should impact cash flows and discount rates. In general, many papers have found those macroeconomic variables to explain stock market returns. Empirical papers that have investigated macroeconomic factors in the US and Japan, have found those variables to explain stock market returns.

Finally, we have laid out the basic theoretical considerations for rational bubbles. This theory allows for a bubble component in the present value relationship. They are called rational bubble because the presence of the bubble term is entirely consistent with rational expectations and constant expected returns as long as the bubble is expected to grow at the rate of return required for investors willing to hold the stock. Investors do not care if they are paying for the bubble rather than the fundamental value as long as the actual market price pays the required rate of return (Cuthbertson 2000).

Bubbles have been investigated empirically in the stock market. The evidence is mixed and even so some papers have concluded that there is good reason to believe in rational bubbles, others have criticised the fundamental model. Basically, less restrictive

fundamental models of stock prices that for example allow for time-varying discount rates, risk aversion or structural breaks allow the fundamental part of the model to fit the data better and give less room for a bubble.

In our investigation we will start in chapter 3 to motivate macroeconomic variables by hearkening back to the present value model. This will allow us to identify macro-variables that should impact corporate cash flows and discount rates in the US and Japan. Once appropriate variables have been found, we will use a cointegration approach to model long-term equilibrium relationship between those variables and the stock market. We will mainly add to the literature in respect to Japan. There have been many empirical investigations in the US but Japan has lagged far behind. One of the reasons might be that Japan experienced extremely high stock market returns between 1980 and 1990 followed by a period of very negative returns between 1990 and 2003. This makes it more difficult to model long-term equilibrium as the stock market returns have been extreme for more than 20 years. We are the first to report a structural break in Japan during 1993 and our analysis shows that monetary policy might have played a key role for the prolonged stock market downturn.

In the second part of our investigation in chapter 4 we will extend the explanatory data set to include an international output variable, the exchange rate and various state variables or risk factors. Furthermore, in the second part we will apply a non-linear modelling approach instead of the cointegration analysis. The idea of non-linearity will be motivated by behavioural finance theory. The analysis shows that there is non-linear stock market behaviour and the out of sample forecasting exercise reveals stock market predictability. We will add to the literature as we are one of the first to include an international leading indicator to the data set. This indicator has been reported to predict future economic output

and should therefore also predict future corporate cash flows. In our empirical investigation we will find the leading indicator to have predictive power in the US and Japan.

Finally, in the third part of our empirical investigation in chapter 5 we test whether we can find a non-linear model in the dividend yield with an inner regime that follows a random walk or momentum behaviour, whereas the outer regime shows mean reverting behaviour. This model fits the idea of trading costs and other risks involved in mean reversion trades (e.g. financing costs, borrowing constraints, clients' impatience when trades do not show immediate profits). Therefore, an inner regime where trading costs outstrip the profits by a mean reversion trade allows for momentum or noise traders whereas in the outer regime fundamental investors get involved in mean reversion trades as costs are overcompensated by potential profits. In the empirical analysis, we find this model to be supported in the data. We add to the literature as we find the momentum regime to be much smaller in Japan than in the US. This supports the empirical findings on momentum profits in the technical trading rule literature. We believe, as the momentum regime is relatively tiny in Japan, momentum players cannot survive for long, whereas in the US the regime is much larger and momentum traders have better chances to survive for a while, before informed traders enter the market and erode momentum profits.

In the next chapter we will start with the empirical investigation of the US and Japanese stock market.

Chapter 3

3.0 Long term equilibrium approach in a cointegration framework

In this chapter we will start with the empirical investigation of the thesis. Chapter 3 reports long-term equilibrium analysis using cointegration in the US and Japan. We expect that the equilibrium model will show positive deviations from equilibrium during periods of economic boom and negative deviations during periods of recession and economic crisis. This implies overreaction to economic news (for a discussion see DeBondt and Thaler 1985, 1987 and 1990). In chapter 3.3 we extend the overview of economic history that has been discussed in chapter 1.1.1 in order to include some further details. In particular the occurrence of a liquidity trap in Japan during the early 1990s is a major event in recent economic history. We expect that the hypothesised relationship in chapter 3.4 might change due to a liquidity trap. As we have discussed in chapter 2, there are no significant differences in market anomalies between the US and Japan, we therefore attribute any differences in the cointegration analysis to historical or institutional differences.

For our empirical analysis we have chosen the US and Japanese aggregate stock market. While there exists a vast literature on the US stock market, research on the Japanese stock market has lagged far behind and very little is known about the differences and commonalities of those two markets. Japan is particularly interesting, as it experienced one of the largest booms followed by one of the largest depressions in recent history. The US stock market has been much more robust and smooth compared to the Japanese market. In finding an answer to the Japanese experience, we expect to get a better understanding of the interaction between macroeconomic variables and the stock market. This will then

enable us to get a good understanding of the historical events, and what measures might help to avoid a recurrence of the Japanese experience in the future. In particular monetary policy could have had a significant impact on the market development. As discussed in chapter 1.1.1, during the early 1990s the Japanese economy started to weaken seriously but monetary policy was very tight. In contrast to Japan, the US monetary authorities did react very fast to the economic slowdown between 2001 and 2003. In this chapter we will apply cointegration methodology in order to model the long-term equilibrium between macroeconomic variables and the stock market in the US and Japan.

A significant literature now exists which investigates the relationship between stock market returns and a range of macroeconomic and financial variables across a number of different stock markets and over a range of different time horizons. Existing financial economic theory provides a number of models that provide a framework for the study of this relationship. For example APT, C-CAPM, I-CAPM, multifactor models and dividend discount models, as discussed in chapter 2, have been used to study the relationship between macroeconomic variables and the stock market.

In this chapter we will start by discussing some of the most relevant empirical papers for our econometric analysis. This is important as it will provide a better understanding of the empirical findings in the US and Japan. Second, we will give an overview of economic history in the US and Japan during the relevant period. This will enable us to form a priori expectations for our findings as discussed in chapter 1. Third, we will motivate the economic variables for our empirical analysis based on theoretical and empirical literature, as well as our own intuition and background knowledge. Fourth, we will discuss the econometric techniques we are going to use. More specifically, econometric methods for unit root tests, cointegration analysis, error correction and variance decomposition will be

explained in some detail. Fifth, we will carry out the empirical investigation to discuss and summarise the findings. Particular emphasis will be placed on Japan as we find a structural break in March 1993. The findings support the idea that a monetary trap occurred in Japan and this led the normal relationships between macroeconomic variables and the stock market to change. Finally we will summarise the findings in the conclusion and give recommendations for further research.

3.1 Introduction

Most institutional investors like insurance companies or pension funds have rather long term investment horizons of several years or even decades. Thus a large part of their asset allocation is based on strategic considerations and portfolio optimisation¹⁷. As such, long term investors are more interested in the expected long-term asset returns, rather than short term fluctuations based on business cycles or investor sentiment. In a macroeconomic context, stock holders will have an interest to know and understand the long-term relationship between economic growth and the stock market performance, the impact of inflation shocks as well as the implication of interest rate shocks on equity returns. Thus we will apply a long term equilibrium approach to aggregate stock market pricing to address the question as to how a shift in economic growth, inflation or interest rates might change expected long-term stock market returns for long-term investors.

Many economic variables such as GDP, consumption or stock prices have been found to be non-stationary in levels. As a result, an OLS regression of non-stationary variables would yield a spurious regression. However, if a linear combination of them is stationary, then the

¹⁷ In particular, life insurance companies and pension funds have long-term asset-liability requirements. For that reason, the investment portfolio must often be constructed to match liabilities in 20 to 40 years. As a result, it is common to have a strategic investment in stocks that is mainly constrained by regulation requirements.

series are said to be cointegrated. Therefore, cointegration is a statistical tool that can be used to analyse a long-term relationship between macroeconomic variables and the stock market. Thus the validity of long-term equilibrium between non-stationary variables can be examined using cointegration techniques. Cointegration methodology was initially developed by Noble Prize winners Engle and Granger (1987).

The theoretical foundation of our empirical analysis is based on the present value model. Underlying theory, as well as empirical evidence and intuition lead us to suspect that real industrial production, consumer prices, real interest rates and real money supply might have an impact on real stock prices.

As one would expect we find that real stock prices show a positive long-term relationship with real industrial production and a negative long-term relationship with consumer prices and interest rates in the US. While the impact of money supply is not significant in the US, it is very significant in Japan and shows a negative coefficient. In Japan, we find two cointegration vectors. One vector is normalised on the stock market and has a positive coefficient with industrial production as well as a negative relationship with money. The second vector is normalised on industrial production and shows a negative impact of consumer prices and interest rates.

A possible explanation for the different stock market behaviour in Japan is the severe downturn in the real estate market that ended in a bad loan crisis during the 1990s and arguably impacted the effectiveness of monetary policies. In particular, we advance in our explanation hypothesis that Japan entered a liquidity trap that had severe effects on asset prices and changed the relationship between macroeconomic variables and the stock market.

The structure of this chapter is as follows: In chapter 3.2 we will summarise the relevant empirical literature in order to obtain a better understanding of what researchers have found with respect to macroeconomic variables and the stock market. Chapter 3.3 will then summarise recent economic history in Japan and the US in order to get some idea what might have happened to the economy and the stock market in those countries. In chapter 3.4 we will select and construct our primary variables on the basis of the empirical literature, theoretical asset pricing and economic intuition. Chapter 3.5 will present plots and summary statistics of the relevant variables. In chapter 3.6 we discuss the econometric methodology in detail. In particular unit root tests, cointegration analysis, error correction and variance decomposition will be discussed. This leads to chapter 3.7 where the empirical estimation is carried out and chapter 3.8 where the differences and commonalities in the US and Japan are summarised and explained. In 3.9 the key contribution to the literature will be presented whereas chapter 3.10 summarises the findings with a conclusion and gives recommendations for further research.

3.2 Review of relevant empirical literature.

Engle and Granger (1987), with the introduction of cointegration analysis, that earned them the Nobel Prize for economics in 2003, built the foundation for analysing long term relationships between non-stationary time series such as most macroeconomic variables or stock market prices. Thus the validity of long-term equilibrium between non-stationary variables can be examined using cointegration techniques. The econometrics behind this method will be explained in chapter 3.6.2.

The first and probably most cited paper on cointegration analysis in the stock market was written by Campbell and Shiller (1987). Its cointegration methodology is partly based on a paper by Granger and Engle (1985) from the University of California at San Diego. The theoretical foundation of the stock market model is based on the idea of a dividend discount model, which shows that assuming a constant discount rate, real dividends and real stock prices should build a long-term equilibrium relationship described by cointegration. The analysis is based on annual data over the long period from 1871 till 1986. They find the following relationship:

$$P_t = -12.979 + 31.092 * D_t$$

Where P_t is the real stock price at time t and D_t is the real dividend payment at time t . As the frequency is yearly, they use the end of the year stock price for the S&P500 and the dividends that have been paid over the whole year. The long-term cointegration relationships has an R^2 of 0.842 and the implied discount rate, given by the reciprocal of the coefficient on dividends is 3.2%. However, the sample mean return is 8.2% and this would imply a much smaller dividend coefficient of 12.195. The authors also conclude that the deviations from the long run relationship tend to be very large and persistent.

For papers that have estimated the present value relation of the aggregate S&P500 price level with its dividend stream over time, see inter alia Campbell and Shiller (1987, 1988b), Lee (1995), Sung and Urrutia (1995), Timmermann (1995), and Crowder and Wohar (1998). In general these authors have found a positive long term relationship between aggregate stock prices and the underlying dividend stream over time. To my knowledge, there has not been any empirical investigation of the present value model in Japan comparable to the above mentioned research in the US.

In contrast to Campbell and Shiller (1987), Mukherjee and Naka (1995) apply a multivariate cointegration analysis based on Johansen's (1991) method of cointegration analysis for the Japanese stock market using monthly data between 1971 and 1990. The theoretical basis is a more general present value model with YENUSD exchange rate, money supply, consumer prices, industrial production, long term government bonds and the call money rate as explanatory variables for the Japanese stock market. The authors find two cointegration relationships and decide to select the vector with the highest eigenvalue for their analysis only. The results show a negative effect of consumer prices and long term government bonds whereas the exchange rate, money supply, industrial production and call money reveal a positive effect on stock prices. Furthermore, in an out of sample forecasting exercise, the vector error correction model exhibits superior forecasting ability to the vector autoregressive model between 1990 and 1991. To my knowledge, this is the only paper about Japan that applies a long term cointegration approach that has been motivated by the present value model. However, the analysis does not include the severe downturn with deflation after 1991 in Japan. For this reason we will be the first to analyse the post 1991 period in a cointegration framework. Papers that have investigated the relationship between the Japanese stock market and macroeconomic factors before 1991 in general, include inter alia Hamao (1988), Elton and Gruber (1988) and Brown and Otsuki (1990).

McMillan (2001a) also applies a multivariate cointegration analysis to the US stock market for monthly data between January 1970 and March 2000. In a present value model framework, the author finds one cointegration relationship with a positive impact of industrial production and consumer prices, while money supply, 3 month t-bills and 10-year bond yield show a negative coefficient on US stock prices. As money supply and 3-

month t-bills are not significant, these variables are dropped and the relationship is re-estimated. However, the signs of the remaining variables do not change and the author concludes that US stock prices build a positive long term relationship with industrial production and consumer prices whereas 10-year bond yields have a negative impact. Other papers that have focused on the long term relationship between the stock market and macroeconomic factors include inter alia Maysami and Koh (2000) and Nasseh and Strauss (2000).

Chaudhuri and Smiles (2004) investigate long-term cointegration analysis for the Australian stock market using quarterly data from 1960 until 1998. In contrast to other papers, they focus on the influence of various shocks to real stock prices by impulse response and variance decomposition analysis. In general they find a negative impact of GDP, private consumption, money and oil price shocks on the Australian stock market. Furthermore, they report a significant impact of the US stock market on Australian stocks and conclude that the inclusion of the US stock market significantly improves the results. Other papers that have applied variance decomposition to the relationship between macroeconomic factors and the stock market include inter alia Cheung and Ng (1997), Gjerde and Sættem (1999), Hondroyannis and Papapetrou (2001) and McMillan (2001a).

In contrast to the above papers, Bulmash and Trivoli (1991) start with a three-phase model where they claim that many economic variables have different effects on the stock market depending on the economic cycle. Thus, they argue that for instance a money supply increase or a rise in government debt has a positive effect in the short run as liquidity increases, but a negative effect in the long run due to inflation and indebtedness concerns. In order to analyse this argument, they test macroeconomic variables in an autoregressive framework and the effects on the stock market over different horizons. In particular they

investigate the different effects in the short, medium and long run. As short run they define one to two month, medium run six to twelve month and long run as eighteen to twenty-four month periods. They find that the short run CPI effect is likely to be spurious, whereas the long run effect is negative on stock prices. In the case of money supply, they find positive effects in the short and medium run and a negative effect in the long run. For interest rates they find only negative effects, whereas government debt increases seem to have only a negative effect in the long run. The expected short term positive effect could not be found empirically.

Finally, Cheung and Lai (1999) have analysed cointegration between money supply, industrial production, dividends and the national stock market indices for France, Italy and Germany between 1979 and 1992. First, they find the national stock markets to be cointegrated and thus follow a common long term relationship. Second, the macroeconomic aggregates of the different countries are found to be cointegrated as well. Thus, the authors show, that the co-movements of the national stock indices can at least partly be explained by the co-movements of money supply, industrial production and dividends in France, Italy and Germany. In a second paper, Cheung and Ng (1998) apply a cointegration analysis to five national stock market indices, namely Canada, Germany, Italy, Japan and the US for data spanning 1957 to 1992. They focus on long term equilibrium between aggregate real activity and the stock market. In contrast to other studies, the analysis does not include any discount rate and the included independent variables are oil price, consumption, money and GNP. Four of the five cointegrated systems in the above mentioned countries show a negative relationship between real oil price and the stock market, whereas consumption yields a positive coefficient in four cases as well. However, the effect of money supply and GNP on stock markets is ambiguous. An interesting observation the authors make is that the error term of the Japanese cointegration

system seems to be persistent over time and appears to be $I(1)$. The authors conclude that the cointegration analysis indicates the existence of long run co-movements between real economic variables and the stock market. However, different measures of aggregate real activity exhibit varying effects on the national stock markets indices. This diverse phenomenon may be attributable to differences in industrial structures, stock exchange trading systems, regulations on stock markets and the fiscal and monetary policies.

Overall it can be said that researchers have found relationships between macroeconomic variables and the stock market. However, the Japanese stock market is under-researched and to my knowledge there exists no cointegration analysis between macro variables and the stock market after the stock market boom that covers the prolonged downturn post 1990. As discussed in chapter 1, the stock market almost fell by 75% between 1990 and 2003 in Japan. As a result, it is very likely that empirical results prior to 1990 might not be supported after 1990. This might be one of the reasons why researchers have neglected the Japanese market since 1990. Therefore, we will be able to add to the literature by covering this period. Secondly, we will be able to compare the results in the US and Japan. This will enable us to get a better understanding of stock market behaviour in Japan. As a result, a good understanding of the historical events might help to find pre-emptive measures to avoid a recurrence of the Japanese experience in the future.

3.3 Historical Perspective

In order to get a better understanding of the economic developments in the US and Japan between 1965 and 2006 it is useful to have a historical overview of the period with an emphasis on macroeconomic variables. For this reason the following chapter gives a broad overview of economic growth, inflation, interest rates, money supply and stock market

performance in the US and Japan. Furthermore, the period will be broken down into decades to examine the dynamics and to compare those decades in the US and Japan with each other. Summary growth rates of industrial production, CPI, the stock market, M1 and the long term bond yield, split into decades, are shown in table 1 on page 170.

In the 1950s and 1960s almost all the economies within the OECD enjoyed low unemployment, rapid growth of GNP and living standards as well as low inflation (Bruno and Sachs 1985). After World War II (WWII), Japan was occupied by the US between 1945 and 1952. During that period the economy was rebuilt with major investments in the electric power, coal, iron and steel industries. Furthermore, the US helped to create a democratic state in Japan after the war. Economic growth was very high, often exceeding 10%, due to high productivity increases and a strong labour force growth in the 50s and 60s (Statistical Handbook of Japan 2006). At the same time, inflation and interest rates were relatively low, whereas money supply was relatively high. Unsurprisingly, this resulted in very high stock market returns over that period in Japan. However, while stock market returns in the 1950s were extremely high, the returns slowed down in the 1960s although economic conditions were still very good. This could have an impact on our analysis, as we start in 1965 when economic growth, interest rates and inflation were still very favourable for the stock market. However, the period before 1965 was even better and stock market investors might have expected a favourable environment in the future. As a result, the stock market performed very well before 1965 as expectations about the future improved over that period. Eventually, after 1965 the economic environment was very favourable as well but not better than expected. Therefore, stock returns slowed down after 1965. Thus it seems that most of the good economic environment during the 1950s and 60s was already anticipated by the stock market prior to 1965. The lower stock market performance between 1965 and 1970 might reflect some sort of consolidation phase after a

prolonged bull market period¹⁸. Arguably, economic growth started to slow in the late 1960s, however from a very high level above 10% GNP growth (Statistical Handbook of Japan 2006). Given the good economic environment at the end of the 1960s, risk aversion should have been low and we would expect a positive deviation from equilibrium in the cointegration vector.

In the US economic growth was slower than in Japan, but nonetheless quite high during the 1950s and 1960s. Inflation and interest rates were low and the country enjoyed ample money supply. As in Japan, the US stock market generated very high returns during the 1950s, whereas the 1960s were also characterised by high stock market returns but significantly lower than in the 1950s. For that reason, it seems that to a great extent the very good economic situation during the 1950s and 1960s was already priced into the stock market by 1965. According to data available from Robert Shiller¹⁹, the S&P500 experienced a rapid multiple expansion between 1950 and 1960 from a price earnings ratio of 7.22 to 17.12. During the 1960s the price earnings ratio fell slightly from 17.12 in January 1960 to 15.76 in January 1970. Unfortunately we do not have the price earnings ratio for the Japanese market during the 1950s. It seems reasonable that risk aversion was rather high during and shortly after WWII and the arrival of peace, economic stability and prosperity triggered lower risk aversion. Therefore, the high stock market returns during the 1950s might have been caused by changes in risk aversion whereas the stock market performance during the 1960s could be driven more by economic developments. However, given the good economic environment during the 1950s and 1960s, risk aversion should

¹⁸ In Datastream I could only get data since 1955 for the TSE in Japan and have calculated an average nominal stock market return between 1955 and 1960 of 22% per annum. However, a stock market report by Dr. Bryan Taylor shows a nominal stock market increase of 696% between 1950 and 1960. For the report see: <http://www.globalfindata.com/articles/Smdecade.pdf> (World Stock Market Returns 1900-1995. Stock Market Performance by decade. Bryan Taylor.

¹⁹ The data is available at Robert Shiller's web page at the University of Yale: http://www.econ.yale.edu/~shiller/data/ie_data.xls

have been declining during that period and we expect a positive deviation from long-term equilibrium in the cointegration analysis.

The economic goldilocks scenario during the 1960s changed dramatically in the 1970s. At the beginning of the 1970s severe and seemingly persistent macroeconomic problems emerged. In 1971 the Bretton Woods international monetary system collapsed and rapidly increasing inflation between 1972 and 1973 ended in a deep worldwide recession between 1974 and 1975. In the subsequent years the OECD countries have suffered from rising unemployment, low economic growth and increasingly high inflation, causing another severe recession in the late 1970s and early 1980s (Bruno and Sachs 1985). In the US interest rates increased sharply and the stock market performed very poorly during the 70s. Furthermore the price earnings ratio for the S&P500 fell from 15.76 in January 1970 to 7.39 in January 1980. As a result the US experienced negative real stock market returns in the 1970s. The high inflation was partly driven by increasing wages due to influential labour unions and higher energy prices (for a discussion see Bruno and Sachs 1985). In particular the two oil price shocks at the end of 1973 and 1979 triggered a spike in consumer prices. The first oil crisis in late 1973 was caused by a negative oil-supply shock by the OPEC together with Egypt and Syria. By contrast, the second oil crisis in 1979 was triggered by the Iranian Revolution. After massive protests, the Shah of Iran Mohammad Reza Pahlavi left his country in 1979 and Ayatollah Khomeini took control of the country. The protests led to disruption in Iranian oil production and although the new regime resumed oil exports, volumes declined and oil prices went through the roof²⁰. As those oil price shocks were temporary only, we do not model a permanent level shift for that situation. Today the oil price has increased massively over the last couple a years as well.

²⁰ For a discussion see on Wikipedia: http://en.wikipedia.org/wiki/1979_oil_crisis

However, in contrast to the supply shocks in the 1970s, the current price increase is rather demand-driven.

In Japan the 70s were not as devastating as in the US. Although inflation was very high in Japan as well, industrial production, money supply and stock market returns were much better than in the US. Real interest rates were even negative for most of the 1970s in Japan. As a result the relative-performance of the Japanese economy and stock market were relatively good during that time and the Nikkei 225 even experienced a price earnings expansion between 1970 and 1980²¹. We would expect that risk aversion also increased dramatically during the 1970s as price shocks made future consumption more volatile and uncertain. Therefore, it is likely that an equilibrium model of stock prices in the US and Japan will yield a negative deviation during the 1970s due to increased risk aversion.

In the 1980s the US recovered from the severe stagflation of the 1970s and inflation and nominal interest rates decreased to more normal levels again. However, real growth was relatively low and real interest rates on average increased during that period. As a result, the stock market recovered in the 1980s from the depressed levels of the 1970s. Much of the good stock market performance was driven by a multiple expansion from 7.39 times earnings in January 1980 to a price earnings ratio of 11.69 in January 1990²². In October 1987, the stock market experienced one of the largest crashes in US history. The causes of the crash are not clear and include market psychology, illiquidity and overvaluation to a systematic program trading crash triggered by “limit” sell orders executed by computers

²¹ Merrill Lynch has collected data from the Japanese stock market that shows a multiple expansion from ten times the earnings in 1970 to nineteen times the earnings in 1980. Unfortunately these data are not public and cannot be printed here.

²² The data are available from Robert Shiller’s web page at the University of Yale:
http://www.econ.yale.edu/~shiller/data/ie_data.xls

once the market started falling. In the US the situation normalised in the 80s and we would expect the equilibrium vector to move back to equilibrium again during that period.

While the 1980s can be described as back to normal period in the US, the Japanese economy and asset markets literally went through the roof. Japan enjoyed low inflation and real interest rates in combination with high economic growth and ample money supply. Unemployment was almost zero and Japan became one of the world's fastest growing major industrial economies. As a result Japanese companies were expanding all over the world and the prosperity was underlined by sky-rocketing property and share prices (for a discussion see Turner 2003). The price/earnings ratio of the Nikkei more than doubled and went from 18.88 in January 1980 to 51.53 in January 1990²³. In fact during that period, Mitsui & Co, Sumitomo Corp, Mitsubishi Corp, Marubeni Corp and C Itoh all had larger sales than America's biggest company, General Motors, and the US magazine Forbes' reported the Japanese railway and golf course magnate Yoshiaki Tsutsumi as the richest man in the world (Turner 2003). Real stock market returns in Japan were double digit on average for the whole decade, the highest real stock returns in our empirical sample of the US and Japan between 1965 and 2006. Japan also had a very exceptional period of growth and risk aversion must have been very low as asset prices went through the roof and caused massive wealth effect in the society. We therefore expect positive deviation from equilibrium during this period.

The heyday of the US stock market arrived during the 1990s, notably driven by the high tech and internet boom during that period. The economic environment during the 1990s was quite favourable with low inflation and real interest rates in combination with high economic growth and decent money supply. In fact, the S&P500 price earnings multiple

²³ Data kindly provided by Merrill Lynch Capital Markets.

more than doubled and went from 11.69 in January 1990 to 24.35 in January 2000. The 1990s were also characterised by high productivity growth in the US, arguably caused by new information technologies. This together with the good economic environment triggered some sort of new era thinking and massive investments in the real and financial economy (for a discussion see Shiller 2000). Accordingly, risk aversion probably declined during that period and we expect a positive deviation from the equilibrium relationship.

In contrast to the US, Japan suffered from prolonged deflation during the 1990s partly caused by a massive asset price deflation. Furthermore, real economic growth was very low and real interest rates stayed positive due to deflation and the lower bound of zero on nominal interest rates. In particular during the early 1990s the Bank of Japan (BoJ) was very reluctant to fight the early indications of deflationary pressures and kept money supply tight. Interest rates progressively increased during the early part of the 1990s because the BoJ was still concerned about the possibility of inflation (for a discussion see Turner 2003). In the second half of the 1990s the BoJ changed course but arguably this was already too late and the economy ended in a prolonged downturn with a deep recession, high unemployment, falling asset prices and deflation. Real stock market returns in Japan were in aggregate minus 7% per annum for the whole decade. The price earnings ratio increased slightly from 51.53 in January 1990 to 51.80 in January 2000 as corporate earnings were virtually disintegrating. Many companies went bankrupt during the 1990s and in particular bank profits were hit by the bad loan crisis. Even so the BoJ increased money supply and lowered interest rates in the second part of the 1990s, the Japanese banks could not hand out new loans due to solvency restrictions and a typical Keynesian liquidity trap unfolded (for a discussion see Weberpals 1997, Krugman 1998, Svensson 2003 and also Turner 2003). In Japan, the massive downturn must have increased risk aversion and we would expect the model to move back to equilibrium or even blow.

The period 2000 until 2005 brought about a significant stock market downturn in the US between March 2000 and March 2003, whereas the market recovered afterwards and continued doing so till today. Especially the high flying technology stocks of the 1990s collapsed to very low levels. The market was hit by the recession of 2001, the terrorist attacks in New York of 2001 and numerous bankruptcies. Some of the bankruptcies involved fraud and mismanagement; the most well known being Enron and WorldCom. In contrast to the BoJ in the early 1990s, the Federal Reserve (FED) reacted very fast to the stock market downturn and the potential risk of deflation and prolonged recession beginning in 2001. Policy rates were lowered to an unprecedented post war level of 1% in 2003 and money supply was increased at the same time to stimulate borrowing and to make corporate restructuring easier. This probably prevented a situation similar to Japan a decade earlier and economic growth and prosperity returned relatively fast. The S&P500 has fully recovered its losses from the downturn and consumers have benefited from a strong housing market between 2000 and 2006. In the US risk aversion should have normalised and we would expect that we return to equilibrium in our model.

Japan followed the US into recession in 2001 and the stock market fell even further from the already depressed levels. The price earnings ratio decreased from 51.80 in January 2000 to levels below 20 in 2004. Economic growth has improved since 2000 compared to the 1990s but deflation has been persistent. The stock market fell to a low in 2003 but has recovered since. There are some signs of economic improvement, but whether these are cyclical and temporary is not clear. In Japan, risk aversion may have fallen slightly during that period but nonetheless we expect that our estimated model will be close to equilibrium.

A look at economic history in the US and Japan has revealed that we would expect risk aversion to change over time as the economic environment has been very different during the different periods. The late 1960s were very prosperous in the US and Japan and we would expect lower risk aversion during that period. By contrast the 1970s were very disruptive and risk aversion should have increased. The 1980s were a back to normal period in the US, whereas the decade was very prosperous for Japan. We therefore expect risk aversion to normalise in the US, whereas risk aversion should have fallen in Japan. In the 90s the US experienced a very good economic environment and risk aversion should have fallen during that period. In contrast, Japan experienced a very disruptive period during the 90s and risk aversion should have increase accordingly. Finally, the period 2000 until 2004 has seen a downturn between 2000 and 2003, whereas the rest of the period has improved again. We therefore expect risk aversion to increase between 2000 and 2003, whereas it should have fallen again between 2003 and 2004.

3.4 Data selection, sources and construction of primary variables

In order to motivate our variable selection, we consider a simple present value model. The underpinning concept in this model has been discussed in section 2.4.8 in more detail. As discussed earlier, the present value model entails that share prices depend on the expected stream of dividend payments and the market discount rate. Hence, any macroeconomic variable that may be thought to influence future dividends and/or the discount rate could have a strong influence on aggregate stock prices.

As suggested by Chen, Roll and Ross (1986), the selection of relevant macroeconomic variables requires judgement. Therefore, we draw upon both, on existing theory and existing empirical evidence in this regard.

Many authors (for example Fama, 1981; Chen, Roll and Ross, 1986) find that aggregate output variables such as GDP or industrial production are able to partly explain fluctuations in aggregate corporate cash flows and thus stock market returns (for example Schwert, 1990; Balvers, Cosimano and McDonald, 1990; Mukherjee and Naka, 1995; Cheung and Ng, 1998; Binswanger, 2000). We therefore expect a positive coefficient between economic output and stock markets. For our empirical analysis, we use industrial production as a proxy for GDP because data are available at higher frequency. We assume that in periods of high economic growth (e.g. measured by real GDP or real industrial production) the corporate sector in aggregate will be able to increase sales and generate higher turnover. Furthermore, economies of scale may generate higher profitability and higher profits due to increased turnover. As a result, corporate profits and cash flows should be linked to economic growth. In the present value model, future profits or cash flows are discounted to derive a current firm value. Hence, in our macroeconomic framework we use industrial production as proxy for aggregate corporate cash flows or profits.

Inflation is likely to influence stock prices directly through changes in the price level and indirectly through the policies designed to control it. In particular, high inflation could lead to a tight monetary policy with low money supply growth and higher interest rates. Such a policy is likely to have a negative effect on stock prices. Inflation influences the risk-free rate and discount rate thus determining the value of future cash flows. In the present value model corporate cash flows are discounted by the discount rate. If interest rates increase,

the cost of capital and the discount rate will increase as well. As a result, the current value of future cash flows falls. Contrary to the US, Japan experienced periods of deflation and this should have had a negative impact on share prices as well. Sustained deflation can cause risk adjusted returns of assets to become negative. As a result, investors will hoard currency rather than invest it and this can result in a liquidity trap. The lack of investors or buyers during deflation should depress stock prices. Furthermore, the fall in spending during deflation will have a negative impact on aggregate corporate turnover as well. On the contrary, high inflation can cause uncertainty about future prices and trigger precautionary savings. Higher precautionary savings will impact consumption and hence corporate sales growth. As we find reason to think that deflation as well as high inflation should have a negative impact on share prices, a moderate inflation level might be the best macroeconomic environment for the stock market.

The money supply $M1$ might also be related to future inflation uncertainty and policy response; for a discussion see Urich and Wachtel (1981) as well as Rogalski and Vinso (1977). High money supply can lead to higher inflation and policy makers often increase interest rates to slow demand and decrease inflation pressure. As discussed above, in the present value model corporate cash flows are discounted by the discount rate. If interest rates increase, the cost of capital and the discount rate will increase as well. As a result, the current value of future cash flows falls. In addition, portfolio theory relates an increase in money supply to a portfolio shift from non-interest bearing money to financial assets including equities. In particular, high growth in the money supply that exceeds the rate of economic growth could cause excess liquidity that increases demand for financial assets. As a result, higher demand for financial assets could increase share prices.

The interest rate directly changes the discount rate in the valuation model and thus influences current and future values of corporate cash flows. As a result, the current value of future cash flows falls when the discount rates increases. Furthermore, the cost of capital increases with higher interest rates as well. Hence, corporate costs increase and profits might fall in response. For Japan we use the official discount rate instead of 10-year bond yield due to data availability constraints and the fact that the lending rate has been the major monetary tool for the Bank of Japan during most of the period covered (for a discussion see Cargill, Hutchison and Ito 1997). In addition to this availability issue, the 10-year bond yield in Japan has not been a liquid market for most of the time period covered. Since the discount rate is an official lending rate for banks, the absolute value is generally lower than a market rate (for a discussion see Dotsey 1986). This and the fact that there is not a liquid market for the discount rate implies the size of the coefficient should be greater than for a long-term market rate. However, even if the nature of a bank-lending rate should be rather long-term, the influence of monetary policy might make it behave like a short-term rate.

We do not include an exchange rate variable, although some studies of open economies include an exchange rate variable (for example Mukherjee and Naka, 1995; Maysami and Koh, 2000). The reason is that we think the domestic economy should adjust to currency developments over time and thus reflect the impact of foreign income due to firms' exports measured in domestic currency over the medium run. Also in the white paper on the Japanese Economy in 1993, published by the Japanese Economic Planning Agency, it has been pointed out that the boom in the economy during the late 1980s was driven by domestic demand rather than exports (Government of Japan 1993). We therefore chose a purely domestic view at this point. However, in the second part of our empirical investigation we will include the exchange rate in the non-linear application.

Since the driving force for our variable selection is the discounted value approach, the two main variables are an approximation for corporate earnings or cash flows and the discount rate for those earnings. For the corporate earnings or cash flow we chose industrial production instead of GDP, as data on the former is available on a monthly basis but the latter is not. Over the sample period the correlation between industrial production and corporate earnings is 0.91 in levels and 0.48 in first differences. As discussed earlier, many authors (for example Fama, 1981; Chen, Roll and Ross, 1986) have found that GDP or industrial production are good approximations for corporate cash flows and thus most authors have used industrial production (for example Chen, Roll and Ross, 1986; Maysami and Koh, 1998; Mukherjee and Naka, 1995). As discount rate we chose the long-term interest rate of 10 years for the US and the official discount rate for Japan. Generally authors have included a long-term interest rate such as the 10-year bond yield (for example Chen, Roll and Ross 1986; Mukherjee and Naka 1995) and some have also used a short-term interest rate like the 3-month t-bill rate (for example Chen, Roll and Ross 1986; Mukherjee and Naka 1995). We do not use a short-term rate as our aim is to find a long-term relationship between the stock market and macroeconomic variables and the short rates are usually driven by the business cycle and monetary policy. In contrast, the long-term interest rate should indicate the longer-term view of the economy on the discount factor. Furthermore we use the consumer price index and money supply in our model. First of all, inflation should impact share prices directly via the price level. Second, inflation should influence the risk-free rate and the discount rate thus determining the value of future cash flows. The money supply may also be related to future inflation uncertainty and policy response to it. Authors who have included inflation or CPI in their analysis include Chen, Roll and Ross (1986) and Mukherjee and Naka (1995) whereas money supply has been used in the studies by Chaudhuri and Smiles (2004) and Rogalski and Vinso (1977).

In contrast to our study, many researchers have based their analysis on business cycle variables or stock market valuation measures such as the term spread or default spread for the former category or dividend yield as well as the earnings yield for the later. Examples include Black, Fraser and MacDonald (1997); Campbell and Hamao (1992); Chen, Roll and Ross (1986); Cochran, DeFina and Mills (1993); Fama (1990); Fama and French (1989); Harvey, Solnik and Zhou (2002) and Schwert (1990). These variables are found to be stationary and as we will model long-term equilibrium with non-stationary variables, this valuation and business cycle factors are not included in our model because of their statistical properties and the fact that they mainly forecast short-term stock returns, whereas the variables we include are supposed to form a long-term equilibrium relationship. Finally, the aim is to estimate a long-term equilibrium with macroeconomic variables and not with stock market valuation measures. However, in chapter 4 we will extend our variable set and include business cycle variables and stock market valuation measures. In order to extend the variable set, we will relax some of the assumptions in the dividend discount model and motivate additional variables by recent findings in the literature. As a result, we can compare our results to the recent literature that has found business cycle variables or stock market valuation measures to have predictive power for stock market returns.

In contrast to our discounted value model, there are consumption based models to explain aggregate stock market behaviour (for example see Campbell and Cochrane (1999)). In our framework of an aggregate discounted value model we will not include private consumption as it would either supplement or replace industrial production or the discount rate as a stochastic discount factor.

As noted in earlier research (see for instance McAdam, 2003), the US has been characterized by more frequent but milder downturns in contrast with Japan. This can be probably explained by the higher capital and export-orientated Japanese economy relative to the US. We might therefore expect higher relative volatility in corporate cash flows and hence also in Japanese share prices. A priori, therefore, we expect share prices in Japan may be more sensitive to changes in output, although the greater relative volatility may also influence the estimated coefficient standard errors in any regression equation. However, previous research (see Binswanger, 2000) has found that although both stock markets move positively with economic output, the coefficient for output on equity returns tends to be larger in the US than in Japan. Also Campbell and Hamao (1992) find smaller positive coefficients for the dividend price ratio and the long-short interest rate spread on stock market returns in Japan compared to the US in a sample covering monthly data from 1971 to 1990. Thus the intuitive expectation of higher coefficients in Japan due to higher capital and export exposure has not been supported empirically.

Japan's banking crisis and subsequent asset deflation during the 1990s could have changed the influence of a number of variables, particularly the interest rates and money supply. We therefore expect the same sign but different magnitudes of the macroeconomic coefficients in the US and Japan. Due to the higher variability, the Japanese coefficients may be less significant than in the US. To our knowledge, there is no prior empirical study of the present value model in Japan, incorporating data from the 1990s onwards and therefore including the severe downturn with low economic growth and deflation. For studies of the Japanese stock market before 1990, see Brown and Otsuki (1990), Elton and Gruber (1988), and Hamao (1988). These papers mainly look at business cycle variables as well as risk factors and find the relationships are more complex than in the US. Thus these papers

cannot give a complete account of the empirical relationships we expect for our model and our chosen variables.

For our empirical analysis we make use of the following US variables: the real S&P 500 price (SP500), real Industrial Production (IndProd), CPI, real M1 and the real ten-year T-Bond yield. US Industrial Production, CPI and the ten-year bond yield have been taken from the IMF, US M1 is also taken from the IMF whereas the S&P500 was downloaded from Bloomberg. The S&P500 is a market capitalisation weighted index and consists of 500 US equities that cover approximately 75% of the market capitalisation of all US equities. Therefore it is an ideal proxy for the total market (for further information see www.indices.standardandpoors.com). For Japan we make use of the real Nikkei 225, real Industrial Production, CPI, real M1 and the real official discount rate (lending rate). Japanese Industrial Production, CPI and the discount rate are taken from the IMF, and Japanese M1 and the Nikkei 225 are taken from the OECD and Datastream respectively. The Nikkei225 is a price weighted index that consists of 225 Japanese equities and is designed to reflect the overall market (for further information see www.nni.nikkei.co.jp). Our data has a monthly frequency and our sample runs from January 1965 until June 2005. Industrial production, M1 and the CPI time series show strong seasonality, therefore seasonally-adjusted data were used²⁴. The following tables give an overview of the data sources.

²⁴ To get seasonal adjusted data, we have calculated year over year changes and then chained the year over year changes to get a seasonal adjusted index.

<i>US DATA SET</i>					
Variable	Name	Sample	Source	Code	SA or NSA
SPX	S&P 500 Stock Index	1965:M1-2005M6	Bloomberg	SPX Index	NSA
IndProd	Industrial Production	1965:M1-2005M6	IMF	11166..CZF...	SA
CPI	Consumer Price Index	1965:M1-2005M6	IMF	11164..ZF...	NSA Will be SA
M1	Money Supply M1	1965:M1-2005M6	IMF	11159MACZF...	SA
10Y	10 Year Interest Rate	1965:M1-2005M6	IMF	11161...ZF...	NSA

<i>JAPANESE DATA SET</i>					
Variable	Name	Sample	Source	Code	SA or NSA
NKY	Nikkei 225	1965:M1-2005M6	Datastream	JAPDOWA	NSA
IndProd	Industrial Production	1965:M1-2005M6	IMF	15866..CZF...	SA
CPI	Consumer Price Index	1965:M1-2005M6	IMF	15864...ZF...	NSA Will be SA
M1	Money Supply M1	1965:M1-2005M6	OECD	OEJPM005	SA
DiscoRate	Discount Rate	1965:M1-2005M6	IMF	15860...ZF...	NSA

In order to generate real variables, the nominal variables are divided by the CPI time series. Furthermore, all variables except the interest rate series are normalised on a starting value of 100 in January 1965.

3.5 Plots of time series, mean, standard deviation and autocorrelations

In this section we show plots of the time series, mean, standard deviations and cross correlations (for mean, standard deviation, kurtosis, skew and Jarque-Bera probabilities see table 2 and 3 on page 170).

Firstly, we show the correlations between the different time series. In the US all series are negatively correlated except for money supply that shows a positive correlation with stock returns (see table 4 on page 171). A negative correlation between consumer prices, the 10 year bond yield and the stock market has been expected. However, the negative correlation with industrial production is not as expected. The largest negative correlations for the stock market are with CPI and the 10 year bond yield. In Japan, all series are positively correlated except for consumer prices. While the positive correlation between industrial production and stock prices has been expected, the positive correlation between stock prices and the discount rate is opposite to our expectations. Industrial production and consumer prices show the highest correlation with the stock market (see table 5 on page 171). The lowest correlation with the stock market has the discount rate in Japan and money supply in the US.

Secondly, the plots of the time series give us an idea about the statistical properties. It should be mentioned that industrial production, the stock market, CPI and M1 are all normalised on 100 for the start date January 1965. The interest rate will be used as R in the empirical investigation, thus R equals one plus the interest rate. The graphs show the logarithm of the constructed data and the first difference (see graphs 5 to 14 on pages 172 to 176). All series seem to trend and appear to have high autocorrelations in levels. The

first difference of the data looks stationary with consumer prices appearing more trending than the other time series. So overall, we would expect the data to be $I(1)$ and the plots hint at a temporary shock in real interest rates and arguably consumer prices during the two oil price shocks.

3.6 Empirical Method

In this section we briefly outline the econometric methods that will be applied to the data in the following empirical chapter. Firstly, we will introduce unit root tests, as we will use them to determine the order of integration of the time series data. Secondly, we will discuss the application of cointegration and error correction within a VAR framework. Thirdly, the Chow structural break point test and variance decomposition methodology are explained.

3.6.1 Unit Root tests.

When working with data, it is important to know the properties of the data in order to make sure that the prerequisites for valid data analysis are fulfilled. One of the most important data characteristic that must be determined before applying econometric methods is the order of integration. When applying regression models or cointegration techniques, the order of integration is essential. If the applied data has not the correct order of integration, spurious regressions or wrong test statistics are the consequences and can make the analysis useless. Tests that can verify the order of integration are called unit root tests and in this chapter we will explain two of those tests. It should be noted that there are a large number of unit roots tests available; we however use only two of the most popular tests. Therefore, the following chapter is not supposed to give a complete overview of unit root

tests but rather discuss the two most frequently used unit root techniques as we will apply those in our empirical analysis.

Dickey Fuller test.

The first unit root test we shall consider was proposed by Dickey and Fuller (1979) and is based on verifying if $\rho < 1$ in the equation $y_t = \mu + \rho y_{t-1} + \varepsilon_t$. Where $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$.

However, we have to subtract y_{t-1} from both sides, since $y_t = \mu + \sum_{i=1}^t \varepsilon_i$ would give an infinitely large error variance. The appropriate equation is therefore:

$$\Delta y_t = \mu + (\rho - 1)y_{t-1} + \varepsilon_t = \mu + \theta y_{t-1} + \varepsilon_t \text{ with } (\rho - 1) \text{ equals } \theta. \quad (3.6.1)$$

The Dickey Fuller procedure (DF test) now tests the null hypothesis of a unit root $H_0: \theta = 0$ against the alternative of no unit root $H_1: \theta < 0$. The remaining problem is the fact that the test does not follow a standard t-distribution and the critical values have to be derived by simulation. Standard critical values have been provided by Dickey and Fuller in order to deal with the non-standard distribution issue. Since the normal DF test assumes that the error term ε_t follows a white noise process, an alternative, the so called Augmented Dickey Fuller test, has been developed to allow serial correlation in the error term ε_t . Thus the autoregressive process to be tested becomes:

$$\Delta y_t = \mu + \theta y_{t-1} + \sum_{i=1}^p \theta_i \Delta y_{t-i} + \varepsilon_t. \quad (3.6.2)$$

Again, the ADF test verifies the null hypothesis of a unit root $H_0: \theta = 0$ against the alternative of no unit root $H_1: \theta < 0$. In order to include the possibility of a time trend δt the specified regression equation to be estimated becomes:

$\Delta y_t = \mu + \theta y_{t-1} + \delta t + \sum_{i=1}^p \theta_i \Delta y_{t-i} + \varepsilon_t$. As for the DF test, the ADF test with and without trend does not follow the standard t-distribution and simulated distributions must be used (for a discussion see Wang 2003).

Phillips and Perron test.

Phillips and Perron (1988) proposed an alternative (nonparametric) unit root test to control for serial correlation in the error terms. The Phillips-Perron test (PP test) estimates a non-augmented Dickey Fuller test equation and modifies the t-ratio of θ so that serial correlation does not affect the asymptotic distribution of the test statistic. The t-statistic of the PP test is calculated as:

$$t = \sqrt{\frac{r_0}{h_0}} t_\theta - \frac{(h_0 - r_0)}{2h_0\sigma} \sigma\theta \quad (3.6.3)$$

where r_0 is the variance of the one period difference $\Delta y_t = y_t - y_{t-1}$ whereas h_0 is the variance of the M-period differenced series $\Delta y_t = y_t - y_{t-M}$. The t-statistic of θ is t_θ with the standard error of θ being σ_θ . Finally the spectrum of Δy_t at the zero frequency is given by:

$$h_0 = r_0 + 2 \sum_{\tau=1}^M \left(1 - \frac{\tau}{T}\right) r_\tau \quad (3.6.4)$$

where r_j is the autocorrelation function at lag j .

3.6.2 Cointegration and error correction analysis

When regressing two or more non-stationary time series on each other, the result must not always yield invalid estimators. In case there exists a linear combination of two or more $I(1)$ time series, these are said to be cointegrated and the regression on each other yields valid estimators. Generally, we can say that if Y_t and X_t are both integrated of order one $I(1)$ and there is a β such that $Z_t = Y_t - \beta X_t$ is $I(0)$, it can be concluded that Y_t and X_t are

cointegrated, with β being named the cointegration parameter. Thus the cointegration vector is described by $\begin{pmatrix} 1 \\ -\beta \end{pmatrix}$. Therefore if both time series are integrated of the same order e.g. $I(1)$, the difference between X_t minus Y_t , might be stable around a fixed mean value. Intuitively, this would imply that both series are drifting upward together at roughly the same pace. In this case we have to distinguish between the long- and the short-run relationship. Hence, the appearance in which the time series drift upward together is called the long-run equilibrium relationship, whereas the short-run dynamics are characterised by the deviation of Y_t from its long-term trend as well as X_t from its long-term trend. In this case, differencing the data would be absurd, as it would ultimately hide the long-run relationship between Y_t and X_t . However, the presence of a long-term relationship between Y_t and X_t has also a consequence on the short term dynamics of the $I(1)$ variables, as there has to be a process that moves the variables back to their long-term equilibrium. This process or mechanism is modelled with a so called error correction model where the equilibrium error also drives the short-term dynamics of the series.

Testing for Cointegration.

In modelling economic relationships it is crucial to distinguish between spurious regressions and cases where time series are cointegrated. When we have two time series that are integrated of order one $I(1)$, we can estimate the following “cointegration regression”:

$$y_t = \alpha + \beta x_t + \varepsilon_t \quad (3.6.5)$$

In case Y_t and X_t are cointegrated, the error term is stationary $I(0)$ and we can test for the presence of a cointegration relationship by testing for a unit root in the ordinary least square residuals by applying the common ADF unit root test. However, the ordinary least square estimator will make the residuals appear as stationary as possible, due to the

optimisation of the sum of the error terms, even if the variables are not cointegrated. Hence, the appropriate critical values are more negative than those for the standard Dickey Fuller tests. This methodology of testing for cointegration has been developed by the Noble Prize laureates Engle and Granger (1987) and is called residual-based cointegration test.

An alternative approach is based on a vector autoregressive process called VAR. Such a process is described as a dynamic system of equations where all variables are treated as being endogenous to start with. Each of the variables in the system is written as a linear function of its own lagged values as well as the lagged values of the other variables in the system and an uncorrelated error term. It should be stated that economic theory is often not very specific on the dynamic structure of such a model and hence vector autoregressive processes are generally data-driven. Only the selected variables are derived by economic theory but the short-run adjustment is often determined by estimating a VAR model. In addition to that, the number of lags in the estimated model is critical and must be set prior to estimation. However, with too many variables and a large lag order in the VAR, which is with many lagged variables, the degree of freedoms can rapidly be exhausted in small samples. There is no commonly agreed technique on how to select the lags and variables structure while the outcome of the estimation heavily depends on the estimated settings. In the general form, a VAR (p) model is described by:

$$Y_t = \mu + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \beta_p Y_{t-p} + \varepsilon_t = \mu + \sum_{i=1}^p \beta_i Y_{t-i} + \varepsilon_t \quad (3.6.6)$$

Y_t is a matrix with n different time series, whereas p is the number of included lags. In the error correction framework, a reduced VAR can be written as:

$$\Delta Y_t = \mu + \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \quad (3.6.7)$$

with $\Gamma_i = -(\beta_{i+1} + \beta_{i+2} + \beta_p)$ and $\Pi = \beta_1 + \beta_2 + \dots + \beta_p - I_n$.

In this case, I_n is an unit matrix whereas Π contains the information on the possible cointegration relationships between the n elements of Y_t . Here Π stands for a constant dynamic adjustment of the first differences of the variables respectively to their levels, and regardless of the time difference. The rank r of the matrix Π equals the dimension of the cointegration space (Burgstaller 2002). By the Granger representation theorem and some general conditions, it is implied that if the rank of the matrix Π is equal to n , that is to say equal to the number of variables in the VAR, the vector process Y_t happens to be stationary (all the variables in Y_t are integrated of order zero and thus there is no necessity for differencing). Furthermore, if the rank of the matrix Π happens to be zero, a VAR system of equations with $I(1)$ variables can be estimated in first differences without losing any relevant information. When the rank of the matrix Π is identical to $r < n$, there happens to be a representation of Π so that $\Pi = \alpha\beta'$ with α and β being both an " $n \times r$ " matrix. The matrix β is then named the cointegration matrix and has the feature that $\beta'X_t \sim I(0)$ whereas $X_t \sim I(1)$. Furthermore, the cointegration vectors $\beta_1, \beta_2, \dots, \beta_r$ are specific columns of the cointegration matrix. Obviously, in a VAR with n variables there can only be at most $r = n - 1$ cointegration vectors. In case an equilibrium error term $\beta'X_t$ is statistically significant in an equation of the vector error correction model (VECEM), the particular variable adjusts to a previous deviation from the long-run equilibrium relationship.

Testing for cointegration with the Johansen approach.

For the Johansen (1991) approach, consider a general Vector Autoregressive model with Gaussian errors written in the following error correction form:

$$\Delta X_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + \phi D_t + \varepsilon_t \quad (3.6.8)$$

Where ε_t is a sequence of zero-mean p -dimensional white noise vectors and D_t are seasonal dummies. The term X_t includes our variables and is a $p \times 1$ vector. The parameters are the $p \times p$ matrix Γ and Π denotes a $p \times p$ matrix that contains the information about the rank and hence the long-term relationship among the variables. There are three possible cases to be considered: Rank (Π) = p and therefore vector X_t is stationary; Rank (Π) = 0 implying absence of any stationary long-run relationship among the variables of X_t or Rank (Π) < p and therefore r determines the number of cointegration relationships. The equation has an error correction representation where $\Pi = \alpha\beta'$. The columns of matrix α are called adjustment (or loading) factors and the rows of matrix β are the cointegration vectors with $\beta' x_t$ being stationary even if X_t consists individually of $I(1)$ processes. Johansen developed two different tests of the hypothesis that there are at most r cointegration vectors. One is called the trace statistic and tests the null hypothesis of at most r cointegration relationships against a general alternative in a likelihood ratio framework. The other test is called maximum eigenvalue statistic and tests the hypothesis of r cointegration relationships against the defined alternative of $r+1$ cointegration relationships.

3.6.4 Structural break point test

In order to test the possibility of a structural change, the Chow break point test has often been applied in empirical analysis. If it is assumed that a structural break has taken place at time T_B , the Chow break point test compares the estimates from the period before T_B and after T_B with each other. Thus an OLS is estimated for the whole sample T and the split sample T_1 with the observations before T_B and the observations after T_B called T_2 . The

resulting residuals are named $\hat{u}_t, \hat{u}_t^{(1)}$ and $\hat{u}_t^{(2)}$. We follow Lütkepohl and Krätzig (2004) and get:

$$\hat{\sigma}_u^2 = T^{-1} \sum_{t=1}^T \hat{u}_t^2, \quad (3.6.9)$$

$$\hat{\sigma}_{1,2}^2 = (T_1 + T_2)^{-1} \left(\sum_{t=1}^{T_1} \hat{u}_t^2 + \sum_{t=T-T_2+1}^T \hat{u}_t^2 \right), \quad (3.6.10)$$

$$\hat{\sigma}_{(1,2)}^2 = T_1^{-1} \sum_{t=1}^{T_1} \hat{u}_t^2 + T_2^{-1} \sum_{t=T-T_2+1}^T \hat{u}_t^2, \quad (3.6.11)$$

$$\hat{\sigma}_{(1)}^2 = T_1^{-1} \sum_{t=1}^{T_1} (\hat{u}_t^{(1)})^2, \text{ and } \hat{\sigma}_{(2)}^2 = T_2^{-1} \sum_{t=T-T_2+1}^T (\hat{u}_t^{(2)})^2. \quad (3.6.12)$$

With this notation, the break point test is given by:

$$\lambda_{BP} = (T_1 + T_2) \log \hat{\sigma}_{(1,2)}^2 - T_1 \log \hat{\sigma}_{(1)}^2 - T_2 \log \hat{\sigma}_{(2)}^2. \quad (3.6.13)$$

The test statistic thus compares the residual variance estimate from a constant coefficient model with the residual variance estimate of a model that permits a change in parameters. Thus the test checks whether there are statistical significant differences in the estimates before and after the break point T_B . The Chow break point test checks the null hypothesis that the AR coefficients, deterministic terms and the white noise variance do not change during the sample period. The test statistics are derived from the likelihood ratio principle and under parameter constancy they have limiting χ^2 distributions with k and $k+1$ degrees of freedom. In this case, k is the difference between the sum of the number of regression coefficients estimated in the first as well as the last subperiods and the number of coefficients in the total sample. The parameter constancy hypothesis is rejected if the values of the test statistic λ_{BP} is large. However, it has been found that in samples of common size, the χ^2 and F approximation compared to the actual distribution may be very poor. Hence, the actual rejection probability may be much larger than desired. Candelon and Lütkepohl (2001) have suggested a bootstrap version of the test to overcome this

problem. The probabilities are obtained by estimating the model of interest, denoting the estimation residuals by \hat{u}_t , computing centered residuals $\hat{u}_1 - \bar{\hat{u}}, \dots, \hat{u}_T - \bar{\hat{u}}$, and generating bootstrap residuals u_1^*, \dots, u_T^* by randomly drawing with replacement from the centered residuals (Lüdkepohl and Krätzig 2004). This is then used to compute bootstrap time series recursively starting from given presample values y_{-p+1}, \dots, y_0 for an AP(p) model. The relevant model is then re-estimated with and without stability restrictions and bootstrap versions of the λ_{BP}^* statistics are computed. Critical values are obtained by repeating this many times and getting an empirical distribution of the bootstrap test statistic. Thus the stability hypothesis is rejected if the original statistic λ_{BP} exceeds the corresponding bootstrap critical value.

3.6.5 Impulse response and Variance decomposition analysis

In a standard VAR model with two variables y_t as well as z_t and with the two types of reduced form shocks e_{1t} as well as e_{2t} we have in matrix notation:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \theta_{10} \\ \theta_{20} \end{bmatrix} + \begin{bmatrix} \theta_{11} & \theta_{12} \\ \theta_{21} & \theta_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}, \quad (3.6.14)$$

and can get:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \bar{y} \\ \bar{z} \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \theta_{11} & \theta_{12} \\ \theta_{21} & \theta_{22} \end{bmatrix}^i \begin{bmatrix} e_{1,t-i} \\ e_{2,t-i} \end{bmatrix}. \quad (3.6.15)$$

In the vector moving average (VMA) representation of the vector autoregressive model (VAR) this can be re-written to get the structural shocks as:

$$\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = B^{-1} \varepsilon_t = \frac{1}{1 - b_{12}b_{21}} \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}. \quad (3.6.16)$$

Where:

$$\varepsilon_t = B e_t.$$

We can get:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \bar{y} \\ \bar{z} \end{bmatrix} + \frac{1}{1 - b_{12}b_{21}} \sum_{i=0}^{\infty} \begin{bmatrix} \theta_{11} & \theta_{12} \\ \theta_{21} & \theta_{22} \end{bmatrix}^i \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}. \quad (3.6.17)$$

This can be simplified by defining the 2x2 matrix ϕ_i with the elements $\phi_{jk}(i)$:

$$\phi_i = \frac{\Theta_1^i}{1 - b_{12}b_{21}} \begin{bmatrix} 1 & -b_{12} \\ b_{21} & 1 \end{bmatrix}. \quad (3.6.18)$$

Thus we can write the moving average representation in terms of ε_{yt} and ε_{zt} as:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \bar{y} \\ \bar{z} \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \phi_{11}(i) & \phi_{12}(i) \\ \phi_{21}(i) & \phi_{22}(i) \end{bmatrix} \begin{bmatrix} \varepsilon_{y,t-i} \\ \varepsilon_{z,t-i} \end{bmatrix}. \quad (3.6.19)$$

Or simplified:

$$X_t = \mu + \sum_{i=0}^{\infty} \phi_i \varepsilon_{t-i}. \quad (3.6.20)$$

Thus the coefficients of ϕ_i can be employed to detect the effect of ε_{yt} and ε_{zt} shocks on the complete time path of y_t and z_t . The four elements $\phi_{jk}(0)$ are named impact multipliers and the coefficient $\phi_{21}(0)$ is the instantaneous impact of a one unit change in ε_{zt} on y_t .

Furthermore, the elements $\phi_{11}(1)$ and $\phi_{12}(1)$ are the one period responses of one unit change in $\varepsilon_{y,t-1}$ and $\varepsilon_{z,t-1}$ on y_t . In updating by one period, it can be shown that $\phi_{11}(1)$ and $\phi_{12}(1)$ also represent the effects on unit change in ε_{yt} and ε_{zt} on y_{t+1} (see Burgstaller 2002).

After n periods we get the cumulated sum of the effects of ε_{zt} on y_{t+1} :

$$\sum_{i=0}^n \phi_{12}(i). \quad (3.6.21)$$

When n approaches infinity, we get the long run multiplier. Since y_t and z_t are assumed to be stationary, it must be the case that for all j and k we get:

$$\sum_{i=0}^{\infty} \phi_{jk}(i). \quad (3.6.22)$$

The four sets of coefficients $\phi_{11}(i)$, $\phi_{12}(i)$, $\phi_{21}(i)$ and $\phi_{22}(i)$ are named impulse response functions (for a discussion see Lütkepohl 1993, Lütkepohl and Krätzig 2004 and Burgstaller 2002).

3.7 Empirical Evidence

In this chapter the empirical evidence is collected by applying the outlined econometric methods. First, unit root tests are applied to test for the order of integration in the selected variables. Second, the cointegration test together with the vector error correction analysis is carried out to find the long-term as well as short-term relationship between the variables. Furthermore, we test some restrictions and evaluate the cointegration vector together with the error correction mechanism. Finally, impulse response analysis will give an idea of the variance decomposition of the relationships we have examined.

3.7.1 Unit Root test results

As a first step, the data are analysed for their statistical properties. For the proposed analysis of cointegration it is necessary to test the variables for stationarity and in this chapter we carry out unit root tests to verify the order of integration of the selected variables. We apply the Augmented Dickey Fuller (ADF) test as well as the Phillips-Perron test. Both methods have been explained and outlined in chapter 3.6.1 in more detail.

In table 6 on page 177, unit root test results for the US data are shown. It can be seen that for the ADF test, all variables appear to be $I(1)$ and only the 10-year bond yield shows stationarity in levels without trend and constant. For the Phillips-Perron test, again, all variables appear to be $I(1)$ and we thus conclude that for the US data set all variables can be seen as $I(1)$ variables and are therefore stationary at first differences.

In table 7 on page 178, unit root test results for the Japanese data set are shown. The ADF test yields good evidence of the variables being $I(1)$ and only industrial production and the discount rate show some evidence of being $I(0)$. However, the Phillips-Perron test finds all

variables following an $I(1)$ process and we thus conclude that all variables in Japan are also $I(1)$ as well. As a result, the following analysis is conducted under the assumption that all variables are stationary in first differences.

3.7.2 Cointegration analysis results

Since we have evidence that all our variables are $I(1)$, the next step is to test for cointegration relationships. For this purpose, the analysis follows the cointegration approach suggested by Johansen (1991). This technique has been described in chapter 3.6.2 in more detail.

3.7.2.1 The US stock market

As a first step, automatic lag length criteria are applied in order to verify the preferred lag length. Some tests show significance at lags of 14 and as a result we use a lag structure of 14 in the cointegration analysis (see table 8 on page 179). This allows for any remaining seasonality on a yearly basis. Two vectors are found via the trace statistics and by the maximum eigenvalue statistic at the 5% level (see table 9 on page 180). Thus we conclude that we might have two cointegration vectors in the US data set. As a first step we consider only one long-term equilibrium relationship (see table 10 on page 180). Here we find all included variables contributing to the long-term relationship, except for money supply which is not significant at the 10% level. The signs of the variables are as expected with industrial production and money showing positive coefficients whereas the price level and 10-year bond yield indicate a negative impact on real stock prices in the US. Also the error correction appears to be significant and driven by the S&P500, CPI and industrial production. Given that money supply M1 is not significant in the long-term relationship, we test for M1 being equal to zero and the test shows a p-value of 0.83 of that being the

case (see table 11 on page 181). Hence we drop money supply and re-estimate the relationship. First, we test for the optimal lag length and find evidence of 14 lags again (see table 12 on page 181). We apply the cointegration test again, and now find only one vector for the trace and maximum eigenvalue statistic when M1 is dropped from the variable set (see table 13 on page 182). In the long term relationship all variables are now found to be statistically significant (see table 14 on page 182). Industrial production gives a large positive coefficient and thus supporting the view that the stock market rises on the back of economic expansion²⁵. In contrast, the 10-year bond yield shows a very large negative coefficient and this supports the assumption of rising real interest rates having a negative impact on real stock prices. The size of the coefficient also indicates how sensitive stock prices are to changes in the discount rate. Also the price level CPI has a negative impact on real stock prices and indicates that rising consumer prices, measured in terms of inflation, are bad news for real stock prices. In particular, the high interest rates as well as high inflation during the 1970s have depressed the stock market. Again, the error term shows a significantly negative relationship with the S&P 500, CPI as well as industrial production and thus supports the expected error correction behaviour. A further look at the cointegration vector reveals a large deviation from the mean during the 1970s, whereas before 1972 and after 1982, smaller and shorter periods of deviation from the mean are recognised (see graph 15 on page 186).

3.7.2.2 The Japanese stock market

The automatic lag length tests are carried out as a starting point again. As in the US, there is evidence of a lag structure with 14 lags and thus we allow for 14 lags in the

²⁵ Theory suggests that markets are forward looking and that the stock market rises on the back of expectations of continuing economic expansion. We therefore assume that current economic growth rates are a good proxy for expected economic growth.

cointegration analysis (see table 15 on page 183). Two cointegration vectors are found via the trace statistics and by the maximum eigenvalue statistic at the 5% level (see table 16 on page 184). Thus we conclude that we might have two cointegration vectors in the Japanese data set. As a first step we have considered only one vector and taken the estimated long-term relationships for one cointegration vector into account. In contrast to the US data set, only CPI appears to be significant in the Japanese case. This would mean that all other variables drop out of the relationship and stock prices only depend on the CPI (see table 17 on page 184). We believe this cannot represent a proper macroeconomic model for stock prices. For this reason, one vector has not been an option for Japan and two vectors have been considered. In the case of two vectors, we allow for a financial vector normalised on the stock market and an output vector normalised on industrial production. Further, we test the probability of restricting individual variables in the two different vectors. We find a high p-value of 0.71 that there exist those two vectors. One vector is normalised on the stock market and shows a positive effect of industrial production and a negative impact of money supply on stock prices. The second vector is normalised on industrial production with a negative effect of CPI and the discount rate on industrial production (see table 18 on page 185). Furthermore, both vectors show some error correction behaviour with the major drivers being M1, CPI and the Nikkei. However, only M1 is statistically significant in both error correction vectors.

To evaluate the relationship further, we consider the plot of the two cointegration vectors against time. Graph 16 on page 186 visualises that the stock market vector appears to trend down until the early 1990s, whereas the industrial production vector (see graph 17 on page 187) seems to shift up until the early 1990s. Thus there is only “one” mean reversion effect in both vectors over the whole period and this indicates a structural shift rather than good error correction behaviour in the cointegrated system. We would expect more mean-

reversion effects in the cointegration vector that indicate recessions, shocks and changes in risk aversion. For this reason, we think the calculated long-term relationship via cointegration analysis might not be very strong in Japan. One reason may be a structural break. Therefore, we will now split the data set. It is generally known that Japan was in a high economic growth period during the 1980s and in a low or no growth period thereafter. Thus it is likely to have an economic structural shift at the end of the 1980s or early 1990s. As our theoretical stock price model assumes that corporate earnings are mainly correlated with economic output and we have used industrial production as the main fundamental driver of stock prices, we first test for a structural break in industrial production between 1985 and 1995. The structural break test, explained in chapter 3.6.4, finds good evidence of a break for industrial production in March 1993 (see table 19 on page 189). Furthermore, the downshifting stock market vector hits a low during the early 1990s whereas the up-shifting output vector reaches a high after 1992. During the early 1990s, Japan experienced a down-shift in economic growth and CPI. We therefore expect a structural break to be most likely during the early part of the 1990s. This gives us good reason to test for a structural break in March 1993 in the Japanese cointegration system. The bootstrapped Chow break point test, as explained in chapter 3.6.4, is applied to the Japanese dataset for March 1993. We set the number of bootstrapped replications to 1000. The p-value for no structural break in March 1993 is found to be zero (see table 20 on page 189) and we conclude that there is reasonable evidence that a structural break occurred in March 1993.

Hence, the next step is to split the data set into two parts, before and after March 1993. First of all, we carry out a unit root test in order to verify the order of integration in the sub periods. In both periods we find good evidence that all series are $I(1)$ (see table 21 and 22 on pages 189 and 190). Furthermore, the optimal lag length is determined via lag length

criteria tests (see table 23 and 24 on pages 190 and 191). We then start with the earlier period between January 1965 and March 1993 with the cointegration analysis. Two vectors are found via the maximum eigenvalue statistics and five²⁶ cointegration vector are found by the trace statistic at the 5% level (see table 25 on page 192). Thus we conclude that we might have two vectors or possibly even more cointegration vectors in the early part of the Japanese data set. As a first step we consider only one vector and take the estimated long-term relationships for one cointegration vector into account. We only find the CPI variable being significant in the long-term relationship whereas M1 is the most insignificant variable (see table 26 on page 192). Given that money supply M1 has been the most insignificant variable in the long term relationship, we test for M1 being equal to zero and the test shows a p-value of 0.65 of that being the case (see table 27 on page 193). Hence we drop money supply and re-estimate the relationship. Now we find two vectors for the trace and for the maximum eigenvalue statistic (see table 28 on page 193). First, we only look at one vector and find that all variables are statistically significant in the long-term relationship²⁷ (see table 29 on page 194). Industrial production gives a large positive coefficient, thus supporting the view that the Nikkei225 rose on the back of economic expansion until March 1993. In contrast, the 10-year bond yield shows a very large negative coefficient und thus supports the assumption of rising real interest rates having a negative impact on real stock prices during that period. Also the price level CPI has a negative impact on real stock prices until 1993 and indicates that rising consumer prices were bad news for real stock prices. Except for CPI, the size of the coefficients is generally larger than the estimates we have found in the US data set between 1965 and 2004. This indicates that until 1993, the Japanese stock market was indeed more cyclical and more

²⁶ This is not in line with economic theory and we make a rational decision to consider at most two cointegration relationships.

²⁷ A second vector could be given by the money equation. However, we could not support the money equation as second vector. As we do not have a theoretical motivation for a second vector, we only allow for one vector.

sensitive to macroeconomic variables. Also the error correction term has a negative impact on the Nikkei as well as consumer prices and the cointegration vector shows mean reversion behaviour (see graph 25 on page 200).

Secondly, we now look at the period between March 1993 and June 2004. Multiple cointegration vectors are found via the maximum eigenvalue statistics and by the trace statistic at the 5% level (see table 30 on page 194). Thus we conclude that we might have more cointegration vectors in the later part of the Japanese data set. As a first step we consider only one vector and take the estimated long-term relationships for one cointegration vector into account (see table 31 on page 195). We find all variables are statistically significant in the long-term relationship. All variables show a positive coefficient except money supply, which indicates a negative impact. Contrary to the early period in Japan, consumer prices show now a large positive coefficient. Industrial production still shows a positive coefficient and the size of the coefficient is comparable to the US or Japan during the 1965M1 to 1993M3 period. Contrary to our expectations, the discount rate also shows a large positive coefficient. Finally, money supply yields a negative impact on the Japanese stock market between March 1993 and June 2004. The error-correction term shows a negative relationship with the Nikkei, the discount rate and money supply M1. A look at the cointegration vector reveals strong mean reversion behaviour for the later period in Japan (see graph 26 on page 200). Thus, the split into the period before and after March 1993 has resulted in much more reasonable results than for the whole period. Furthermore, the early part of the data set seems to yield long-term coefficients that are comparable to the US data set, whereas the later period in Japan seems to be characterised by a change in the impact of inflation, the discount rate and money supply. In section 3.8 we will discuss the findings and try to find reasons and arguments for the differences and commonalties that we have found. However, before we discuss the

findings in detail, we will gather more information by applying variance decomposition to the data.

3.7.3 Variance Decomposition and Impulse Response Function

In this chapter we investigate the variance decomposition and impulse response function for stock prices in order to see the effect of macroeconomic changes on the stock market in terms of magnitude and reaction time. For this reason the variance decomposition in tables 32, 33, 34 and 35 on pages 195 to 197 show which macroeconomic factors explain a substantial part of the variation in stock prices over the periods of one, four and eight years in the US and Japan. Therefore, the variance decomposition extends from the short to the long run and displays the impact over time. Thus, we can analyse the impact of a random innovation of the individual variables on the stock market over different periods. The variance decomposition shows the relative importance of each random innovation in affecting the variables in the VAR (EViews 2004). The tables show the percentage of the forecast variance due to each innovation. This will help us to get a better understanding of short and long-term influences on the stock market.

In the US the strongest impact over one year on stock prices comes from the 10-year bond yield and explains 6% of share price movements over that period. Industrial production shows a similar impact of close to 6% on stock prices over the same period. Finally, the CPI explains 5%, whereas money supply M1 only shows less than one percentage point impact on share prices over one year in the US stock market. This again supports the view that share prices are mainly driven by economic output and the discount rate, whereas the money supply has only medium or long run effects via inflation expectations. This view is also supported by the analysis over four and eight years, as money supply has the strongest

explanatory power over those periods with 15% and 19% respectively. Furthermore, the CPI is the second strongest driver of stock prices over the medium and long run whereas the impact of industrial production rises over time to 7% for four years and 11% for 8 years. Finally the effect of 10-year bond yields reduces with time to 4% over four years and 1.5% over eight years (see table 32 on page 195).

In Japan, the strongest impact on stock prices for the whole sample over the one-year period is given by money supply, followed by CPI, the discount rate and finally industrial production. Over four years, the highest impact comes from money supply, again followed by discount rate, CPI and industrial production. Even over the eight year period, money supply has the strongest impact, again followed by discount rate, CPI and industrial production. This supports our findings from the cointegration analysis. Especially, the fact that money supply, the discount rate and CPI play the major role in explaining stock market movements, gives us a hint that this puzzle may have a relation with monetary policy in Japan (see table 33 on page 196).

As before, we now split the data set into two parts; before and after March 1993. We start with the period until March 1993. Over the one-year period, the explanatory power is relatively small, with 2.3% for CPI, 1.3% for the discount rate and 0.8% for industrial production. However, over the 4-year period, explanatory power increases and yields 11.4% for the discount rate, 8.9% for industrial production and 4.2% for CPI. This is as one would expect and supports the findings in the US. Over the 8-year period, the explanatory power does change slightly with 13.3% for industrial production, 12.2% for the discount rate and 4.3% for CPI (see table 34 on page 197).

Finally, we look at the second part of the sample after March 1993. Here, over the one year period by far, the highest explanatory power comes from industrial production with 20.4% followed by 1.5% for the discount rate and M1 whereas CPI only explains 0.5%. Over the 4-year period industrial production explains 31.4%, M1 2.7%, the discount rate 1.3% and CPI 1.25%. Even over eight years, the explanatory power does not change much from the four-year period with industrial production at 30.4% by far explaining the largest part of stock prices. This is followed by M1 with 2.4%, CPI 1.9% and finally the discount rate with 0.7% (see table 35 on page 197). Overall, the second period is to a great extent dominated by industrial production and money supply. Therefore we cannot support the normally expected high impact of the discount rate. However, in chapter 3.8 we will have a detailed discussion of the results and will try to find explanations of these findings.

While variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR, impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in a VAR (EViews 2004). Therefore, a shock to one variable does not only affect the variable itself, but also all the other endogenous variables in the VAR due to the dynamic lag structure. The impulse response functions are plotted out to 96 month (8 years) and the significance of the impulse response is indicated by the 95% confidence intervals.

Graph 21 (page 198) shows the impulse response functions for the S&P500 between 1965 and 2004. All impulse response functions show a negative hump shaped response. A shock to industrial production shows a negative impact on the S&P500 and is significant between the 2nd and 19th month lag. Similarly, a shock to the CPI shows a negative impact on the S&P500 and is significant for the whole period. Furthermore the relative size of the impact is the highest between the four variables. Overall, this could indicate a permanent shift in

the equilibrium because the response stays permanently significantly different from zero. In the case of a shock to M1, the S&P responds negatively as well. However the impulse response is only significant between the 12th and 36th month lags. Finally, shocks to the 10year bond yield show a negative impact on the S&P 500 for lags between 1 and 7 month.

Graph 22 (page 198) shows the impulse response functions for the Nikkei225 between 1965 and 2004. In general, all shocks have a negative impact on the Nikkei225. However, except for the CPI at lags between 12 and 31, the impulse response is not significant. Overall, we find similar results as in the US but less significant. This supports our view that the long-term relationship we have estimated between 1965 and 2004 for the Nikkei225 is not very robust (or marginal significance) and it is reasonable to model a structural break in the relationship between 1965 and 2004.

Graph 23 (page 199) shows the impulse response functions for the Nikkei225 between 1965 and 1993. For this period, shocks to industrial production are positive for short and long-term lags whereas at medium term lags the impact is negative. However, shocks in industrial production are not significant. Furthermore, a shock to CPI or the discount rate has a negative impact. However, as with industrial production the impulse response is not significant for the Nikkei225 except for the CPI at lags between 4 and 32.

Finally, graph 24 (page 199) shows the impulse response functions for the Nikkei225 between 1993 and 2004. A shock to industrial production shows a positive impact on the Nikkei225 and is significant between the 3 and 13 month. The 1993 to 2004 period was characterised by very low growth rates and the result suggests that a positive growth shock would have supported the stock market. Similarly, a shock to the CPI shows a positive impact on the Nikkei225 but is not significant. This supports our view that an increase in

inflation would have been good for the Nikkei225 during the deflationary period. In the case of a shock to M1, the Nikkei225 responds negative and is significant between 2 and 30 month, 33 and 44 month as well as 56 and 61 month. Finally, a shock to the discount rate has a negative impact on the Nikkei225 and is significant between 2 and 51 month lags.

3.8 Differences and commonalities in the US and Japan and how they can be explained

In this chapter we will briefly summarise the findings in order to point out differences and commonalities in the US and Japan. Furthermore, the emphasis will be on explaining the findings.

First of all, it should be noted that we have not found a stable relationship between the selected macroeconomic variables in Japan and the stock market in Japan. In particular, for the period 1965 to 2004, we find two cointegration vectors with one normalised on stock prices and the other one normalised on industrial production. The stock price vector shows a positive impact of industrial production and a negative effect of money supply, whereas the second vector shows a negative impact of the discount rate as well as CPI on industrial production. All variables are significant in that long-term relationship and the p-value of the restriction to hold is 0.71. Furthermore, there exists error correction behaviour with negative coefficients of the error term on Nikkei, CPI and M1. This is all good evidence on our expected cointegration relationship. However, the cointegration vectors do trend and show only one “mean reversion” effect between 1965 and 2004. As discussed in the historical perspective chapter 3.3 we would expect more “cycles” in the cointegration vectors due to the very different economic periods over time. This gives us reason to doubt

a stable long-term relationship between the variables and the stock market. A further test on a structural break during the early 1990s shows a break in industrial production in March 1993 and this break date is supported in the cointegration relationship with a very high probability. For this reason, we have split the data set between January 1965 to March 1993 and March 1993 to June 2004 for Japan. In the US, there is no doubt about the long-run relationship to hold as all properties of significant coefficients, error correction and more frequent mean reversion are fulfilled.

In the theoretical motivation of the selected variables (see chapter 3.4), we have hypothesised a positive relationship between industrial production and stock prices as industrial production should be a good proxy for earnings or cash flows (see Fama, 1981; Chen, Roll and Ross, 1986). In the US and Japanese data set we find a strong positive coefficient between industrial production and stock prices. Generally, the industrial production coefficients are greater than one and this points to share prices being more sensitive toward industrial production. In particular Japan shows an industrial production coefficient of up to 6.1 whereas the US yields a coefficient around 2.4 between 1965 and 2004. However, between 1993 and 2004 Japan also shows a smaller coefficient of 2.1 between share prices and industrial production. Such large coefficients have also been reported in the literature. For instance, McMillan (2001a) finds a coefficient of 1.9 between industrial production and US share prices whereas Cheung and Ng (1998) find a coefficient of 28.6 between real GNP and real stock prices in Japan and a size of 13.8 for the same coefficient in the US.

We think there might be two major components that could explain the large coefficient. First, earnings could have been rising faster than industrial production. As earnings or cash flows are used in the present value model, industrial production can only be seen as an

approximation. Hence, earnings and cash flows could rise faster than industrial production. If earnings rise faster than industrial production, the use of industrial production as approximation for earnings would result in a higher coefficient on industrial production than would have been the case for earnings themselves. Secondly, we could have seen a so-called multiple expansion where the market gets more expensive when measured in terms of share price divided by earnings (P/E ratio). Graph 6 and 11 on pages 172 and 175 show real industrial production, whereas graph 18 on page 187 shows corporate earnings normalised on 100 in 1965 for the US and Japan. The data was provided by JP Morgan where the corporate profits were used to calculate the profit share to GDP ratio shown in graph 19 and 20 on page 188. For the period January 1965 until June 2004 industrial production was rising more than corporate profits in the US and Japan, and this can therefore not explain the large coefficient of industrial production (see graph 29 on page 202). However, at least it shows that over the whole period corporate earnings tend to move with industrial production and that corporate earnings appear much more volatile than industrial production. Thus corporate earnings are more cyclical than the overall economy and the stock market might be very sensitive to changes in industrial production. Graph 27 on page 201 shows the P/E ratio in Japan between January 1965 and December 1993. This explains that there was a large multiple expansion during that period and the price to earnings ratio went from 14 in January 1965 to 32 in March 1993. A multiple expansion means, that a stock valuation measure, such as the price to earnings ratio, expands and the market gets more expensive when measured by this ratio. Although a multiple expansion could be driven by changes in the discount rate, the large coefficient might pick up higher growth expectations for the future, that in turn might have increased the multiple as well. After March 1993, the P/E ratio for Japan becomes very volatile due to sizeable negative earnings caused by extraordinary write offs in the banking sector for the Nikkei225 in 2002. However, corporate profits rose more than industrial production

during March 1993 and June 2004, which partly explains the industrial production coefficient of 2.1 during this period (see graph 30 on page 202). In particular since 2003 corporate earnings have risen more than industrial production because the massive write offs Japanese banks had experienced since 1990 fell rapidly due to the economic recovery after 2003. In the US, the P/E ratio does contract slightly and moves from 19 in 1965 to 17 in 2004. While we cannot find a good explanation why the coefficient for industrial production on stock prices is greater than one in the US, the much larger coefficient in Japan is likely to be caused by a large multiple expansion in the Nikkei225 between 1965 and 1993. Furthermore, the finding supports our expectation that the Japanese stock market is more sensitive to macroeconomic variables. In chapter 1.1.2 we have presumed that the higher exposure to cyclical sectors in the Japanese economy and the less independent central bank could make the stock market more sensitive to macroeconomic news.

The second main driver in a present value model, besides the cash flow, is the discount rate. For the whole period, the US and Japanese data set shows a large negative coefficient for the discount rate on stock prices. In the present value framework, the discount rate is the hypothesised denominator in the equation and is therefore expected to have a negative impact on share prices. In Japan the impact of the discount rate is indirect as it has a negative relationship with industrial production and as reported earlier, industrial production has a positive effect on real stock prices. It is also interesting to note that the discount rate coefficient in Japan is again much larger than in the US but becomes positive between March 1993 and June 2004. This supports our expectation in chapter 1.1.2 that the Japanese stock market is more sensitive to macroeconomic variables. In contrast, the coefficient is negative, large and significant for real stock prices between 1965 and March 1993. In Japan nominal interest rates fell to virtually zero during the 1993-2004 period and this might have broken down the relationship. Although real interest rates were positive

due to deflation in the country, policymakers were bounded with the nominal zero interest rate policy because nominal interest rates cannot become negative (for a discussion see Hunt and Laxton 2004). This in turn means that monetary authorities could not actively lower real or nominal interest rates any more and we think this might have broken down the relationship between the discount rate and the stock market during 1993 and 2004. Basically, since 1998 the real interest rate has been driven only by inflation and not monetary decision making or free market forces. It is therefore understandable that the stock market did react differently to real interest changes as those have been driven by inflation. Thus, it is rational that the consumer price index became much more important for the stock market because it has been the driving force for real interest rates at a bounded nominal zero interest rate²⁸.

Consumer prices have been included as a variable in the stock market equation. In the US we find a negative coefficient of -1.0 of the consumer price index on real stock prices. Thus the rationale of a negative coefficient might be that rising consumer prices can trigger an interest rate increase by policymakers in order to fight inflation. In Japan we find a negative coefficient of consumer prices on industrial production for the whole period and also a negative impact of inflation between 1965 and March 1993 directly on real stock prices. However, for the period March 1993 until June 2004 the consumer price coefficient is positive. As discussed earlier, the positive coefficient for the period after 1993 may be explained by the zero nominal interest rate and the fact that a pick-up in inflation would have indicated higher economic growth and the chance to escape deflation in Japan during this period.

²⁸ For instance brokerage research by Goldman Sachs has analysed the relationship between bond yields and equity returns. The empirical research suggests that the relationship is non-linear. They report an optimal bond yield around 4% and any deviation from that threshold on either side (lower or higher bond yields) has a negative impact on stock returns (Peter Oppenheimer, Goldman Sachs, 2004).

Finally, money supply M1 was included in the real stock price equation and its impact was tested. In the US money supply shows a positive coefficient with real stock prices, but is not significant and has been dropped, as the p-value of the money coefficient being zero is 0.83. In Japan for the whole period money supply M1 shows a large negative coefficient on real stock prices, whereas it drops out, as in the US, for the period 1965 until March 1993. Finally, it becomes negative and significant between March 1993 and June 2004. This gives us reason to believe that there might have been a monetary problem in Japan during the later period (for a discussion see Weberpals 1997, Krugman 1998, Svensson 2003 and also Turner 2003). To give a better understanding of circumstances in Japan during the 1990s, the next chapter will briefly outline the historical developments with an emphasis on monetary policy.

However, before we look more closely at Japan during the 1990s, it is interesting to note that the cointegration vectors nicely display the expected variations in the business cycle as expected in chapter 1.1.1. Furthermore, we provided an economic history interpretation to changes in risk-aversion over the different periods in chapter 3.3, and this can be supported when looking at the cointegration vectors (see graph 15 on page 186). In the US, the late 1960s were good and we expected below average risk aversion to result in an above equilibrium stock market state. This is supported by the positive cointegration vector between 1965 and 1970. During the 1970s there were many difficulties in the world economy and in particular the US. Therefore, we expected high risk aversion resulting in a below equilibrium stock price. The US cointegration vector clearly reflects this a priori expectation with two large negative deviations during the 1974 and 1979/1980 recessions²⁹. There is anecdotal evidence that at the time of the largest deviation of the US cointegration vector in 1974, one of the most famous fundamental investors claimed that

²⁹ Black, Fraser and Groenewold (2003) also find stock market undervaluation from the mid 1970s through 1980s in the US.

the stock market would be extremely cheap and that he would invest every penny he owned. In 1969 Warren Buffet sold all his investments and came back to the stock market in 1974. Forbes magazine published an interview with Warren Buffet in November 1974 when he said: “Now is the time to invest and get rich” (Forbes November 1st 1974)³⁰. He got it right and is today the second richest man in the world after Bill Gates (Forbes 2007)³¹. During the 1970s the US has experienced various macroeconomic shocks. Fraser and Groenewold (2006) have shown that the stock market is particularly exposed to macroeconomic shocks and that the relative impact on stock prices is greater than on the real economy. This also supports the idea that the US stock market was undervalued during the 1970s. In the historical perspective section we then expected a normalisation back to equilibrium during the 1980s. This is also supported in the US vector, indeed the 1990s have been very good and the vector moves above equilibrium. Finally the aftermath of the 2001 recession moves the vector below equilibrium again in 2003. All this has precisely been predicted by our historical analysis in chapter 3.3.

In Japan, one of the reasons to test for a structural break in 1993 was the poor cointegration vector with only one “mean reversion” effect for the whole period 1965 until 2004. For this reason, we will not comment on the whole period vector and directly move to the two vectors before and after 1993 (see graph 25 and 26 on page 200). As expected at the end of the 1960s, the economic situation was good in Japan and the vector is above zero. However, as in the US, the 1970s have been characterised by recession and supposedly high risk-aversion and the stock market vector moves below equilibrium. In contrast to the US, the Japanese vector recovered equilibrium by 1980 and stayed above equilibrium during the 1980s. This supports our expectations based on very good economic

³⁰ For a discussion see: http://en.wikiquote.org/wiki/Warren_Buffett

³¹ For the latest Forbes list of the riches people in the world see:
<http://www.forbes.com/2001/06/21/billionairesindex.html>

development and high growth rates during the 1980s that must have resulted in low risk aversion. The second vector between 1993 and 2004 also very clearly displays the expected economic cycles. In 1995, there was an economic slowdown that did not result in a recession, but was close to it. The second negative deviation from equilibrium was caused by the Asian crisis, whereas the third below average move reflects the 2001 recession. Finally, the 2003 move below equilibrium was also caused by an economic slowdown that did not end in a recession but has been expected by many market participants to have severe consequences. Thus, we can also support what the historical perspective in chapter 3.3 has suggested for the Japanese stock market vector.

3.8.1 What happened in Japan?

In order to get a better understanding about Japan, we return to a further discussion of the historical background to the development in the country as noted earlier. The 60s were characterised by high economic growth with low inflation and are similar to the developments in the US. In the 70s the situation changed dramatically as in the rest of the world (for a discussion see Bruno and Sachs 1985).

However, during the 1980s Japan experienced an economic hype with high economic growth, very impressive stock market returns and sky rocketing real estate prices. For instance, the White Paper on Japanese Economy by Economic Planning Agency (1993) reports excessive consumption and investment activity due to enormous capital gains during the bubble process. Thus, consumers and corporations speculating in financial markets earned very high returns and increased spending accordingly. In general, Case, Quigley and Shiller (2005) have reported a statistically significant and rather large effect of housing-wealth upon household consumption. Therefore, it is likely that the 1980s housing

boom in Japan had a positive effect on household spending and consumer confidence. However, at the end of the 1980s and early 1990s, the economic growth came to a sudden end and house prices as well as the stock market fell sharply. The White Paper on Japanese Economy by Economic Planning Agency (1993) quotes on page 60: “As the bubble formed, companies and households which had increased their assets with very little effort stepped up investment in such high-risk areas as shares and real estate, while at the same time increasing their debt burden. Although the mechanism was not a source of problems while asset prices were rising, it had an adverse effect on corporate, household and financial sector balance sheets once asset prices dropped”. As discussed by Goyal and McKinnon (2003), Japanese banks have been extensively exposed to the real estate market via bank lending.

The collapse of real estate prices caused heavy credit cost for banks due to disposal of non performing loans since 1992. Furthermore, in order to fulfil the 4% Tier 1 capital ratio, banks have reduced new lending. This is because under the international harmonised regulatory framework based on the Basel Accord, a bank has an incentive to reduce the supply of loans in the wake of loss of its own capital. The Basel Accord requires that the ratio of capital to risk weighted assets of a bank, known as risk-based capital (RBC) ratio should not to be below the stated 4%. Bank lending has been assigned the highest 100% risk weight irrespective of the credit risk of each contract. Thus reducing the supply of loans allows the bank to restore the risk-based capital ratio without raising equity capital (Nishiyama, Okada and Watanabe 2006).

This may have impacted the relationship between money supply, economic growth and lending. Arai and Hoshi (2004) show that the relationship between real GDP and money supply changed in the mid 1990s. In a cointegration framework the authors report that

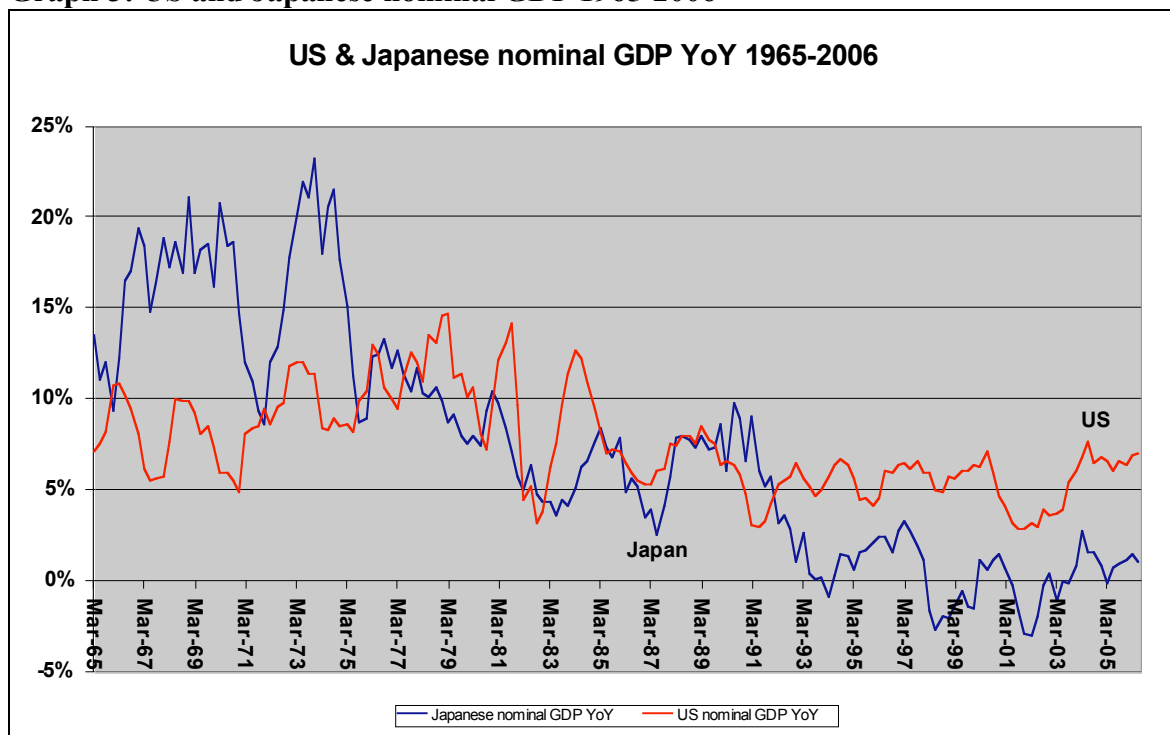
there is a positive relationship between real GDP and money supply but that the relationship became much weaker after 1995 and the coefficient became much smaller, indicating that monetary policy became less effective after 1995. This supports our view, that restrictive bank lending due to bad loan crises made the increased money supply less supportive for the real economy. We would even go a step further and argue that a liquidity trap explains the negative money coefficient we have found between 1993 and 2004. Furthermore, Goyal and McKinnon point out the impotence of monetary policy at the zero lower bound of nominal interest rates. They argue that as long-term interest rates have been pushed to very low levels, short-term interest rates have been reduced to zero and Japan has found itself in a liquidity trap, where the Bank of Japan has been unable to halt deflation even though it has been increasing the monetary base at a high rate. Although nominal interest rates have been close to zero, real interest rates stayed positive due to deflation in the Japanese economy.

The impact of money supply on the stock market, it has been argued in the variable motivation section, could be due to a change in inflation expectations. Furthermore portfolio theory relates an increase in money supply to a portfolio shift from non-interest bearing money to financial assets including equities (for a discussion see Wachtel (1981) and Rogalski and Vinso (1977)). However, in the case of Japan between 1993 and 2004, it is likely that neither has been the case. First of all, the coefficient is significantly negative for that period and thus contradicting what portfolio theory suggests. Goyal and McKinnon (2003) as well as Lane and Milesi-Ferretti (2001) show a large increase in Japan's net foreign asset position in the late 1980s and 1990s. Thus Japan became one of the largest creditor nations and in 2000 the total net foreign asset position stood at nearly 1.2 trillion USD, which is over 20% of GDP (IMF, International Financial Statistics March 2002). Therefore, we would argue that a large portion of the increased liquidity went into

international markets rather than the domestic financial market and therefore did not support the Japanese stock market. The second theoretical idea that increased money supply indicates higher future inflation risk would generally allow for a negative coefficient between money supply and the stock market. In general, the consumer price index has often been found to have a negative relationship with stock markets in many international studies. However, in the special case of Japan between 1993 and 2004 this is very unlikely because the country was in a deflation period. For that reason, the emergence of inflation would have been a positive due to the possibility of negative or at least lower real interest rates and thus more effective, as well as flexible monetary policy. We would argue it is more realistic that the negative relationship between money supply and the stock market between 1993 and 2004 was caused by a liquidity trap (for a discussion of the Japanese liquidity trap see Weberpals 1997, Krugman 1998, Svensson 2003 and also Turner 2003). Thus the insignificance of interest rates for the stock market and the significant negative relationship between money supply and the Nikkei might have been caused by the impotence of monetary policy at the zero nominal interest rate bound. Furthermore, the reduced bank lending pre-emptively in response to capital losses, made the money supply ineffective. Therefore, the negative relationship between money supply and the stock market picks up the ineffectiveness of monetary policy in a liquidity trap.

In contrast to the US economy, Japan experienced periods of negative nominal GDP growth. As can be seen in the following chart, Japan experienced some quarters of a fall in nominal GDP between 1993 and 2003.

Graph 3: US and Japanese nominal GDP 1965-2006



We think a fall in nominal GDP makes it particularly hard for corporations to lower their cost base and restructure during a recession. As the largest portion of corporate costs are unit labour costs, it is hard to bring down the cost base in nominal terms. Most working contracts are fixed contracts that state a fixed salary (in nominal terms). If the nominal GDP growth becomes negative even a stagnation in wages means that real costs increase. Normally, corporates try to avoid nominal wage increases during recessions. As long as the nominal GDP growth stays positive this effectively lowers the real wage costs of a corporation. However, as soon as nominal GDP growth gets negative, corporations would have to negotiate nominal wages to fall. Given that fixed contracts have fixed salaries bound by the contract, it is virtually impossible to lower real wages in such a case. We believe this is another reason why it took a long period for Japanese companies to restructure.

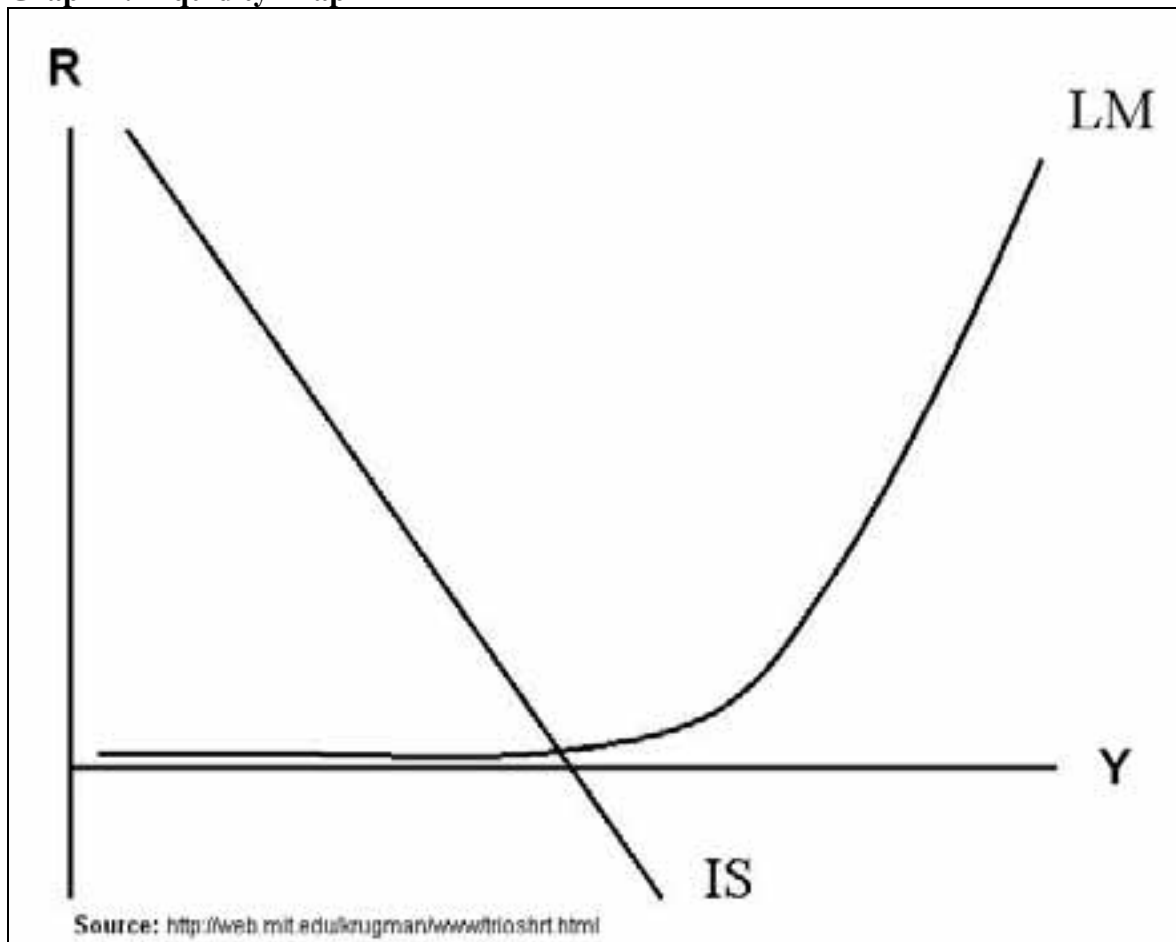
3.8.2 The occurrence of a liquidity trap

Partly due to the developments during the great depression in the US in the 1930s, Keynes argued that interest rates could be so low that they can only go up again and therefore asset prices down (Keynes 1936). The concept of a liquidity trap can best be explained by Hicks's (1937) IS-LM model. The so called IS-curve shows the goods market equilibrium in the context of a closed economy without government³² (Pentecost 2000). Furthermore, the model assumes fixed prices. In this case the goods market equilibrium requires that investment (I) equals savings (S). The IS curve plots the goods market equilibrium in the interest rate-output space, where output equals planned aggregate expenditure (AE). As interest rates (R) fall, aggregate expenditure raises by an extent that must be matched by a rise in output so that the goods market equilibrium is maintained. So the IS-curve is downward sloping and shows how lower interest rates increase the demand for goods and hence real output (Y). The LM-curve shows the equilibrium between demand for liquidity or liquidity preference (L) and the supply of money (M) from banks and the central bank. Along this line, the interest rate is determined by the level of real GDP. So the LM-curve is upward sloping and shows that increased output increases the demand for money and drives up the interest rate. In this framework, fiscal policy shifts the IS-curve whereas monetary policy shifts the LM-curve. Under usual circumstances monetary policy might be used to effectively increase output, since an increase in money supply bids down interest rates as agents use excess money holdings to buy financial assets. The fall in rates will then stimulate the economy. However, as discussed above, Hicks (1937) realised that monetary policy might be ineffective under "depression" conditions as agents are not willing to hold assets (Krugman 2000). As nominal interest rates cannot be negative, at interest rates near zero the demand for money becomes infinitely elastic. This means that the leftmost part of the LM-curve becomes flat (Boianovsky 2003). If the IS-curve intersects the LM-curve in

³² Although the model can easily be extended to include the government.

the flat region, changes in money supply, which move the LM-curve back and forth, have no effect on the interest rates or output (Krugman 2000). The following graph illustrates the flat LM-curve area where monetary policy is ineffective.

Graph 4: Liquidity Trap



However, the liquidity trap concept is a theory that was developed from the experience during the 1930s and until the 1990s most economists thought it would be irrelevant to the modern world (DeLong and Olney 2006). On theoretical grounds there are two arguments that might nullify the liquidity trap concept. First, in an open economy the goods market equilibrium depends on the level of the real exchange rate. Hence, when prices fall as

suggested by a liquidity trap³³, other things being equal, domestic goods become more competitive on world markets and the demand for domestic goods rises due to increased exports (Pentecost 2000). Second, even in a closed economy the demand for goods depends on real income and real wealth. As a result, when the price level falls, real wealth increases and raises the aggregate demand for domestic output.

However, in Japan during the 1990s, the asset price deflation (housing and stock market) was much higher than the consumer price deflation and real wealth fell rather than increased (Turner 2003). As a result the wealth or Pigou effect (Pigou 1943) did not help the Japanese economy during the 1990s. The first argument of increased exports due to falling domestic prices has been partly the case but could not overcompensate the falling domestic demand. Overall, the Japanese economy enjoyed a trade balance surplus during the 1990s. However, deflation was also partly driven by food prices, public services and other goods that are imported rather than exported or cannot be exported like public services (for a discussion see Turner 2003).

Other models of the liquidity trap exist, for instance Goodhart, Sunirand and Tsomocos (2003) apply a more up to date computable general equilibrium (CGE) model to allow for a liquidity trap. They show that in an adverse economic environment, expansionary monetary policy can aggravate financial fragility since the extra liquidity injected by the central bank may be used by certain banks to gamble for resurrection, worsening their capital position, and therefore the overall financial stability of the economy (Goodhart, Sunirand and Tsomocos 2003).

³³ In contrast to the neo-classical theory, Keynes argued that even if real wages were to fall the economy would not return automatically to full employment. For the neo-classical analysis to be correct, prices must fall less rapidly than money wages, so that the real wage rate falls to induce a higher demand for labour and hence a higher supply of output (for a discussion see Pentecost 2000).

3.9 Contribution of this analysis to the existing literature

In the preceding empirical analysis we have modelled the long-term relationship between stock prices and macroeconomic variables in the US and Japan.

In the US we have been able to find our hypothesised relationships and can also support what has been found in previous empirical research. In particular, we find a positive relationship between stock prices and industrial production. Furthermore, the expected negative relationship between stock prices and interest rates could be verified as well. Also the negative relationship between stock prices and inflation is evident from our US analysis. However, the more tentative negative relationship between money supply and stock prices has not been found. As money supply appears to be insignificant in the US equation, it has been dropped from the variable set. All these findings support earlier research (for a discussion of the hypothesised relationships and earlier empirical findings see 3.4). As we have done one of the most up to date analyses we can support findings of earlier research of the US stock market.

Regarding Japan, we add to the literature in several ways. First of all, the hypothesised relationships have not been supported in Japan. Over the period January 1965 until June 2004 we find two cointegration relationships. The first cointegration vector points to a long-term relationship between stock prices, industrial production and money supply. Normalised on stock prices, industrial production has a positive effect whereas money supply is negatively related. The second vector demonstrates a long-run relationship between industrial production, consumer prices and the discount rate. Normalised on industrial production, consumer prices and the discount rate have a negative impact on industrial production. Thus indirectly via the second vector, consumer prices and the discount rate have a negative impact on share prices. It is interesting to note that this

relationship is not direct but via the industrial production relationship and the second vector. So overall, the built in relationships are as expected, but the existence via two vectors is somewhat unexpected. Furthermore, examination of the cointegration vectors reveals that both vectors show only a single mean reversion over the whole period. For this reason we tested for a structural break in the data and find evidence for a break point in March 1993. Also the two cointegration vectors reach a low or high at this time respectively, and we split the data before and after March 1993. To our knowledge, there is no earlier research that has tested for a structural break in relation with the Japanese stock market during the early 1990s. In the literature, we have found evidence of a liquidity trap that occurred after 1993. We believe this must have caused the relationship between macroeconomic variables and the stock market to change.

The analysis of the data before March 1993 shows that before the break, Japan followed a similar pattern as the US and as we have hypothesised originally. It appears that Japan used to react to macroeconomic variables in a comparable way to the US. However, the relationships change severely after March 1993, as the discount rate and consumer prices show a positive effect, whereas money supply yields a negative effect on stock prices. We are the first to report this change in the relationship between the stock market and macroeconomic variables. It is likely that the emergence of deflation in Japan during the 1990s has changed the relationship between consumer prices and the stock market.

Thus, the deflation had very disruptive effects on the Japanese economy and higher inflation would have been a positive. Furthermore, money supply increased massively by the end of the 1990s, but this had no effect due to the bad loan crisis and a liquidity trap formed. We therefore believe the negative relationship between money supply and stock prices during the 1990s is caused by a liquidity trap in Japan. Again, we are the first to link

the severe stock market downturn in Japan between 1993 and 2003 to the build-up of a liquidity trap and the emergence of deflation.

3.10 Conclusion

In chapter 1.1.2 we expected that an equilibrium model of the stock market would reflect the business cycles in the US and Japan. The empirical findings in 3.7.2 have supported this view. In general we support the expected relationships between the stock market and macroeconomic variables as expected in chapter 3.4. However, our empirical analysis in chapter 3.7.2.2 has also demonstrated that the generally accepted relationship between the stock market and macroeconomic variables did break down in Japan after 1993. This is a very important finding as it shows that the expected relationship can collapse under certain circumstances. As we look at a long-run equilibrium, this means that the equilibrium relationship between stock prices and macroeconomic variables can break down in specific situations. In particular for long term investors this is highly relevant. For instance, insurance companies or pension funds try to anticipate in the economy over the long-run by buying equities. Therefore, they expect that their stock portfolio anticipates in economic growth and counterbalance a decline in fixed income from bond investments when interest rates fall. Furthermore, they might make predictions about the effect of inflation and money supply on their portfolio. However, we have shown that the long-term equilibrium can collapse if the economy enters into deflation or a liquidity trap. This should not only be kept in mind by investors but also by policy makers. Once an economy enters a deflationary period or a liquidity trap, many investors may suffer severe wealth effects and reinforce the economic downturn. In particular, the fact that we have found that the long-run equilibrium might break down due to deflation or a liquidity trap should motivate policy makers to do everything necessary to avoid such a development. As Japan has not

recovered yet, we do not even know how it is possible to escape such a destructive environment and what it takes to restore the normal relationship.

In the next chapter we will try to find alternative explanations for the different stock market developments in the US and Japan by using a non-linear model of stock prices. Furthermore, we will add an international output variable, the exchange rate and risk measures to account for the differences in cyclicalities and export dependence in the US and Japan.

3.11 Tables and Graphs

Table 1: Selected macro variables in the US and Japan

Selected macro variables in the US and Japan					
Years	1960-1970	1970-1980	1980-1990	1990-2000	2000-2005
<i>US real IndProd</i>	4.61%	2.93%	1.71%	4.06%	0.68%
<i>US CPI Growth</i>	2.36%	7.13%	5.83%	2.98%	2.55%
<i>US real Stock Return</i>	1.93%	-3.86%	5.44%	12.19%	-5.67%
<i>US real M1</i>	1.55%	-0.62%	1.96%	0.50%	1.41%
<i>US average real 10YR yield</i>	2.34%	0.37%	5.02%	3.66%	2.22%
<i>Japan real IndProd</i>	14.18%	4.47%	3.63%	0.31%	1.31%
<i>Japan CPI Growth</i>	5.39%	8.95%	2.48%	1.17%	-0.51%
<i>Japan real Stock Return</i>	3.72%	2.17%	15.61%	-7.44%	-9.38%
<i>Japan real M1</i>	11.71%	5.40%	2.45%	6.40%	10.86%
<i>Japan average real 10YR yield</i>	0.86%	-3.20%	2.18%	0.97%	0.71%

Table 2: Summary Statistics US data set

Variable	Mean	Std.Dev.	Skewness	Kurtosis	Jarque-Bera probability
LSPX	4.933875	0.489716	0.738587	2.865309	0.000000
DLSPX	0.002166	0.043739	-0.610906	5.294070	0.000000
LIndProd	5.328582	0.370893	-0.214733	2.357609	0.001303
DLIndProd	0.002471	0.007339	-0.625918	5.982716	0.000000
LCPI	5.582973	0.646391	-0.221881	1.492299	0.000000
DLCPI	0.003497	0.003049	0.961584	4.563776	0.000000
RL10Year	0.027430	0.023542	-0.362021	4.353760	0.000000
DL10Year	-0.000003	0.004040	0.330600	4.800500	0.000000
LM1	4.795200	0.142542	0.326876	1.925149	0.000000
DLM1	0.000707	0.006112	0.322800	10.09060	0.000000
L stands for logarithm and D for delta. For the definition of the variables see chapter 3.4.					

Table 3: Summary Statistics Japanese data set

Variable	Mean	Std.Dev.	Skewness	Kurtosis	Jarque-Bera probability
LNKY	5.423553	0.519051	0.309060	2.350183	0.000291
DLNKY	0.001605	0.053762	-0.699369	4.924331	0.000000
LIndProd	5.745976	0.412250	-1.097829	3.439670	0.000000
DLIndProd	0.003205	0.013719	-0.195641	3.145374	0.171958
LCPI	5.934182	0.480373	-0.992393	2.429898	0.000000
DLCPI	0.002989	0.003576	1.905679	7.842914	0.000000
RLDiscoRate	0.000898	0.032100	-3.019468	14.72197	0.000000
RDLDiscoRate	0.000002	0.007786	0.455426	10.18971	0.000000
LM1	5.797774	0.579026	0.215113	2.899802	0.138660
DLM1	0.005011	0.010860	0.931611	10.10004	0.000000
L stands for logarithm and D for delta. For the definition of the variables see chapter 3.4.					

Table 4: Cross correlations US**US cross correlations 1965M1 until 2004M6**

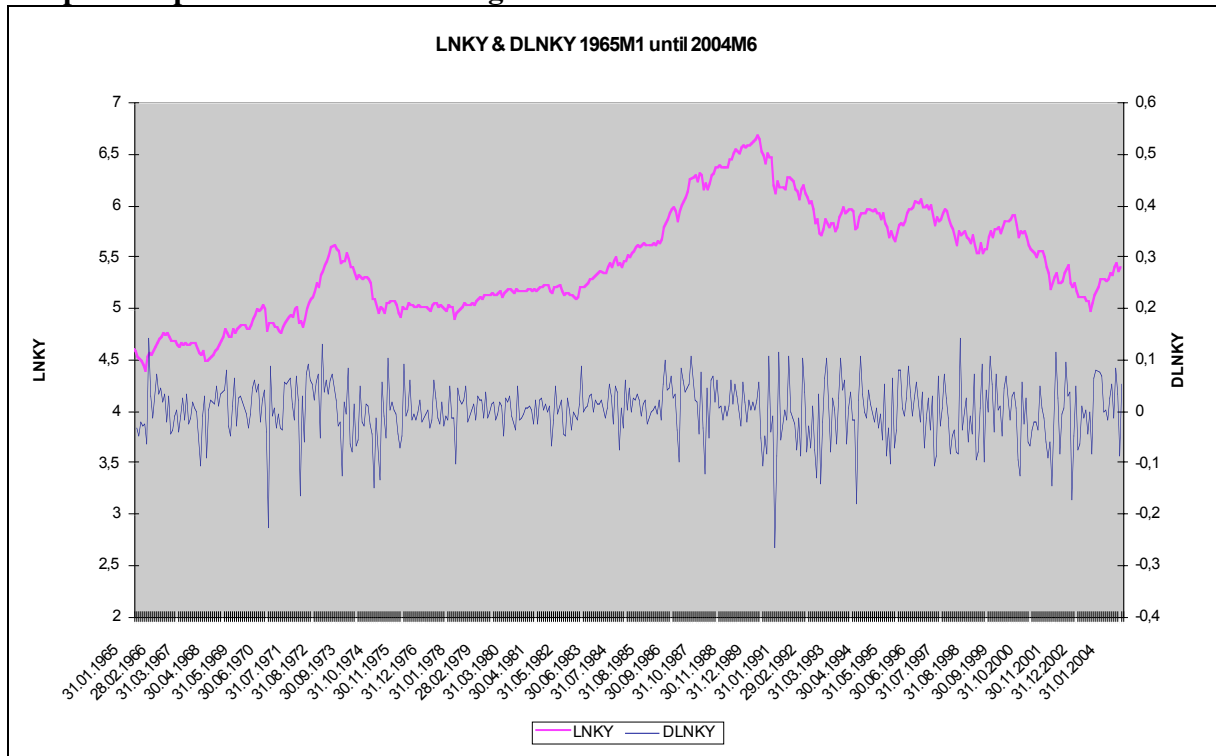
	DLSPX	DLindProd	DLCPI	DLM1	DL10YR
DLSPX	1.000000	-0.022517	-0.105757	0.001595	-0.057059
DLindProd	-0.022517	1.000000	-0.275164	0.072877	0.043880
DLCPI	-0.105757	-0.275164	1.000000	-0.343086	0.048814
DLM1	0.001595	0.072877	-0.343086	1.000000	0.092555
DL10YR	-0.057059	0.043880	0.048814	0.092555	1.000000

L stands for logarithm and D for delta. For the definition of the variables see chapter 3.4.**Table 5: Cross correlation Japan****Japan cross correlations 1965M1 until 2004M6**

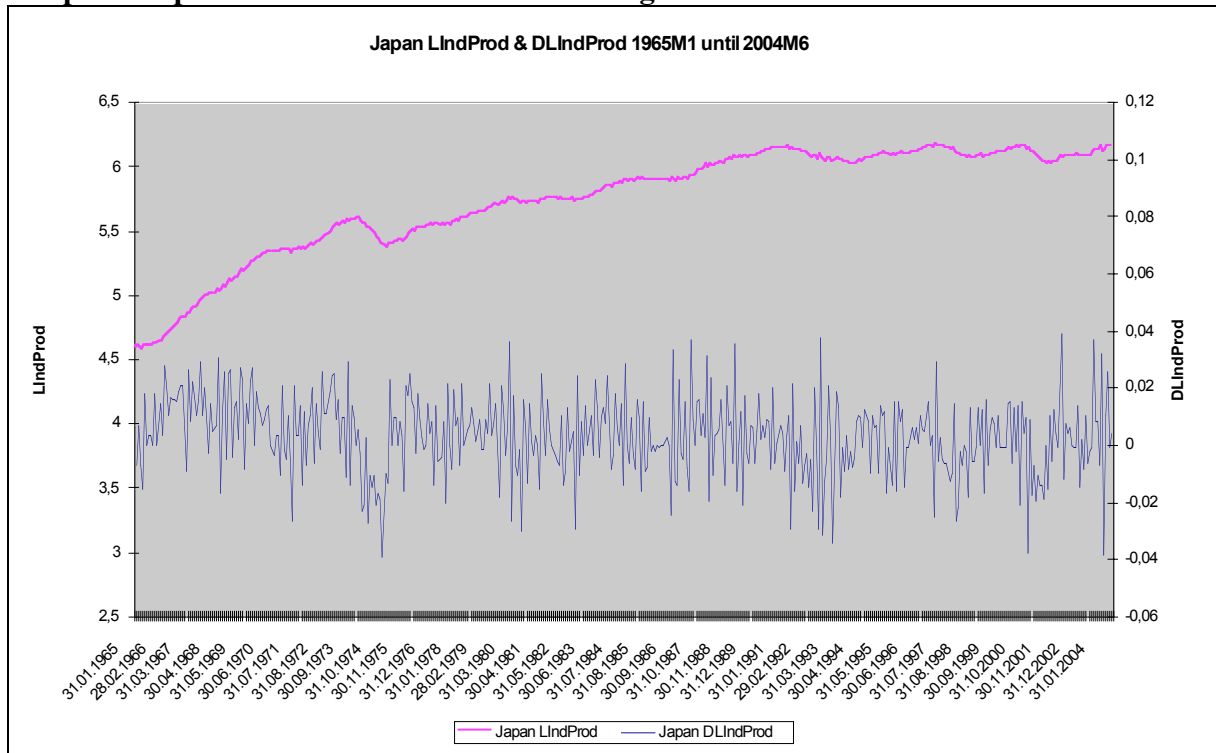
	DLNKY	DLindProd	DLCPI	DLM1	DLDISCO
DLNKY	1.000000	0.109589	-0.077231	0.069399	0.019486
DLindProd	0.109589	1.000000	-0.061073	0.045064	-0.056487
DLCPI	-0.077231	-0.061073	1.000000	-0.231315	-0.058412
DLM1	0.069399	0.045064	-0.231315	1.000000	-0.018107
DLDISCO	0.019486	-0.056487	-0.058412	-0.018107	1.000000

L stands for logarithm and D for delta. For the definition of the variables see chapter 3.4.

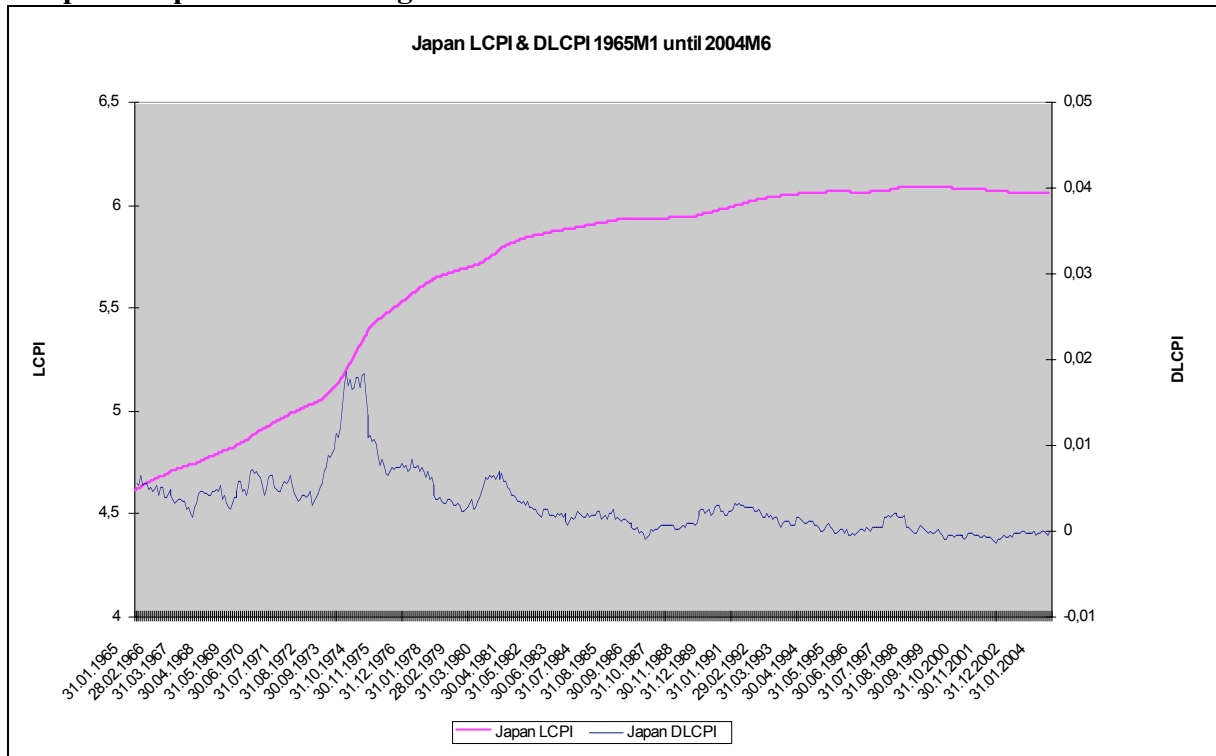
Graph 5: Japanese Nikkei 225 in log and first difference



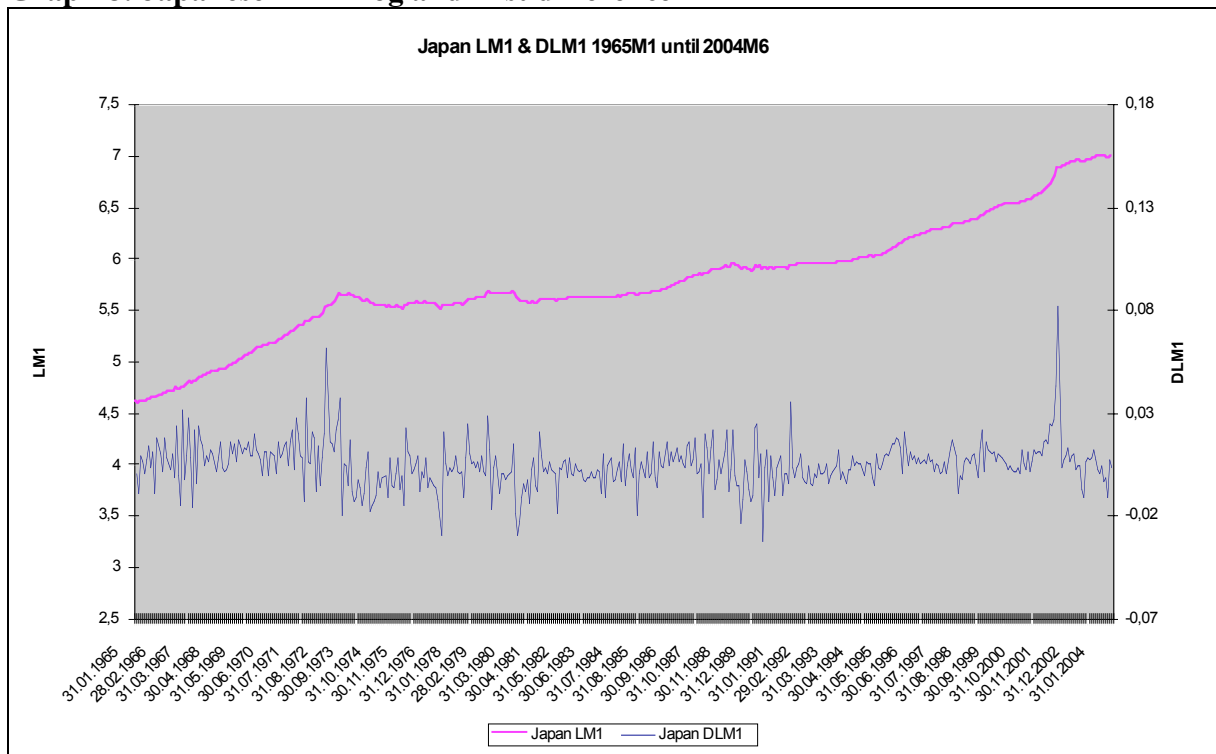
Graph 6: Japanese Industrial Production in log and first difference



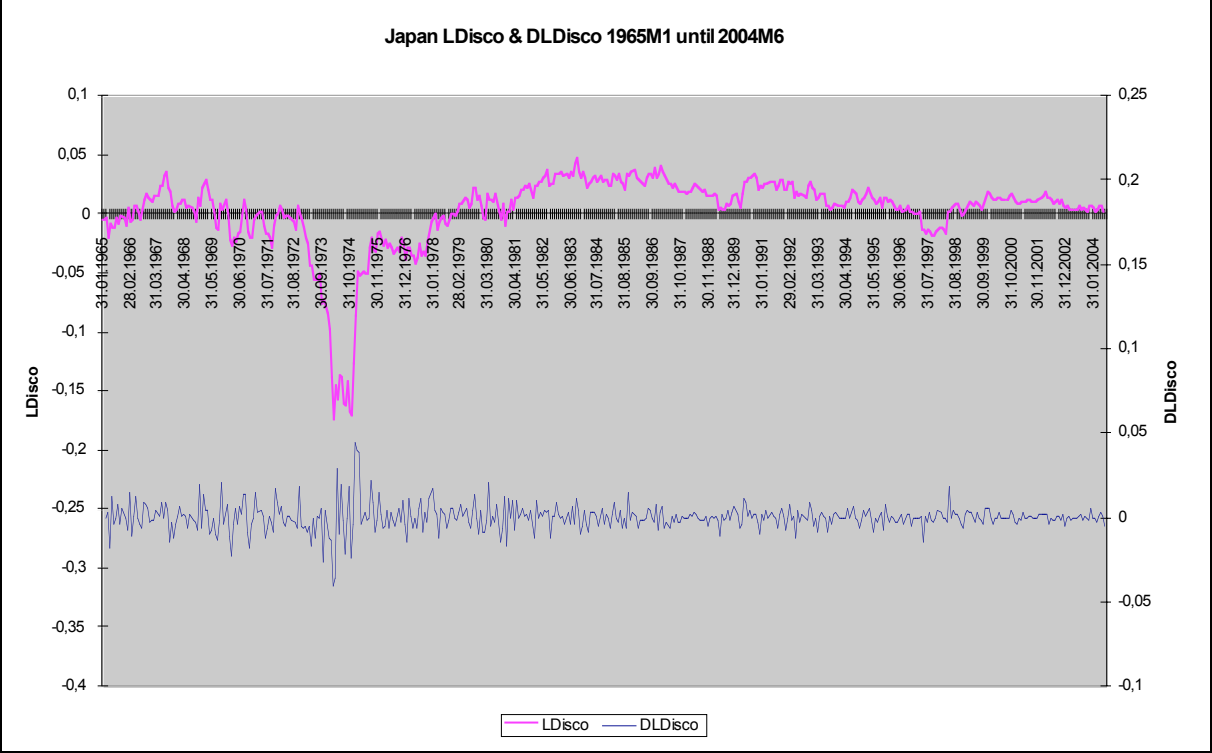
Graph 7: Japanese CPI in log and first difference



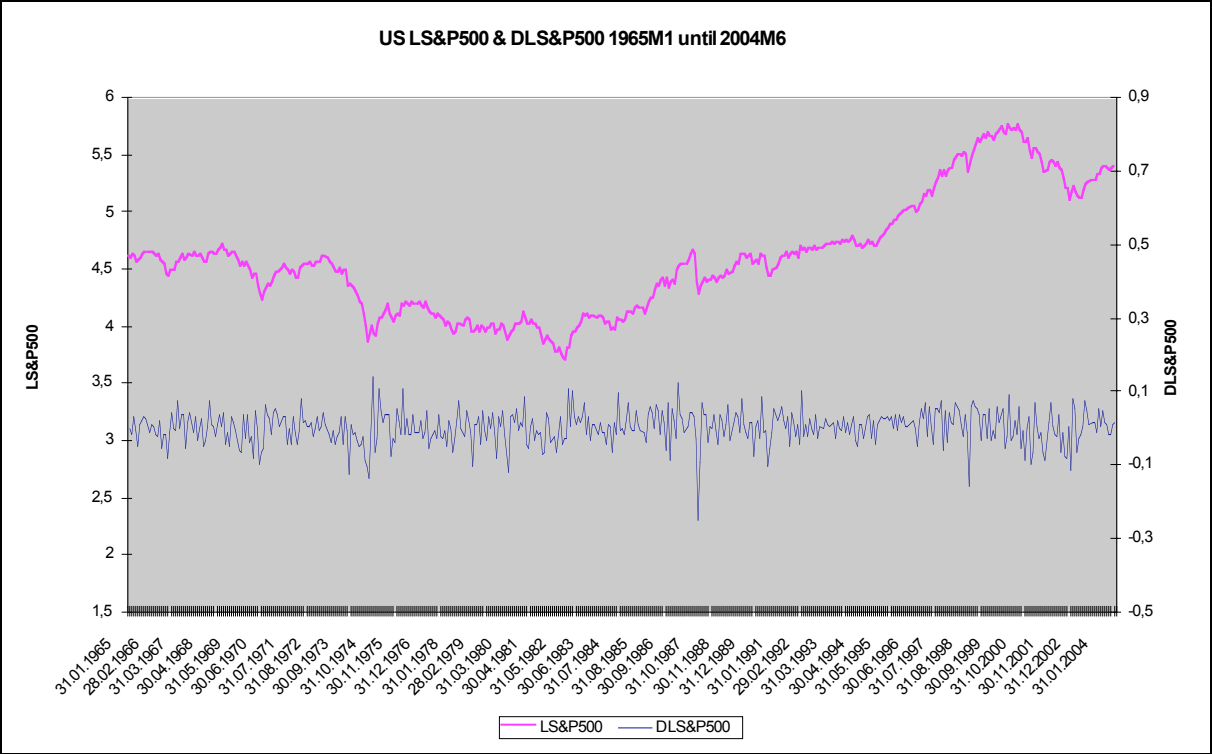
Graph 8: Japanese M1 in log and first difference



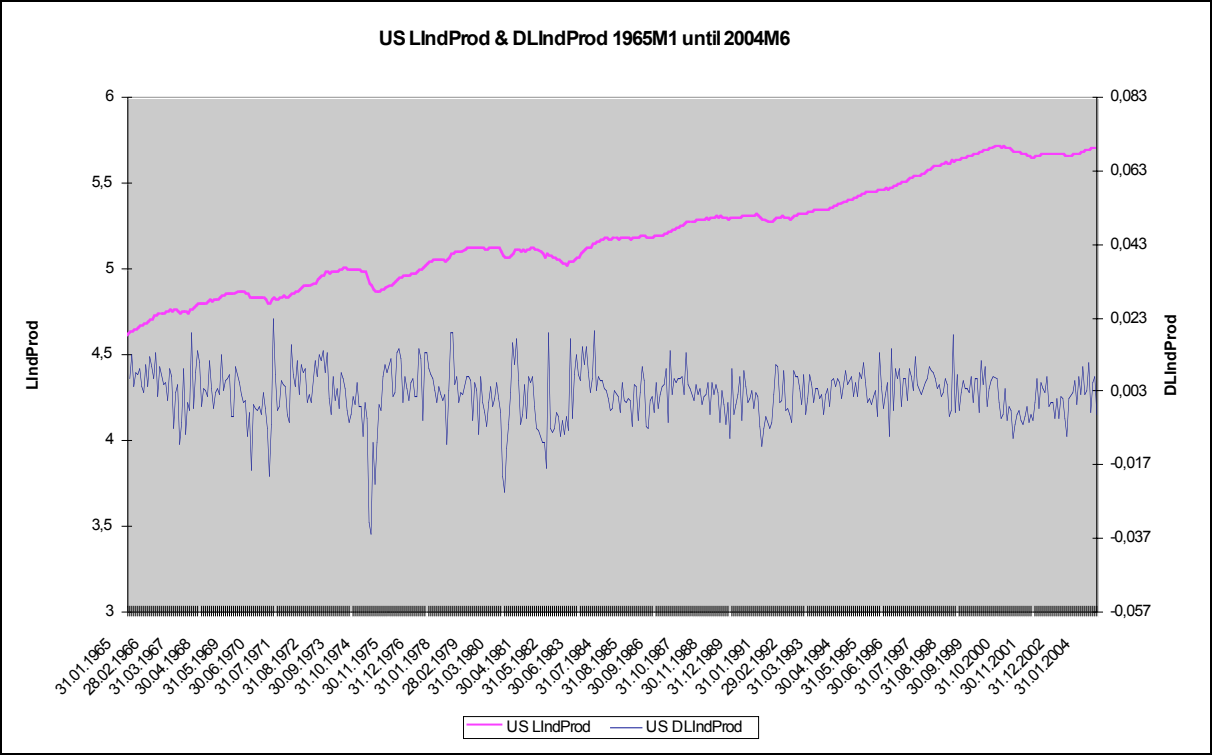
Graph 9: Japanese Discount Rate in log and first difference



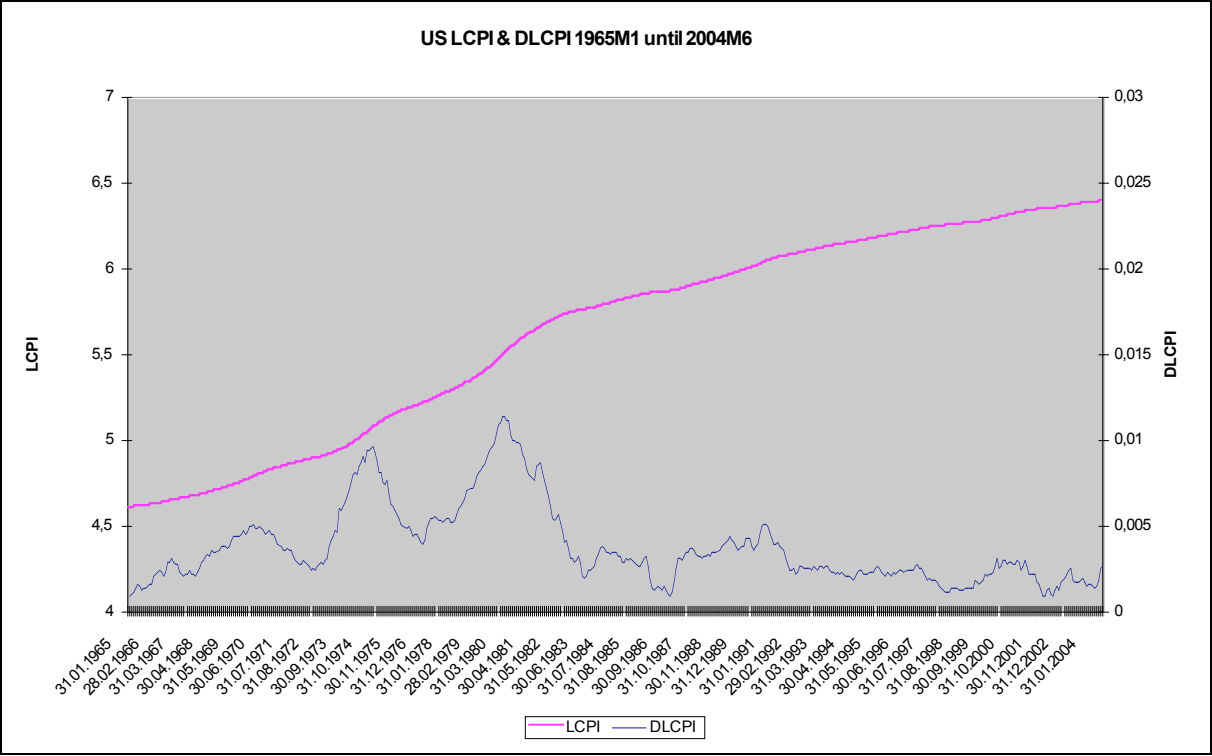
Graph 10: US S&P500 in log and first difference



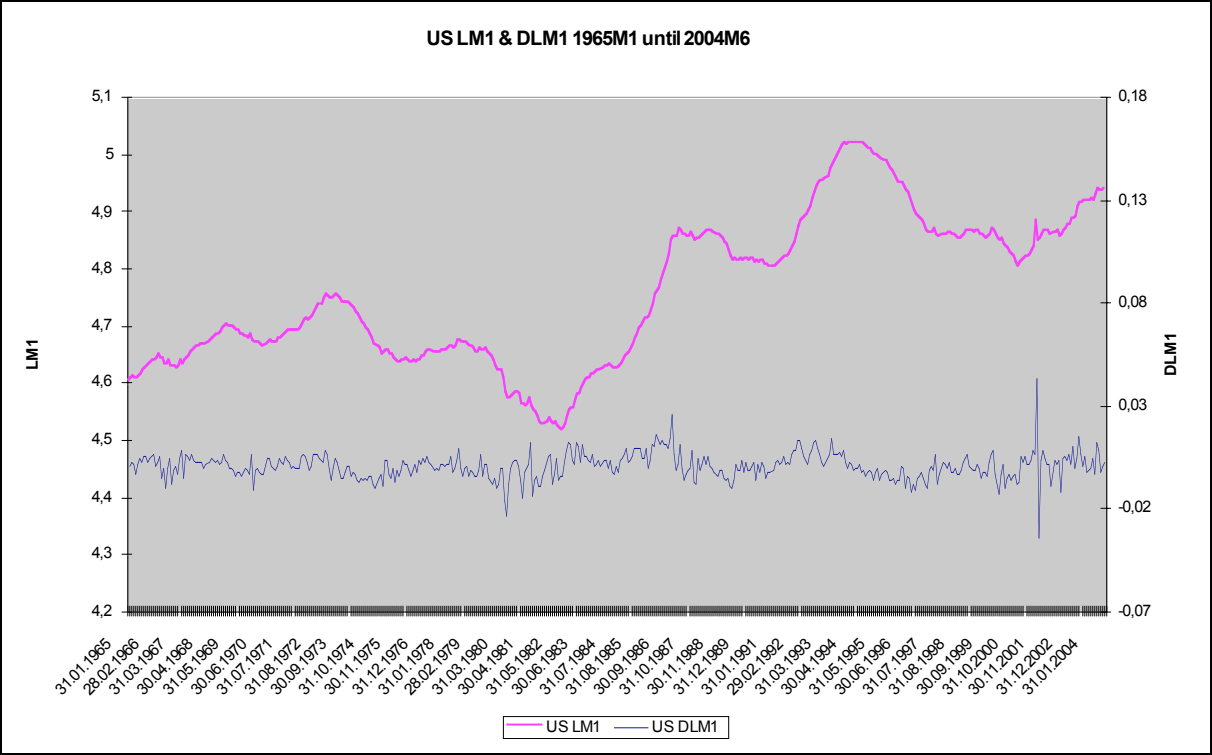
Graph 11: US Industrial Production in log and first difference



Graph 12: US CPI in log and first difference



Graph 13: US M1 in log and first difference



Graph 14: US 10 Year Bond Yield in log and first difference

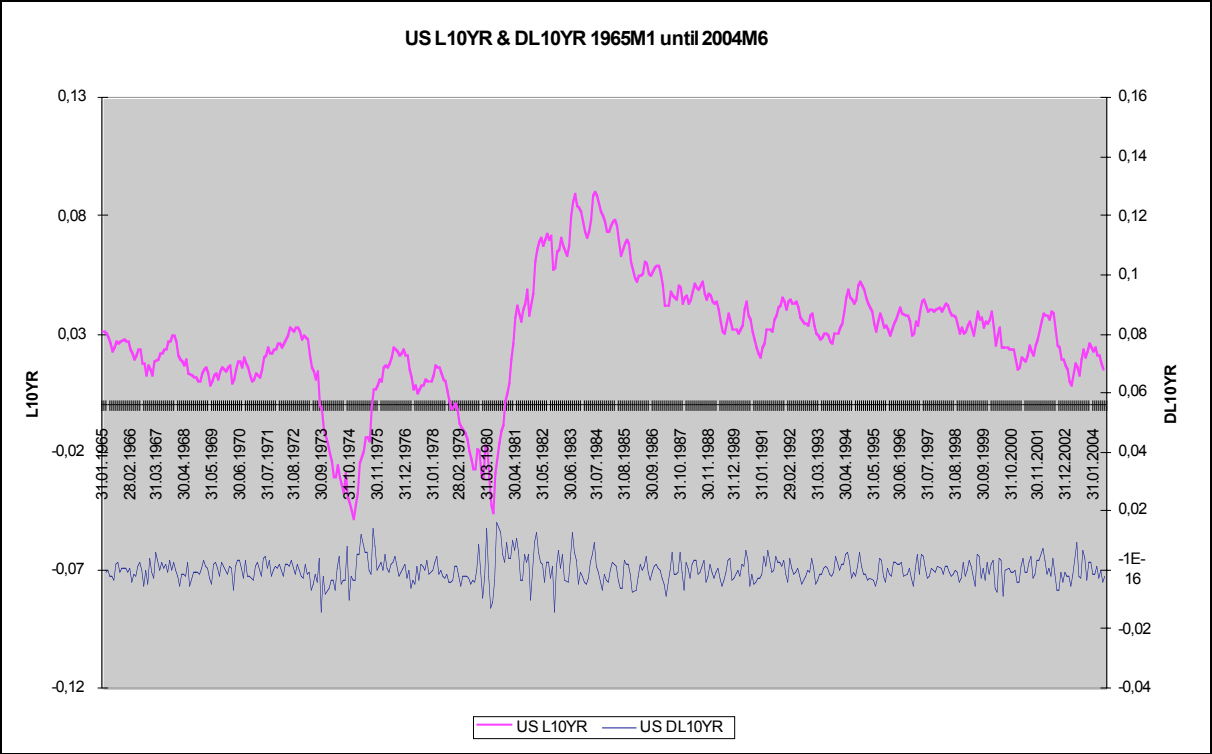


Table 6: US Unit Root tests 1965M1 until 2004M6

TESTS for US		Augmented Dickey Fuller Test (1965:M1 to 2004:M6)		
Variable	Trend/Constant	Trend/Constant	Constant	None
LSPX (Lag)	-1.6488 (0)	-0.2798 (0)	0.7924 (0)	
Δ LSPX (Lag)	-21.2794* (0)	-21.2043* (0)	-21.1980* (0)	
LIndProd (Lag)	-3.1049 (3)	-0.8135 (3)	3.0927 (3)	
Δ LIndProd (Lag)	-8.1072* (2)	-8.1105* (2)	-7.4037* (2)	
LCPI (Lag)	-1.8936 (2)	-2.0895 (2)	1.4479 (2)	
Δ LCPI (Lag)	-4.0861* (10)	-3.5629* (10)	-1.6452* (10)	
LR10Y (Lag)	-2.3722 (1)	-2.2986 (1)	-1.6435* (1)	
Δ LR10Y (Lag)	-16.4335* (0)	-16.4497* (0)	-16.4663* (0)	
LRM1 (Lag)	-2.4603 (6)	-1.4685 (6)	1.0395 (3)	
Δ LRM1 (Lag)	-7.2497* (2)	-7.2539* (2)	-7.1739* (2)	
	Phillips-Perron Test (1965:M1 to 2004:M6)			
LSPX (Lag)	-1.700085 (7)	-0.422299 (7)	0.689410 (7)	
Δ LSPX (Lag)	-21.27850* (7)	-21.22178* (7)	-21.22130* (7)	
LIndProd (Lag)	3.853732 (12)	-0.951523 (12)	-2.899288 (12)	
Δ LIndProd (Lag)	-15,61199* (10)	-16,03824* (10)	-16,03816* (10)	
LCPI (Lag)	0,530722 (12)	-2,198764 (12)	8,012644 (12)	
Δ LCPI (Lag)	-3,296849* (13)	-2,767337* (13)	-1,748816* (13)	
LR10Y (Lag)	-2,396528 (1)	-2,314302 (1)	-1,434928 (1)	
Δ LR10Y (Lag)	-16,47784* (7)	-16,49442* (7)	-16,51084* (7)	
LRM1 (Lag)	-2,649840 (6)	-1,611624 (6)	1,075742 (3)	
Δ LRM1 (Lag)	-13,03623* (2)	-13,05543* (2)	-12,90249* (2)	
Notes: Asterik denotes coefficient significance at 10% level. L stands for logarithm and Δ for delta. For the definition of the variables see chapter 3.4.				

Table 7: Japanese Unit Root tests 1965M1 until 2004M6

TESTS for Japan		Augmented Dickey Fuller Test (1965:M1 to 2004:M6)		
Variable	Trend/Constant	Trend/Constant	Constant	None
LNKY (Lag)	-1.1233 (0)	-1.6663 (0)	0.5111 (0)	
Δ LNKY (Lag)	-21.0373* (0)	-20.9865* (0)	-20.9874* (0)	
LIndProd (Lag)	-3.0479 (4)	-3.8625* (4)	2.4236 (4)	
Δ LIndProd (Lag)	-6.6787* (3)	-6.1102* (3)	-5.4480* (3)	
LCPI (Lag)	-1.3227 (2)	-2.2672 (2)	0.7503 (2)	
Δ LCPI (Lag)	-3.2496* (12)	-3.6552* (12)	-1.8098* (12)	
LRDisco (Lag)	-2.7568 (0)	-2.8175* (0)	-2.2693* (0)	
Δ LRDisco (Lag)	-6.7499* (11)	-6.7587* (11)	-6.7671* (11)	
LRM1 (Lag)	-1.6090 (7)	-0.3641 (7)	3.0576 (7)	
Δ LRM1 (Lag)	-5.1193* (6)	-5.1235* (6)	-4.0244* (6)	
Phillips-Perron Test (1965:M1 to 2004:M6)				
LNKY (Lag)	0.895900 (7)	-1.713962 (7)	0.813600 (7)	
Δ LNKY (Lag)	-21.06678* (6)	-21.03494* (7)	-21.03996* (7)	
LIndProd (Lag)	-2.554388 (13)	-3.947668* (13)	0.999400 (14)	
Δ LIndProd (Lag)	-44.37113* (3)	-43.65519* (3)	-41.78372* (3)	
LCPI (Lag)	-1.019474 (2)	-2.553250 (2)	1.316519* (2)	
Δ LCPI (Lag)	-3.808615* (12)	-2.654348* (23)	-1.808554* (8)	
LRDisco (Lag)	-2.875649 (2)	-2.7556325* (2)	-2.756742* (2)	
Δ LRDisco (Lag)	-20.57325* (4)	-20.59572* (4)	-20.61830* (4)	
LRM1 (Lag)	-1.094875 (14)	-0.108233 (14)	5.268885 (14)	
Δ LRM1 (Lag)	-19.54080* (12)	-19.55256* (12)	-18.62747* (12)	
Notes: Asterik denotes coefficient significance at 10% level. L stands for logarithm and Δ for delta. For the definition of the variables see chapter 3.4.				

Table 8: US lag length criteria 1965M1 until 2004M6

<i>VAR Lag Order Selection Criteria for US</i> <i>Endogenous variables: LRSPX LRINDPROD LCPI LRM1 LR10YR</i> <i>Exogenous variables: C</i> <i>Sample: 1965M01 2004M06</i> <i>Included observations: 474</i>						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	1715.482	NA	3.99e-10	-7.453082	-7.408104	-7.435369
1	8729.927	13845.51	2.37e-23	-37.90818	-37.63831	-37.80190
2	9473.755	1452.004	1.03e-24	-41.04033	-40.54556*	-40.84548
3	9528.082	104.8659	9.09e-25	-41.16811	-40.44845	-40.88470*
4	9562.570	65.82058	8.72e-25	-41.20946	-40.26490	-40.83748
5	9576.020	25.37528	9.18e-25	-41.15913	-39.98968	-40.69858
6	9592.400	30.54841	9.53e-25	-41.12157	-39.72723	-40.57246
7	9616.731	44.84452	9.57e-25	-41.11865	-39.49942	-40.48097
8	9631.812	27.46827	1.00e-24	-41.07543	-39.23130	-40.34919
9	9649.342	31.54585	1.03e-24	-41.04288	-38.97386	-40.22807
10	9670.529	37.66546	1.05e-24	-41.02627	-38.73235	-40.12289
11	9696.220	45.11462	1.05e-24	-41.02928	-38.51047	-40.03734
12	9715.404	33.26754	1.08e-24	-41.00394	-38.26023	-39.92343
13	9770.662	94.62481	9.48e-25	-41.13578	-38.16718	-39.96670
14	9820.793	84.75416*	8.52e-25*	-41.24529*	-38.05179	-39.98764
15	9832.442	19.43954	9.06e-25	-41.18711	-37.76872	-39.84090
Notes: Asterik indicates lag order selected by the criterion. L stands for logarithm. For the definition of the variables see chapter 3.4.						
LR: sequential modified LR test statistic (each test at 5% level) FPE: Final prediction error AIC: Akaike information criterion SC: Schwarz information criterion HQ: Hannan-Quinn information criterion						

Table 9: US Cointegration test 1965M1 until 2004M6

<i>Sample US: 1965M01 2004M06</i>				
<i>Trend assumption: Linear deterministic trend</i>				
<i>Series: LRSPX LRINDPROD LCPI LRM1 LR10YR</i>				
<i>Lags interval (in first differences): 1 to 14</i>				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5% Critical Value	p-value
None *	0.088529	100.9367	69.81889	0.0000
At most 1 *	0.064586	58.38928	47.85613	0.0038
At most 2	0.033777	27.74357	29.79707	0.0847
At most 3	0.019083	11.97214	15.49471	0.1583
At most 4	0.006792	3.128194	3.841466	0.0769
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5% Critical Value	p-value
None *	0.088529	42.54742	33.87687	0.0036
At most 1 *	0.064586	30.64571	27.58434	0.0196
At most 2	0.033777	15.77142	21.13162	0.2385
At most 3	0.019083	8.843950	14.26460	0.2994
At most 4	0.006792	3.128194	3.841466	0.0769
Notes: Asterik denotes coefficient significance at 5% level.				
L stands for logarithm. For the definition of the variables see chapter 3.4.				

Table 10: US Cointegration Relationship 1965M1 until 2004M6

<i>Sample US: 1965M01 2004M06</i>					
US Normalized cointegrating coefficients (standard error in parentheses)					
LRSPX	LRINDPROD	LCPI	LRM1	LR10YR	C
1.000000	-2.292125*	0.849487*	-0.117135	6.264198*	2.932466
	(0.43233)	(0.25104)	(0.37339)	(2.45972)	
	[-5.30184]	[3.38392]	[-0.31371]	[2.54672]	
US Vector Error Correction with standard errors and t-values					
	D(LRSPX)	D(LRINDPROD)	D(LCPI)	D(LRM1)	D(LR10YR)
ECM(-1)	-0.066206*	-0.008411*	-0.00022*	-0.001356	0.003200
	(0.01838)	(0.00253)	(8.7E-05)	(0.00206)	(0.00148)
	[-3.60286]	[-3.32323]	[-2.58421]	[-0.65667]	[2.16064]
Notes: (value) gives standard error and [value] is relevant t-value.					
Asterik denotes coefficient significance at 10% level.					
L stands for logarithm and D for delta. For the definition of the variables see chapter 3.4.					

Table 11: US Cointegration Restriction test for M1=0 during 1965M1 until 2004M6

Cointegration Restrictions Test:	
<i>Sample US: 1965M01 2004M06</i>	
<i>Trend assumption: Linear deterministic trend</i>	
<i>Series: LRSPX LRINDPROD LCPI LRM1 LR10YR</i>	
<i>Lags interval (in first differences): 1 to 14</i>	
Restriction tests: LRM1=0	
<i>Convergence achieved after 8 iterations</i>	
<i>LR test for binding restrictions (rank = 1):</i>	
Chi-square(1)	0.045975
Probability	0.830221

Table 12: US lag length criteria 1965M1 until 2004M6 without M1

<i>VAR Lag Order Selection Criteria for US</i> <i>Endogenous variables: LRSPX LRINDPROD LCPI LR10YR</i> <i>Exogenous variables: C</i> <i>Sample: 1965M01 2004M06</i> <i>Included observations: 474</i>						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	1188.953	NA	6.73e-08	-5.163193	-5.127210	-5.149022
1	6881.484	11261.04	1.22e-18	-29.89753	-29.71762	-29.82668
2	7672.861	1551.721	4.15e-20	-33.27608	-32.95224	-33.14855
3	7729.019	109.1331	3.49e-20	-33.45106	-32.98328*	-33.26684*
4	7756.422	52.77687	3.32e-20	-33.50075	-32.88904	-33.25985
5	7765.180	16.71567	3.43e-20	-33.46920	-32.71355	-33.17161
6	7777.297	22.91318	3.48e-20	-33.45227	-32.55270	-33.09801
7	7789.896	23.60645	3.54e-20	-33.43746	-32.39395	-33.02651
8	7802.337	23.09306	3.59e-20	-33.42195	-32.23451	-32.95432
9	7812.193	18.12261	3.69e-20	-33.39518	-32.06381	-32.87086
10	7829.752	31.98194	3.67e-20	-33.40197	-31.92667	-32.82098
11	7843.723	25.20097	3.70e-20	-33.39313	-31.77389	-32.75545
12	7856.782	23.33050	3.76e-20	-33.38031	-31.61715	-32.68595
13	7896.399	70.08439	3.39e-20	-33.48322	-31.57612	-32.73218
14	7936.374	70.02225*	3.06e-20*	-33.58769*	-31.53665	-32.77996
15	7942.789	11.12540	3.19e-20	-33.54592	-31.35096	-32.68151
Notes: Asterik indicates lag order selected by the criterion. L stands for logarithm. For the definition of the variables see chapter 3.4. LR: sequential modified LR test statistic (each test at 5% level) FPE: Final prediction error AIC: Akaike information criterion SC: Schwarz information criterion HQ: Hannan-Quinn information criterion						

Table 13: US Cointegration test without M1 1965M1 until 2004M6

<i>Sample US: 1965M01 2004M06</i>				
<i>Trend assumption: Linear deterministic trend</i>				
<i>Series: LRSPX LRINDPROD LCPI LR10YR</i>				
<i>Lags interval (in first differences): 1 to 14</i>				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5% Critical Value	p-value
None *	0.072948	63.39547	47.85613	0.0009
At most 1	0.034632	28.62837	29.79707	0.0677
At most 2	0.016343	12.45064	15.49471	0.1366
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5% Critical Value	p-value
None *	0.072948	34.76710	27.58434	0.0050
At most 1	0.034632	16.17773	21.13162	0.2146
At most 2	0.016343	7.563209	14.26460	0.4248
Notes: Asterik denotes coefficient significance at 5% level.				
L stands for logarithm. For the definition of the variables see chapter 3.4.				

Table 14: US Cointegration Relationship without M1 1965M1 until 2004M6

<i>Sample US: 1965M01 2004M06</i>				
US Normalized cointegrating coefficients (standard error in parentheses)				
LRSPX	LRINDPROD	LCPI	LR10YR	C
1.000000	-2.641013*	1.015803*	5.564508*	3.269357
	(0.38167)	(0.19813)	(1.97469)	
	[-6.91964]	[5.12703]	[2.81791]	
US Vector Error Correction with standard errors and t-values				
	D(LRSPX)	D(LRINDPROD)	D(LCPI)	D(LR10YR)
ECM(-1)	-0.044612*	-0.008038*	-0.000259*	0.003498*
	(0.01762)	(0.00242)	(8.2E-05)	(0.00140)
	[-2.53194]	[-3.31589]	[-3.17738]	[2.49719]
Notes: (value) gives standard error and [value] is relevant t-value.				
Asterik denotes coefficient significance at 10% level.				
L stands for logarithm and D for delta. For the definition of the variables see chapter 3.4.				

Table 15: Japanese lag length criteria 1965M1 until 2004M6

<i>VAR Lag Order Selection Criteria for Japan</i> <i>Endogenous variables: LRNKY LRINDPROD LCPI LRM1 LRDISCO</i> <i>Exogenous variables: C</i> <i>Sample: 1965M01 2004M06</i> <i>Included observations: 474</i>						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	1029.672	NA	7.69e-09	-4.494175	-4.448972	-4.476369
1	7565.498	12899.66	3.05e-21	-33.05043	-32.77921	-32.94359
2	8387.005	1603.381	9.26e-23	-36.54388	-36.04665*	-36.34801*
3	8415.281	54.56721	9.13e-23	-36.55825	-35.83501	-36.27335
4	8459.050	83.50649	8.41e-23	-36.64057	-35.69131	-36.26664
5	8491.282	60.78862	8.15e-23	-36.67229	-35.49702	-36.20933
6	8516.103	46.26775	8.16e-23	-36.67151	-35.27022	-36.11951
7	8543.882	51.17015	8.07e-23	-36.68369	-35.05639	-36.04266
8	8558.606	26.80085	8.45e-23	-36.63862	-34.78531	-35.90856
9	8572.981	25.85053	8.86e-23	-36.59202	-34.51270	-35.77293
10	8600.104	48.17818	8.79e-23	-36.60133	-34.29599	-35.69321
11	8619.692	34.36526	9.01e-23	-36.57760	-34.04624	-35.58044
12	8640.217	35.55810	9.21e-23	-36.55797	-33.80060	-35.47178
13	8700.687	103.4364	7.90e-23	-36.71354	-33.73016	-35.53832
14	8726.374	43.37418*	7.90e-23*	-36.71655*	-33.50715	-35.45230
15	8741.254	24.80076	8.28e-23	-36.67217	-33.23676	-35.31889
Notes: Asterik indicates lag order selected by the criterion L stands for logarithm. For the definition of the variables see chapter 3.4.						
LR: sequential modified LR test statistic (each test at 5% level) FPE: Final prediction error AIC: Akaike information criterion SC: Schwarz information criterion HQ: Hannan-Quinn information criterion						

Table 16: Japanese Cointegration test 1965M1 until 2004M6

<i>Sample Japan: 1965M01 2004M06</i>				
<i>Trend assumption: Linear deterministic trend</i>				
<i>Series: LRNKY LRINDPROD LCPI LRM1 LRDISCO</i>				
<i>Lags interval (in first differences): 1 to 14</i>				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5% Critical Value	p-value
None *	0.086256	93.11373	69.81889	0.0002
At most 1 *	0.062207	51.70959	47.85613	0.0208
At most 2	0.026261	22.22998	29.79707	0.2859
At most 3	0.021514	10.01502	15.49471	0.2796
At most 4	7.00E-05	0.032128	3.841466	0.8577
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5% Critical Value	p-value
None *	0.086256	41.40414	33.87687	0.0053
At most 1 *	0.062207	29.47961	27.58434	0.0282
At most 2	0.026261	12.21495	21.13162	0.5266
At most 3	0.021514	9.982894	14.26460	0.2131
At most 4	7.00E-05	0.032128	3.841466	0.8577
Notes: Asterik denotes coefficient significance at 5% level.				
L stands for logarithm. For the definition of the variables see chapter 3.4.				

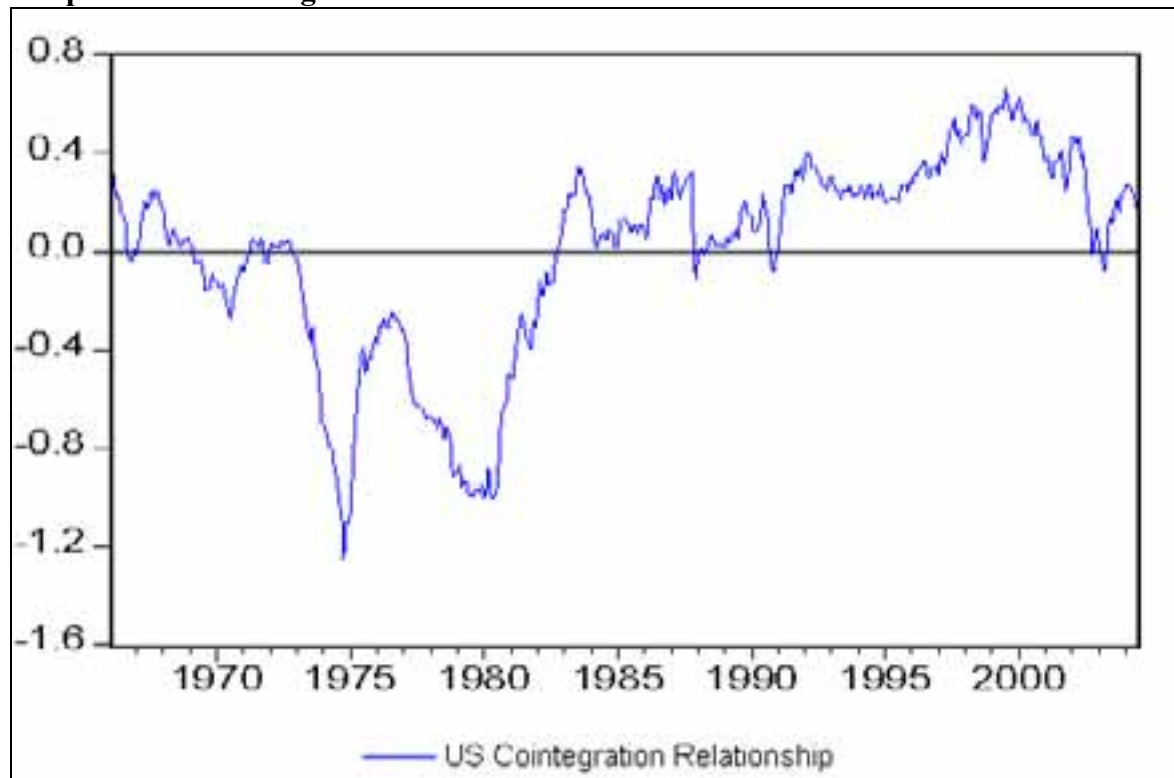
Table 17: Japanese Cointegration Relationship 1965 until 2004M6

<i>Sample Japan: 1965M01 2004M06</i>					
Japan Normalized cointegrating coefficients (standard error in parentheses)					
LRNKY	LRINDPROD	LCPI	LRM1	LRDISCO	C
1.000000	-11.12168	-24.03012*	0.613347	-236.0836	192.0793
	(11.5633)	(10.8133)	(6.37719)	(109.104)	
	[-0.96181]	[-2.22228]	[0.09618]	[-2.16385]	
Japan Vector Error Correction with standard errors and t-values					
	D(LRNKY)	D(LRINDPROD)	D(LCPI)	D(LRM1)	D(LRDISCO)
ECM(-1)	0.000365	0.000293*	-6.99E-06	0.000339*	0.000102
	(0.00044)	(9.2E-05)	(3.6E-06)	(7.4E-05)	(5.3E-05)
	[0.83235]	[3.20339]	[-1.91822]	[4.60923]	[1.94581]
Notes: (value) gives standard error and [value] is relevant t-value.					
Asterik denotes coefficient significance at 10% level.					
L stands for logarithm and D for delta. For the definition of the variables see chapter 3.4.					

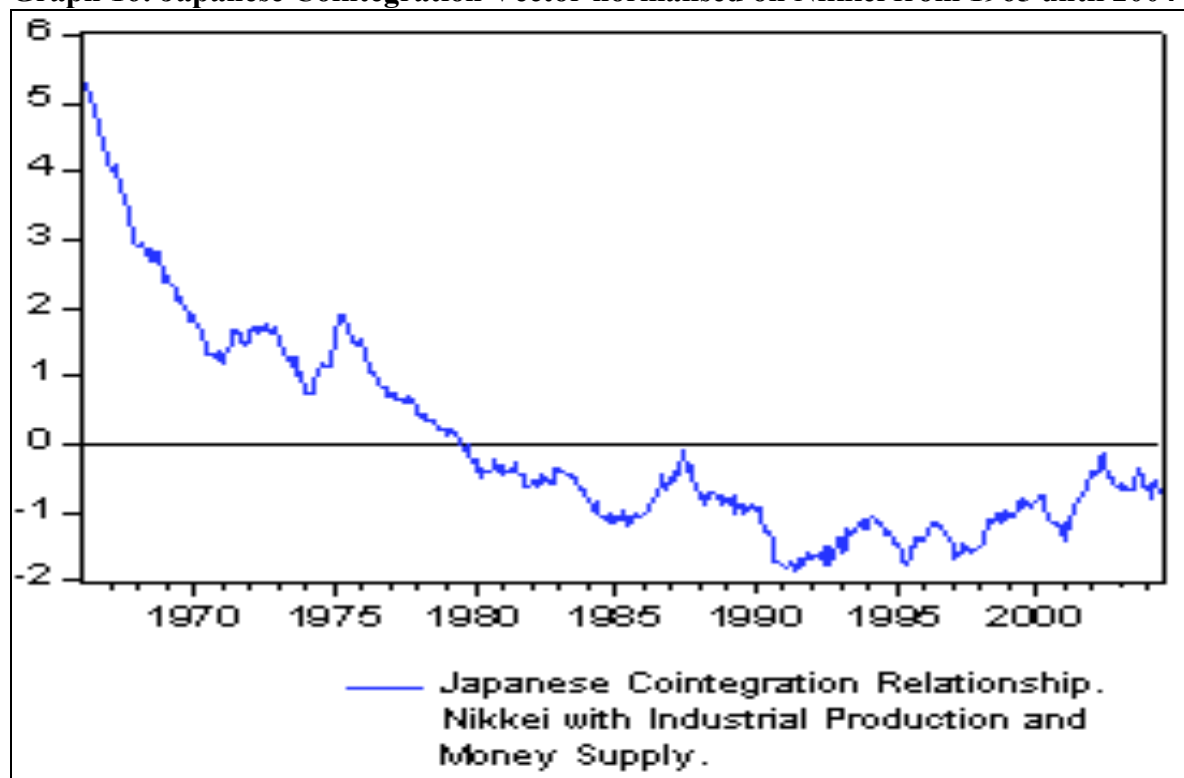
Table 18: Japanese Cointegration Restriction test 1965M1 until 2004M6

Cointegration Restrictions Test with two vectors: <i>Sample Japan: 1965M01 2004M06</i> <i>Trend assumption: Linear deterministic trend</i> <i>Series: LRNKY LRINDPROD LCPI LRM1 LRDISCO</i> <i>Lags interval (in first differences): 1 to 14</i> Restriction tests in first vector: LRNKY=1 LCPI=0 LRDISCO=0 Restriction tests in second vector: LRINDPROD=1 LRNKY=0 LRM1=0 <i>Convergence achieved after 500 iterations</i> <i>LR test for binding restrictions (rank = 2):</i> Chi-square(1) 0.677363 Probability 0.712709					
Japan Normalized cointegrating coefficients (standard error in parentheses)					
LRNKY	LRINDPROD	LCPI	LRM1	LRDISCO	C
1.000000	-6.089195*	0.000000	1.413278*	0.000000	21.48166
	(0.61634)		(0.36813)		
	[-9.87965]		[3.83907]		
0.000000	1.000000	7.674404*	0.000000	53.72554*	-49.47346
		(1.11357)		(14.6844)	
		[6.89168]		[3.65867]	
Japan Vector Error Correction with standard errors and t-values					
	D(LRNKY)	D(LRINDPROD)	D(LCPI)	D(LRM1)	D(LRDISCO)
ECM(1)	-0.010059	0.005602*	-0.000142	-0.003588*	0.001738
	(0.00794)	(0.00164)	(6.6E-05)	(0.00132)	(0.00095)
	[-1.26745]	[3.42549]	[-2.15630]	[-2.72111]	[1.83041]
ECM(2)	-0.005385	0.000961	-2.87E-05	-0.002627*	0.000310
	(0.00333)	(0.00069)	(2.8E-05)	(0.00055)	(0.00040)
	[-1.61562]	[1.39873]	[-1.04009]	[-4.74526]	[0.77760]
Notes: (value) gives standard error and [value] is relevant t-value. Asterik denotes coefficient significance at 10% level. L stands for logarithm and D for delta. For the definition of the variables see chapter 3.4.					

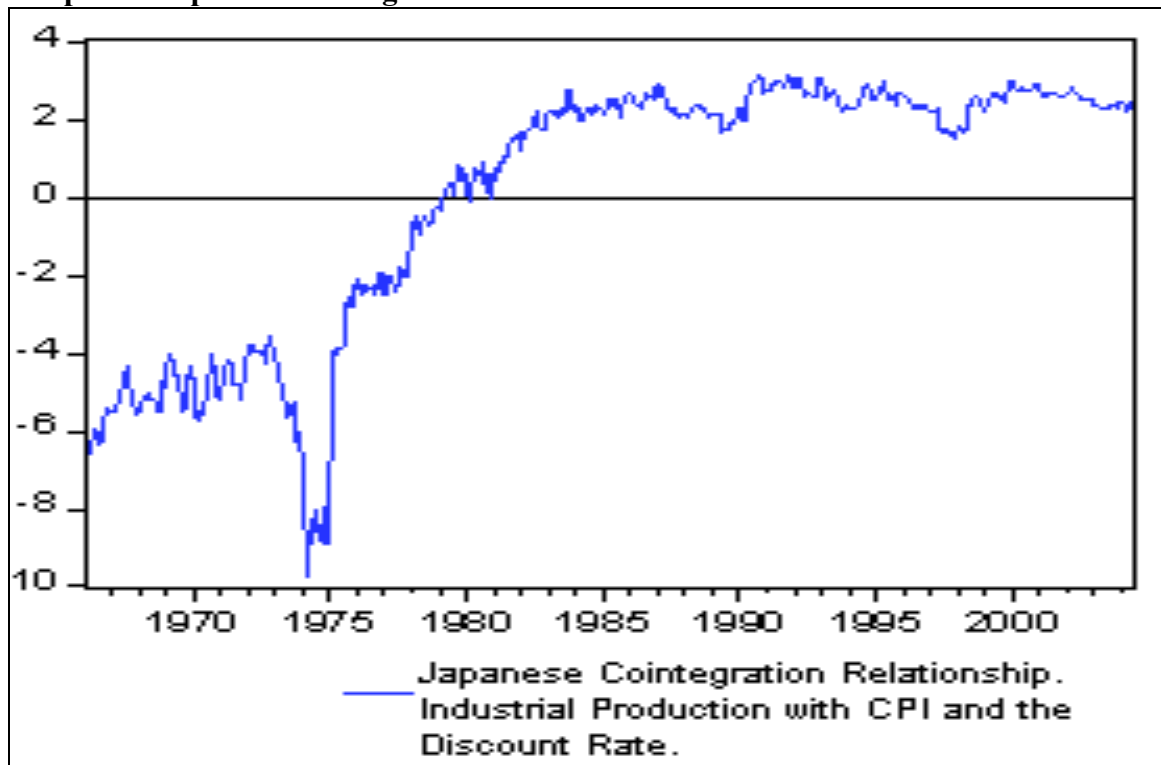
Graph 15: US Cointegration Vector 1965M1 until 2004M6



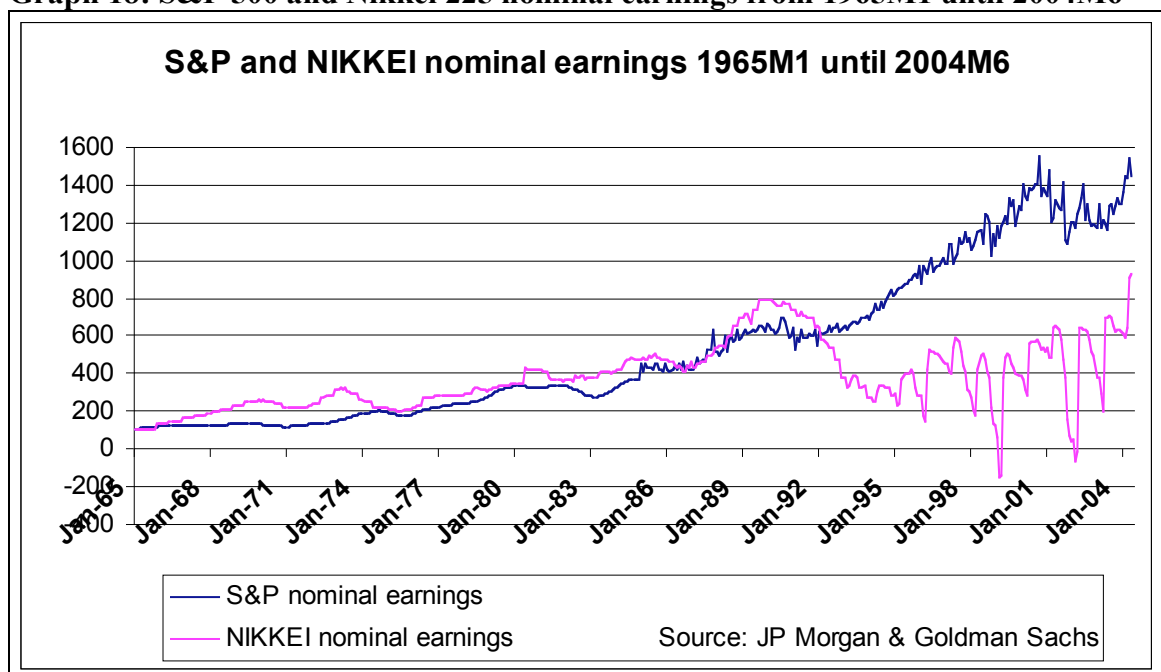
Graph 16: Japanese Cointegration Vector normalised on Nikkei from 1965 until 2004



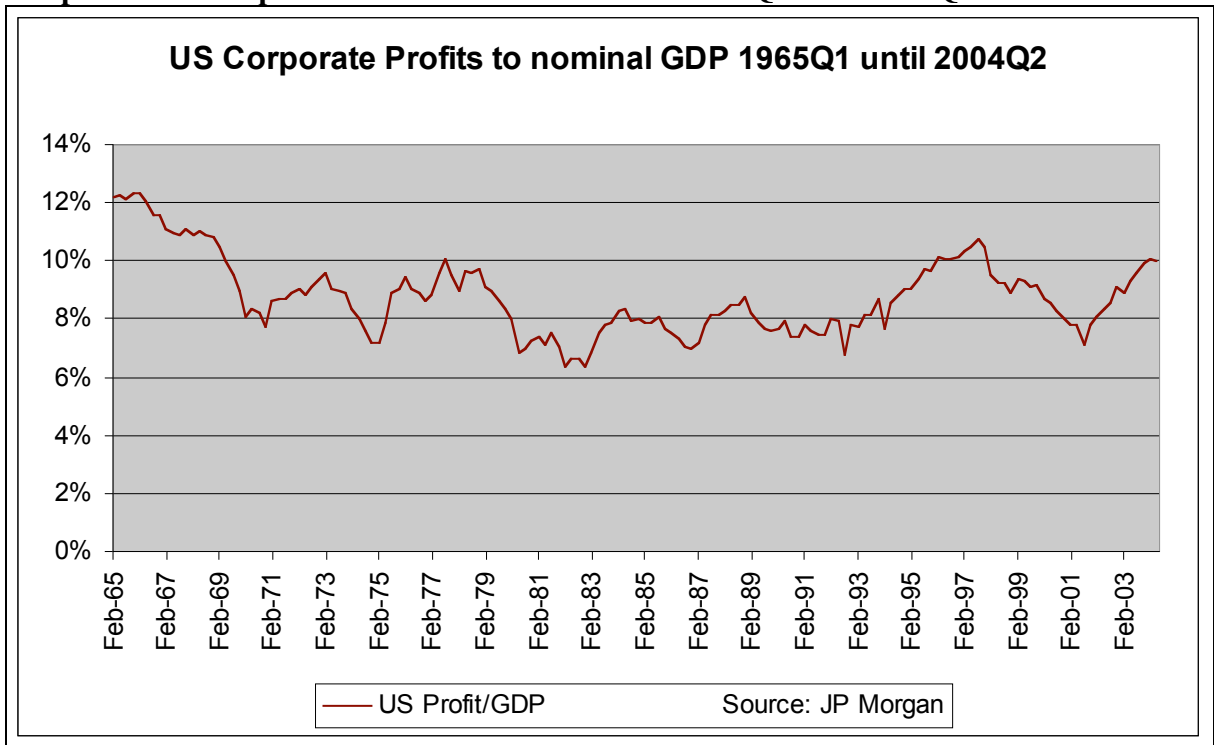
Graph 17: Japanese Cointegration Vector normalised on Ind. Prod. 1965 until 2004



Graph 18: S&P 500 and Nikkei 225 nominal earnings from 1965M1 until 2004M6



Graph 19: US Corporate Profits to nominal GDP 1965Q1 until 2004Q2



Graph 20: Japanese Corporate Profits to nominal GDP 1965Q1 until 2004Q2

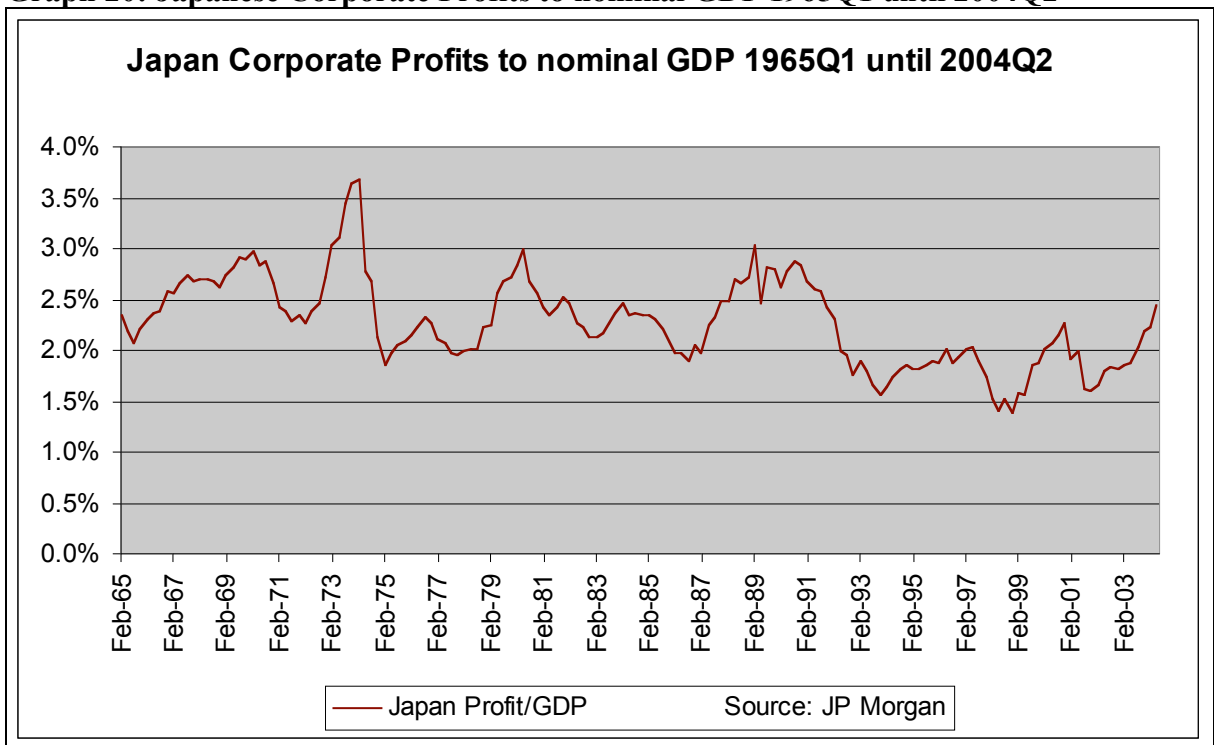


Table 19: Japanese Industrial Production Break Point test 1965M1 until 2005M6

Break date search for series with shift dummy	RIndProd_log
Sample range	1965M4, 2005M6, T=483
Search range	1965M6, 2005M4, T=479
Suggested break date:	1993M3

Table 20: Japanese Break Point test for Cointegration Relationship in March 1993

Break point Chow test:	Japan
Bootstrapped replications	1000
Tested Break	1993M3
Break point Chow test	687.7853
Bootstrapped p-value	0.00000
Asymptotic χ^2 p-value	0.00000

Table 21: Japanese Unit Root test 1965M1 until 1993M3

Unit Root TESTS for Japan		Augmented Dickey Fuller Test (1965:M1 to 1993:M3)		
<div>Trend/Constant</div> <div>Variable</div>	Trend/Constant	Constant	None	
LNKY (Lag)	-1.5164 (0)	-1.0501 (0)	1.2311 (0)	
Δ LNKY (Lag)	-17.5029* (0)	-17.5204* (0)	-17.4496* (0)	
LIndProd (Lag)	-3.1110 (4)	-3.4669* (4)	2.3243 (4)	
Δ LIndProd (Lag)	-6.5964* (2)	-5.0417* (3)	-4.2887* (3)	
LCPI (Lag)	-1.4559 (2)	-1.7057 (2)	0.9664 (2)	
Δ LCPI (Lag)	-3.7615* (9)	-3.0746* (9)	-2.0201* (9)	
LRDisco (Lag)	-2.7581 (12)	-2.3311 (12)	-2.3351* (0)	
Δ LRDisco (Lag)	-5.6227* (11)	-5.6272* (11)	-5.6374* (11)	
LRM1 (Lag)	-2.5402 (6)	-2.5666 (9)	1.7838 (6)	
Δ LRM1 (Lag)	-4.5030* (6)	-4.1287* (6)	-3.4968* (6)	
Notes: Asterik denotes coefficient significance at 10% level. L stands for logarithm and Δ for delta. For the definition of the variables see chapter 3.4.				

Table 22: Japanese Unit Root test 1993M4 until 2004M6

Unit Root TESTS for Japan		Augmented Dickey Fuller Test (1993:M4 to 2004:M6)		
Variable	Trend/Constant	Trend/Constant	Constant	None
LNKY (Lag)	-2.3179 (0)	-1.2908 (0)	-0.7985 (0)	
Δ LNKY (Lag)	-11.4184* (0)	-11.4643* (0)	-11.4612* (0)	
LIndProd (Lag)	-2.9987 (4)	-2.9523* (4)	0.7030 (4)	
Δ LIndProd (Lag)	-3.6152* (3)	-3.6311* (3)	-3.5933* (3)	
LCPI (Lag)	-1.8498 (2)	-2.0143 (1)	-0.0289 (1)	
Δ LCPI (Lag)	-3.3605* (11)	-2.9232* (11)	-1.7786* (12)	
LRDisco (Lag)	-1.8103 (12)	-1.8051 (12)	-1.5876 (12)	
Δ LRDisco (Lag)	-4.0754* (11)	-4.0959* (11)	-4.1116* (11)	
LRM1 (Lag)	-2.2943 (1)	0.4556 (1)	4.2791 (1)	
Δ LRM1 (Lag)	-6.9834* (0)	-6.9610* (0)	-2.3751* (3)	
Notes: Asterik denotes coefficient significance at 10% level. L stands for logarithm and Δ for delta. For the definition of the variables see chapter 3.4.				

Table 23: Japanese Lag length criteria 1965M1 until 1993M3

<i>VAR Lag Order Selection Criteria for Japan</i> <i>Endogenous variables: LRNKY LRINDPROD LCPI LRM1 LRDISCO</i> <i>Exogenous variables: C</i> <i>Sample: 1965M01 1993M03</i> <i>Included observations: 339</i>						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	1008.798	NA	1.48e-09	-6.139435	-6.081484	-6.116311
1	5455.662	8730.541	2.67e-21	-33.18448	-32.83677	-33.04574
2	5959.797	974.3524	1.42e-22	-36.11496	-35.47751*	-35.86061*
3	5991.035	59.41991	1.37e-22	-36.15312	-35.22591	-35.78315
4	6035.834	83.84397	1.21e-22	-36.27422	-35.05726	-35.78863
5	6060.625	45.63928	1.22e-22	-36.27294	-34.76622	-35.67173
6	6085.037	44.19608	1.22e-22	-36.26934	-34.47288	-35.55253
7	6116.321	55.67934	1.18e-22*	-36.30777*	-34.22156	-35.47534
8	6138.889	39.47743	1.20e-22	-36.29290	-33.91693	-35.34485
9	6159.571	35.54397	1.23e-22	-36.26649	-33.60077	-35.20283
10	6187.723	47.52360	1.21e-22	-36.28577	-33.33030	-35.10649
11	6203.290	25.80087	1.29e-22	-36.22807	-32.98284	-34.93318
12	6227.866	39.98356*	1.30e-22	-36.22548	-32.69050	-34.81497
Notes: Asterik indicates lag order selected by the criterion. L stands for logarithm. For the definition of the variables see chapter 3.4.						
LR: sequential modified LR test statistic (each test at 5% level) FPE: Final prediction error AIC: Akaike information criterion SC: Schwarz information criterion HQ: Hannan-Quinn information criterion						

Table 24: Japanese Lag Length criteria 1993M4 until 2004M6

Table 24:						
<i>VAR Lag Order Selection Criteria for Japan</i>						
<i>Endogenous variables: LRNKY LRINDPROD LCPI LRM1 LRDISCO</i>						
<i>Exogenous variables: C</i>						
<i>Sample: 1993M04 2004M06</i>						
<i>Included observations: 135</i>						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	1202.242	NA	1.36e-14	-17.73692	-17.62932	-17.69319
1	2571.638	2617.068	3.05e-23	-37.65390	-37.00828	-37.39154
2	2751.607	330.6086	3.08e-24*	-39.94973	-38.76610*	-39.46873*
3	2761.556	17.54110	3.86e-24	-39.72676	-38.00512	-39.02713
4	2780.064	31.25790	4.28e-24	-39.63058	-37.37093	-38.71232
5	2810.974	49.91373	3.97e-24	-39.71814	-36.92047	-38.58124
6	2828.402	26.85212	4.52e-24	-39.60596	-36.27028	-38.25043
7	2842.442	20.59094	5.45e-24	-39.44358	-35.56988	-37.86942
8	2855.713	18.48183	6.70e-24	-39.26982	-34.85811	-37.47703
9	2873.827	23.88312	7.74e-24	-39.16780	-34.21808	-37.15637
10	2889.530	19.54232	9.39e-24	-39.03008	-33.54234	-36.80002
11	2901.775	14.33120	1.22e-23	-38.84112	-32.81536	-36.39242
12	2921.049	21.12984	1.44e-23	-38.75629	-32.19252	-36.08895
13	2951.093	30.71165	1.49e-23	-38.83101	-31.72923	-35.94505
14	2971.243	19.10481	1.82e-23	-38.75915	-31.11936	-35.65455
15	2992.708	18.76234	2.24e-23	-38.70679	-30.52898	-35.38356
16	3027.290	27.66500	2.35e-23	-38.84873	-30.13291	-35.30687
17	3082.410	40.01320	1.89e-23	-39.29496	-30.04112	-35.53446
18	3154.351	46.89489*	1.25e-23	-39.99038*	-30.19853	-36.01125
Notes: Asterik indicates lag order selected by the criterion.						
L stands for logarithm. For the definition of the variables see chapter 3.4.						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

Table 25: Japanese Cointegration test 1965M1 until 1993M3

<i>Sample Japan: 1965M01 1993M03</i>				
<i>Trend assumption: Linear deterministic trend</i>				
<i>Series: LRNKY LRINDPROD LCPI LRM1 LRDISCO</i>				
<i>Lags interval (in first differences): 1 to 12</i>				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5% Critical Value	p-value
None *	0.128830	118.1719	69.81889	0.0000
At most 1 *	0.084969	73.21065	47.85613	0.0000
At most 2 *	0.058170	44.26270	29.79707	0.0006
At most 3 *	0.047602	24.72535	15.49471	0.0016
At most 4 *	0.026709	8.825548	3.841466	0.0030
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5% Critical Value	p-value
None *	0.128830	44.96123	33.87687	0.0016
At most 1 *	0.084969	28.94795	27.58434	0.0333
At most 2	0.058170	19.53735	21.13162	0.0823
Notes: Asterik denotes coefficient significance at 5% level.				
L stands for logarithm. For the definition of the variables see chapter 3.4.				

Table 26: Japanese Cointegration Relationship 1965M1 until 1993M3

<i>Sample Japan: 1965M01 1993M03</i>					
Japan Normalized cointegrating coefficients (standard error in parentheses)					
LRNKY	LRINDPROD	LCPI	LRM1	LRDISCO	C
1.000000	-16.87975	19.89268*	5.455575	96.08432	-50.37638
	(7.84374)	(4.52653)	(8.83932)	(49.5346)	
	[-2.15200]	[4.39469]	[0.61719]	[1.93974]	
Japan Vector Error Correction with standard errors and t-values					
	D(LRNKY)	D(LRINDPROD)	D(LCPI)	D(LRM1)	D(LRDISCO)
ECM(-1)	-0.001567	-0.000490	2.37E-05	-0.001247*	-0.000355
	(0.00127)	(0.00029)	(1.3E-05)	(0.00023)	(0.00019)
	[-1.23101]	[-1.71946]	[1.79314]	[-5.43415]	[-1.84986]
Notes: (value) gives standard error and [value] is relevant t-value.					
Asterik denotes coefficient significance at 10% level.					
L stands for logarithm and D for delta. For the definition of the variables see chapter 3.4.					

Table 27: Japanese Cointegration Restriction test M1=0 for 1965M1 until 1993M3

Cointegration Restrictions Test with two vectors:	
<i>Sample Japan: 1965M01 1993M03</i>	
<i>Trend assumption: Linear deterministic trend</i>	
<i>Series: LRNKY LRINDPROD LCPI LRM1 LRDISCO</i>	
<i>Lags interval (in first differences): 1 to 12</i>	
Restriction tests: LRM1=0	
<i>Convergence achieved after 12 iterations</i>	
<i>LR test for binding restrictions (rank = 1):</i>	
Chi-square(1)	0.202282
Probability	0.652885

Table 28: Japanese Cointegration test without M1 for 1965M1 until 1993M3

<i>Sample Japan: 1965M01 1993M03</i>				
<i>Trend assumption: Linear deterministic trend</i>				
<i>Series: LRNKY LRINDPROD LCPI LRDISCO</i>				
<i>Lags interval (in first differences): 1 to 12</i>				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5% Critical Value	p-value
None *	0.079604	61.62723	47.85613	0.0015
At most 1 *	0.062831	34.58501	29.79707	0.0130
At most 2	0.026617	13.43035	15.49471	0.0999
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5% Critical Value	p-value
None	0.079604	27.04222	27.58434	0.0585
At most 1 *	0.062831	21.15466	21.13162	0.0496
At most 2	0.026617	8.794653	14.26460	0.3036
Notes: Asterik denotes coefficient significance at 5% level.				
L stands for logarithm. For the definition of the variables see chapter 3.4.				

Table 29: Japanese Cointegration Relationship without M1 from 1965 until 1993M3

<i>Sample Japan: 1965M01 1993M03</i>				
Japan Normalized cointegrating coefficients (standard error in parentheses)				
LRNKY	LRINDPROD	LCPI	LRDISCO	C
1.000000	-2.938418*	0.947305*	22.83050*	5.951519
	(0.55845)	(0.43480)	(7.03680)	
	[-5.26172]	[2.17872]	[3.24444]	
Japan Vector Error Correction with standard errors and t-values				
	D(LRNKY)	D(LRINDPROD)	D(LCPI)	D(LRDISCO)
ECM(-1)	-0.011991	0.007233*	-0.000258*	0.002693
	(0.00952)	(0.00210)	(0.00010)	(0.00148)
	[-1.26003]	[3.44599]	[-2.55159]	[1.82075]
Notes: (value) gives standard error and [value] is relevant t-value. Asterik denotes coefficient significance at 10% level. L stands for logarithm and D for delta. For the definition of the variables see chapter 3.4.				

Table 30: Japanese Cointegration test for 1993M4 until 2004M6

<i>Sample Japan: 1993M04 2004M06</i>				
<i>Trend assumption: Linear deterministic trend</i>				
<i>Series: LRNKY LRINDPROD LCPI LRDISCO</i>				
<i>Lags interval (in first differences): 1 to 18</i>				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5% Critical Value	p-value
None *	0.528379	232.6960	69.81889	0.0000
At most 1 *	0.394375	131.2327	47.85613	0.0000
At most 2 *	0.180752	63.53084	29.79707	0.0000
At most 3 *	0.153368	36.61615	15.49471	0.0000
At most 4 *	0.099443	14.14011	3.841466	0.0002
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5% Critical Value	p-value
None *	0.528379	101.4634	33.87687	0.0000
At most 1 *	0.394375	67.70182	27.58434	0.0000
At most 2 *	0.180752	26.91469	21.13162	0.0068
At most 3 *	0.153368	22.47604	14.26460	0.0020
Notes: Asterik denotes coefficient significance at 5% level. L stands for logarithm. For the definition of the variables see chapter 3.4.				

Table 31: Japanese Cointegration Relationship from 1993M4 until 2004M6

<i>Sample Japan: 1993M04 2004M06</i>					
Japan Normalized cointegrating coefficients (standard error in parentheses)					
LRNKY	LRINDPROD	LCPI	LRM1	LRDISCO	C
1.000000	-2.101106*	-6.908005*	0.772585*	-8.038286*	44.14819
	(0.13794)	(0.48547)	(0.02180)	(1.17188)	
	[-15.2321]	[-14.2296]	[35.4433]	[-6.85929]	
Japan Vector Error Correction with standard errors and t-values					
	D(LRNKY)	D(LRINDPROD)	D(LCPI)	D(LRM1)	D(LRDISCO)
ECM(-1)	-2.106388*	0.228294*	0.001138	-0.101093	-0.010873
	(0.45357)	(0.09711)	(0.00226)	(0.08409)	(0.02871)
	[-4.64405]	[2.35088]	[0.50356]	[-1.20223]	[-0.37875]
Notes: (value) gives standard error and [value] is relevant t-value. Asterik denotes coefficient significance at 10% level. L stands for logarithm and D for delta. For the definition of the variables see chapter 3.4.					

Table 32: US Variance Decomposition 1965M1-2004M6

<i>Variance Decomposition of Stock Prices</i>		
<i>Sample US: 1965M01 2004M06</i>		
Series	Year	LRSPX
LRIndProd	1	5.591048
	4	7.287506
	8	10.73906
LCPI	1	4.994504
	4	11.73181
	8	10.49519
LRM1	1	0.847098
	4	14.80198
	8	18.66238
LR10YR	1	5.953626
	4	3.596376
	8	1.462942
Notes: Rows report forecast variance of stock prices after one, four and eight years. L stands for logarithm. For the definition of the variables see chapter 3.4.		

Table 33: Japanese Variance Decomposition 1965M1-2004M6

<i>Variance Decomposition of Stock Prices</i> <i>Sample Japan: 1965M01 2004M06</i>		
Series	Year	Nikkei 225
LRIndProd	1	0.170274
	4	0.435528
	8	0.217465
LCPI	1	1.279576
	4	1.847681
	8	0.960575
LRM1	1	2.259111
	4	5.742231
	8	5.516197
LRDisco	1	1.013788
	4	4.472937
	8	4.601996
Notes: Rows report forecast variance of stock prices after one, four and eight years. L stands for logarithm. For the definition of the variables see chapter 3.4.		

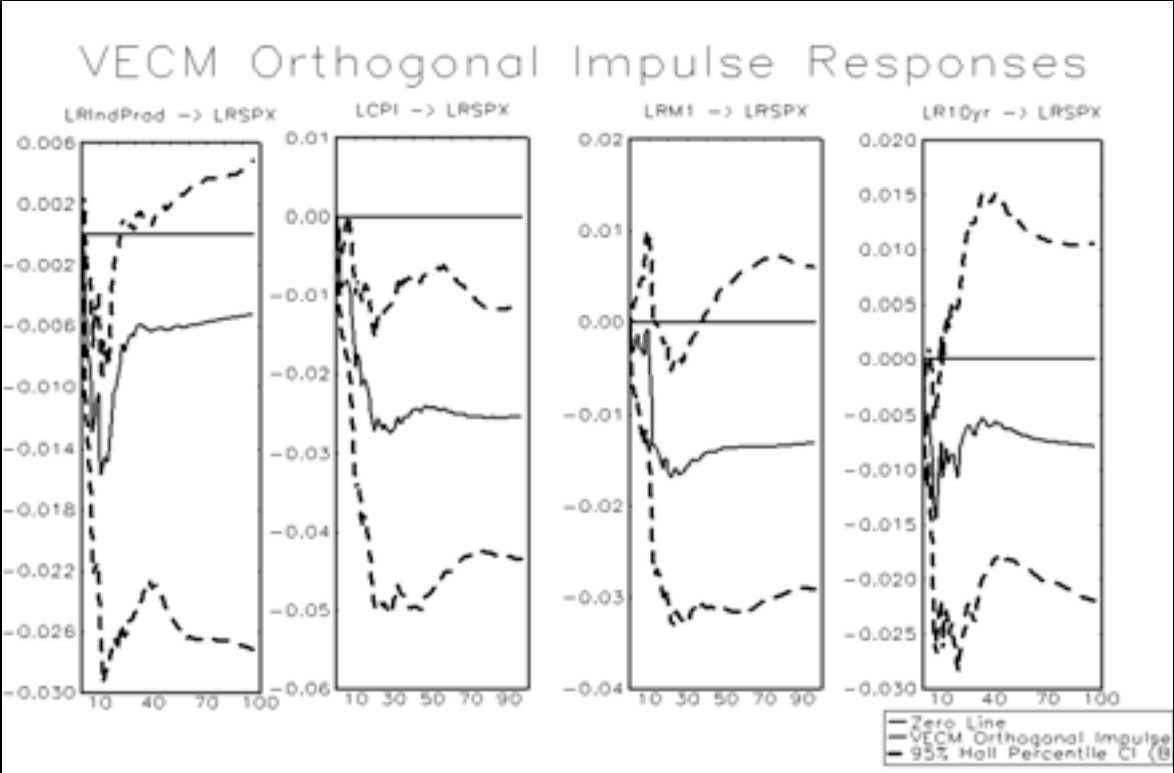
Table 34: Japanese Variance Decomposition 1965M1-1993M3

<i>Variance Decomposition of Stock Prices</i> <i>Sample Japan: 1965M01 1993M03</i>		
Series	Year	Nikkei 225
LRIndProd	1	0.783736
	4	8.868774
	8	13.27237
LCPI	1	2.323408
	4	4.190876
	8	4.258382
LRM1	1	N.A.
	4	N.A.
	8	N.A.
LRDisco	1	1.294044
	4	11.35774
	8	12.15383
Notes: Rows report forecast variance of stock prices after one, four and eight years. L stands for logarithm. For the definition of the variables see chapter 3.4.		

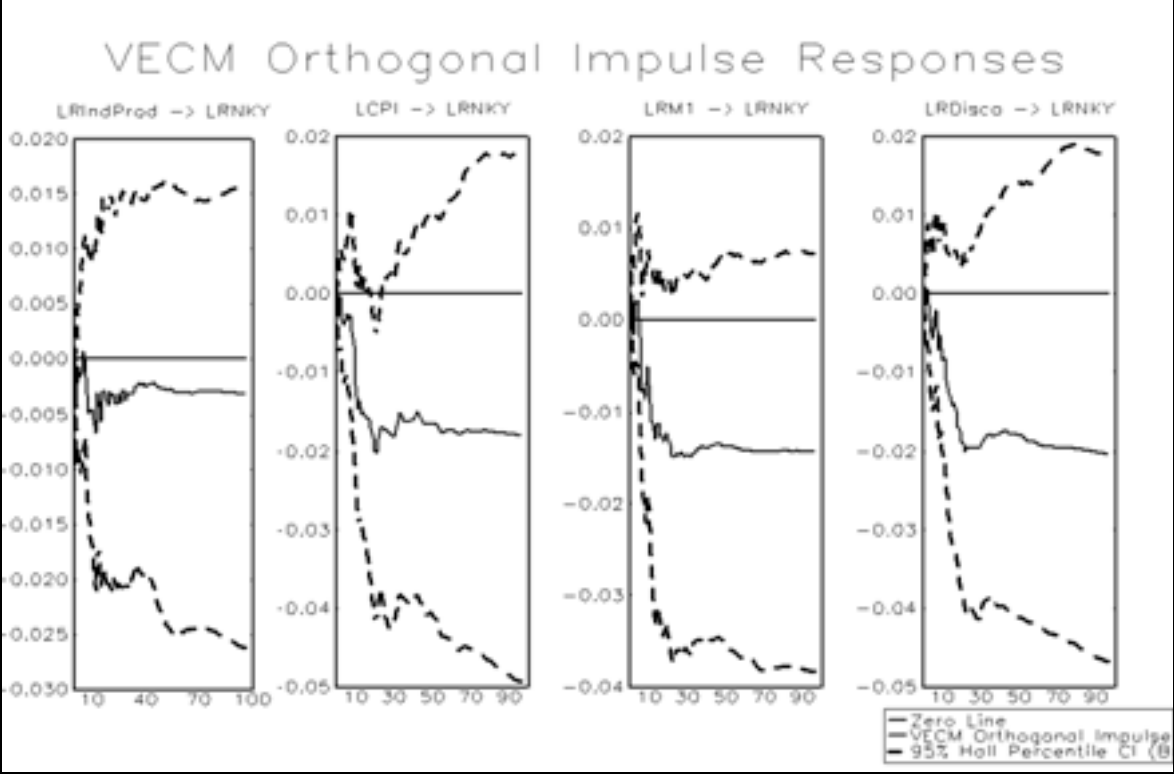
Table 35: Japanese Variance Decomposition 1993M4-2004M6

<i>Variance Decomposition of Stock Prices</i> <i>Sample Japan: 1993M04 2004M06</i>		
Series	Year	Nikkei 225
LRIndProd	1	20.35648
	4	31.41907
	8	30.39264
LCPI	1	0.475270
	4	1.252417
	8	1.854839
LRM1	1	1.496935
	4	2.739168
	8	2.437819
LRDisco	1	1.507863
	4	1.291135
	8	0.713055
Notes: Rows report forecast variance of stock prices after one, four and eight years. L stands for logarithm. For the definition of the variables see chapter 3.4.		

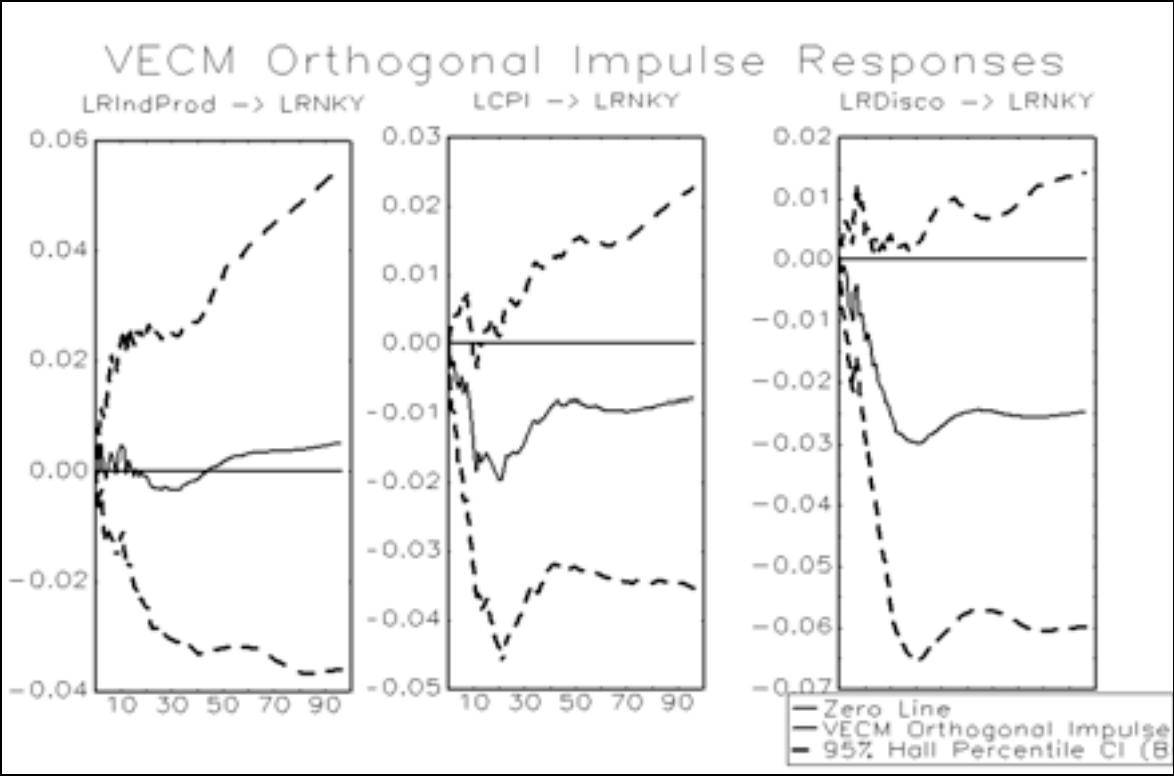
Graph 21: US Impulse Response Functions 1965M1 until 2004M6



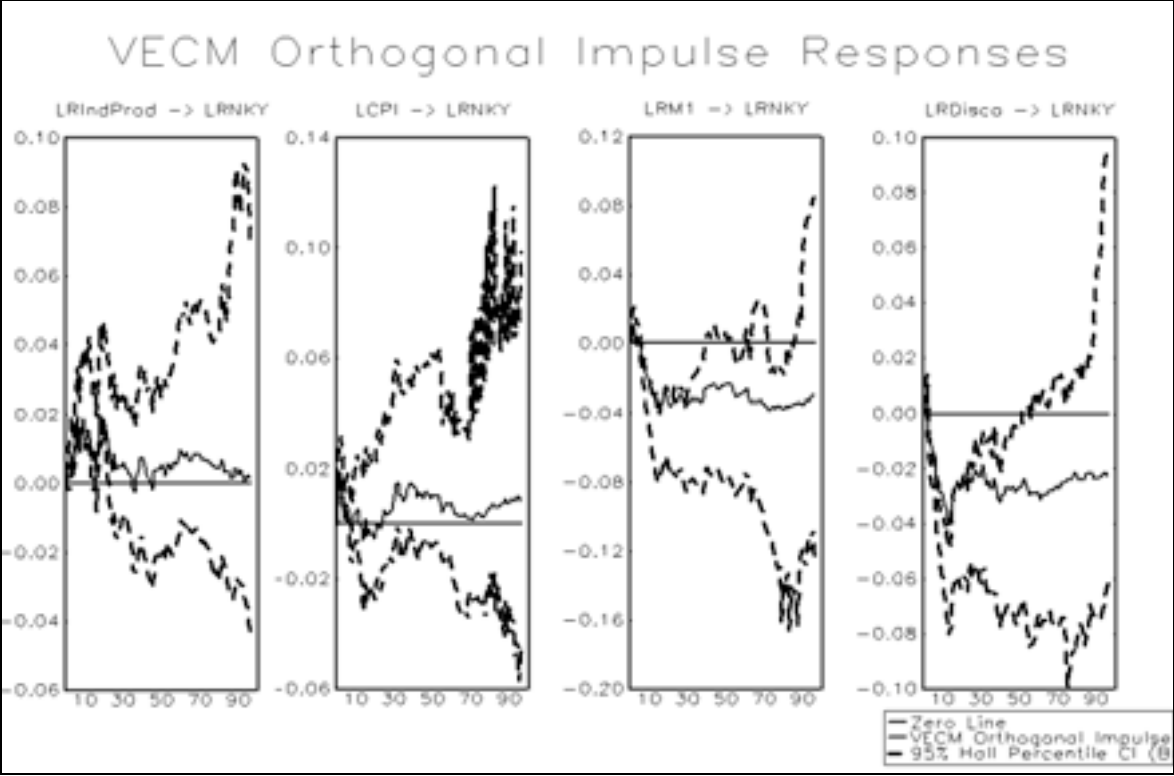
Graph 22: Japanese Impulse Response Functions 1965M1 until 2004M6



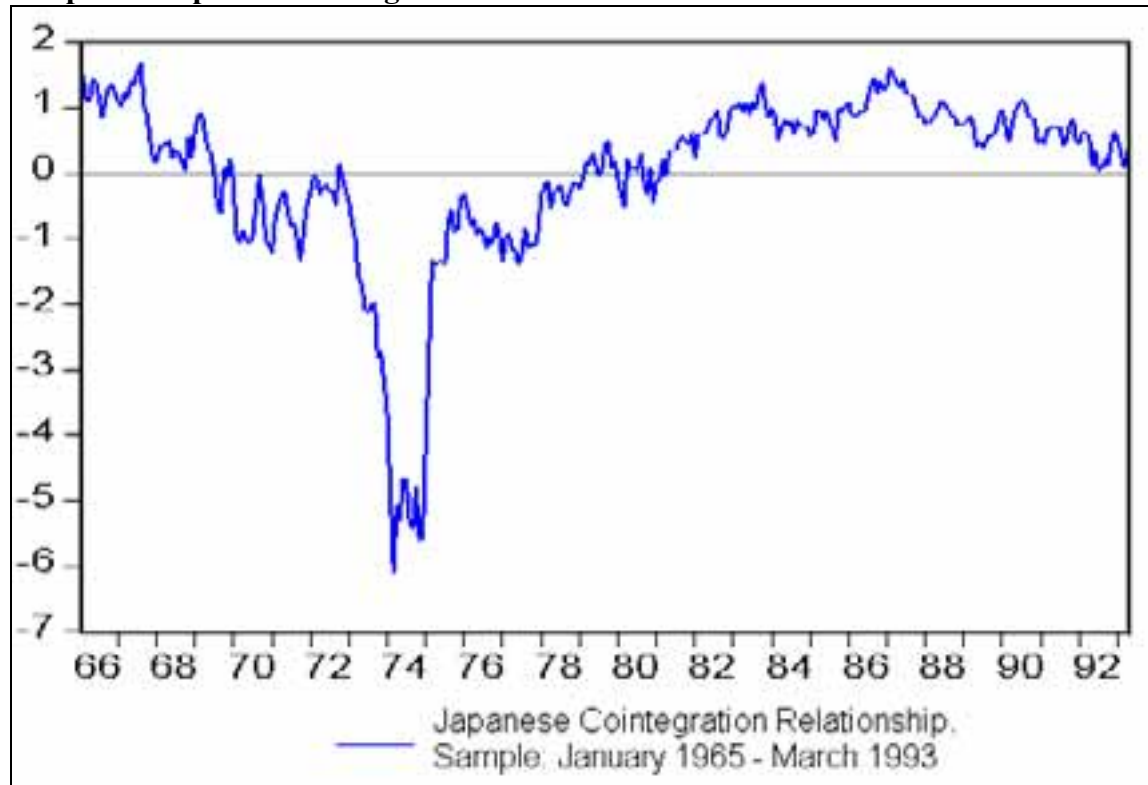
Graph 23: Japanese Impulse Response Functions 1965M1 until 1993M3



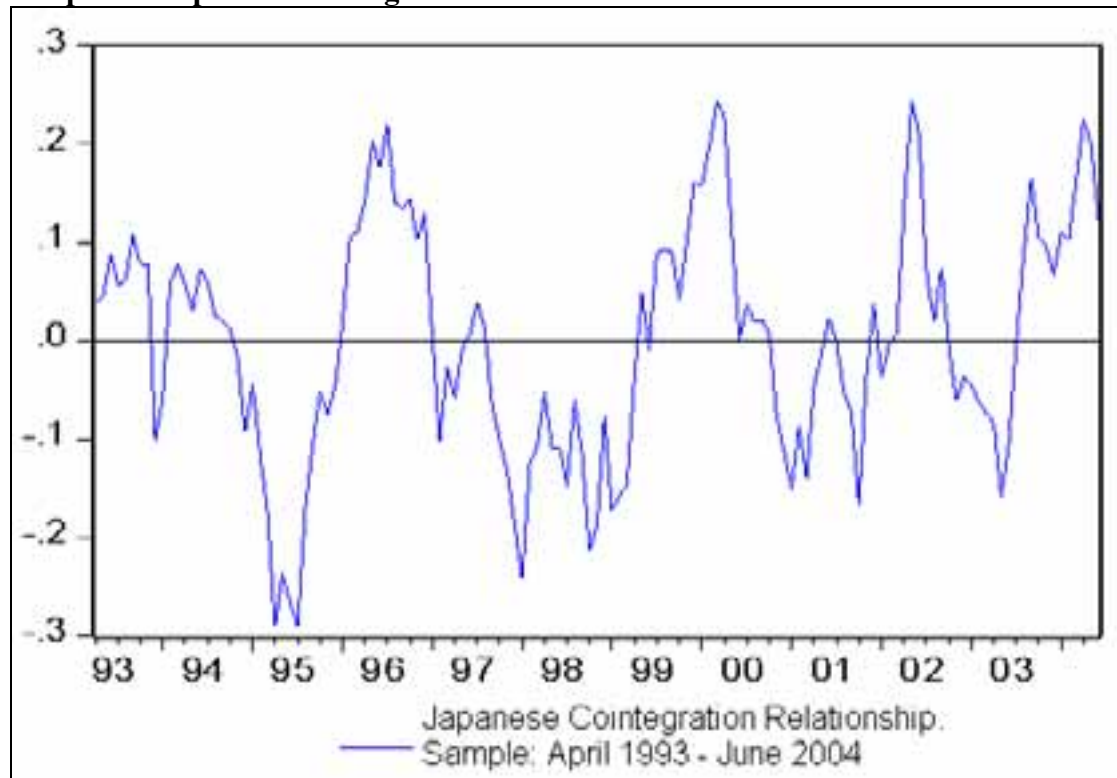
Graph 24: Japanese Impulse Response Functions 1993M4 until 2004M6



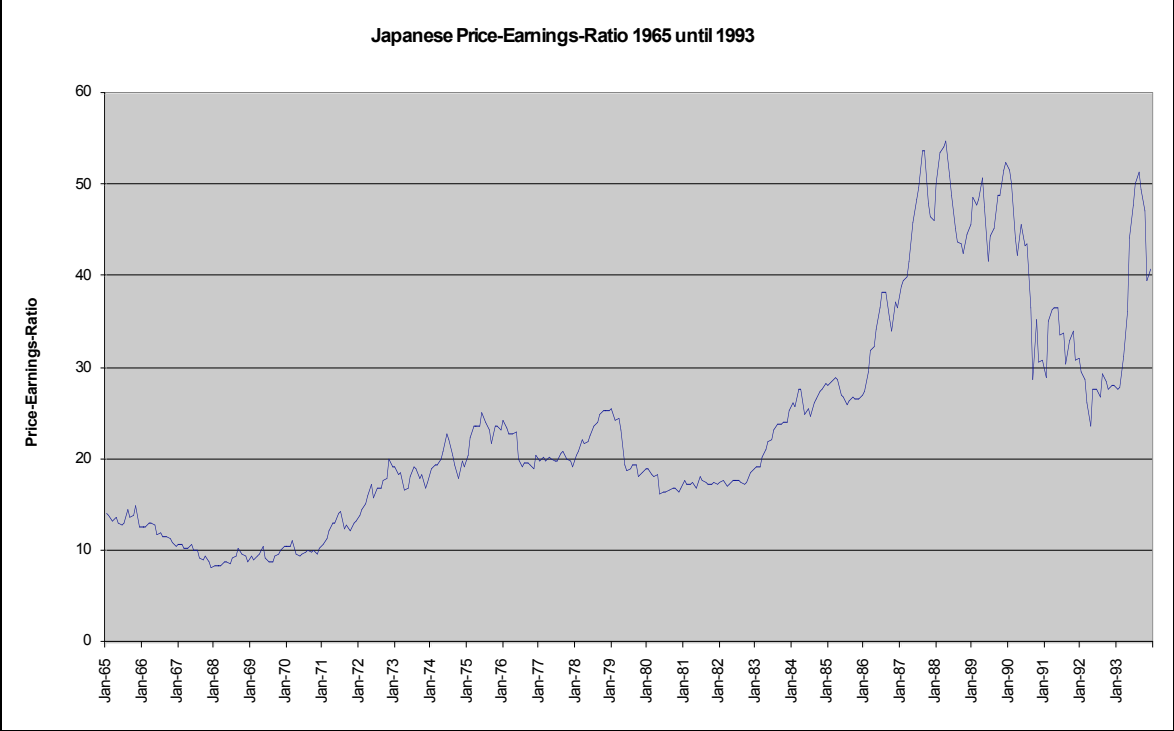
Graph 25: Japanese Cointegration Vector from 1965M1 until 1993M3



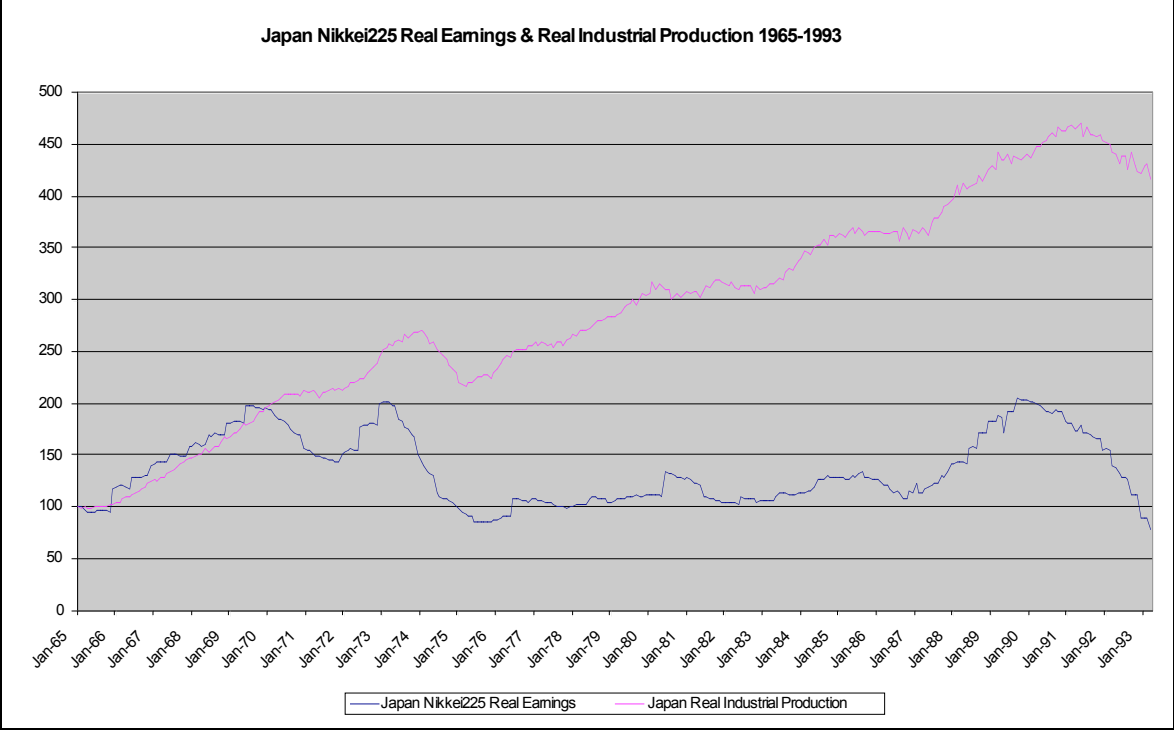
Graph 26: Japanese Cointegration Vector from 1993M4 until 2004M6



Graph 27: Japanese Price-Earnings-Ratio 1965 until 1993



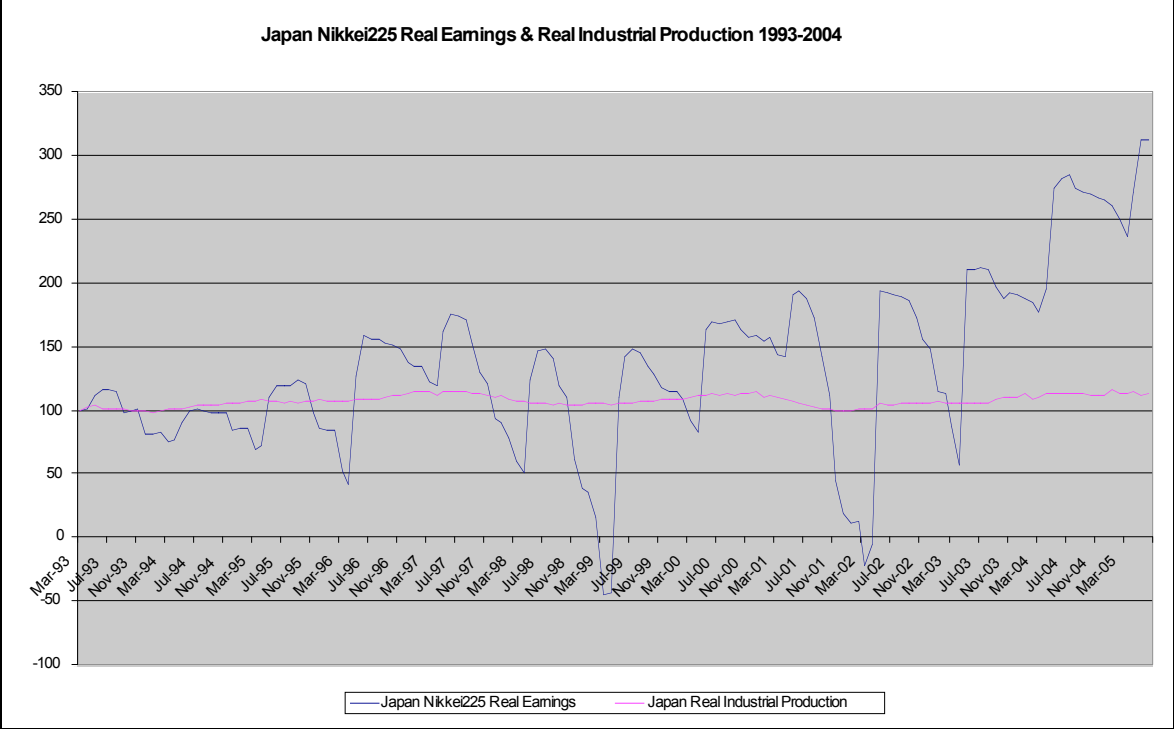
Graph 28: Japanese real Earnings vs. real Industrial Production 1965-1993



Graph 29: Corporate Earnings vs. Industrial Production in the US and Japan



Graph 30: Japanese Earnings and Industrial Production 1993-2004



Chapter 4

4.0 Non linear relationship between macroeconomic variables and the stock market

In this chapter we will investigate a possible non-linear link between macroeconomic variables and the stock market. In contrast to the cointegration model in chapter 3, the non-linear model is able to distinguish between positive and negative stock market returns or large and small returns. As heterogeneity in investors' beliefs give reason to suspect a smooth transition between extremes, rather than abrupt, a smooth transition regression model will be estimated (for discussions see Peters 1994). The cointegration analysis in chapter 3 supported the expected business cycle swings from the long-term equilibrium. In the US we found evidence to support the expected relationships between macroeconomic variables and the stock market. As suggested by the PVM, we observed a positive relationship between industrial production and stock prices, whereas consumer prices and the 10 year bond yield had a negative impact on share prices in the US. In Japan the expected relationships were only observed until March 1993, when we found statistical evidence of a structural break. After March 1993 the relationships change significantly, as the discount rate and consumer prices show a positive effect, whereas money supply yields a negative effect on stock prices. We believe the structural break in Japan can be partly explained by the occurrence of a liquidity trap.

As discussed in chapter 1.1.1 and chapter 3.3, the US and Japanese stock market have experienced large price fluctuations over the last 40 years. In particular the 1980s in Japan and the 1990s in the US were characterised by large positive stock returns. On the other hand, the 1990s in Japan and the years 2001 and 2002 in the US showed large negative

stock market returns. The non-linear model will offer an alternative explanation to the equilibrium model in chapter 3 for stock market behaviour in the US and Japan. We expect different stock market behaviour in periods of positive and negative or large and small stock market returns. In chapter 4.3 we will discuss behavioural finance models that give us reason to suspect non-linear stock market behaviour. Furthermore, we will add additional variables in order to account for international economic growth and classical risk factors such as the term-premium³⁴. As discussed in chapter 1.1.2, the Japanese economy has a larger export share than the US. For this reason we extend the variable set and include the exchange rate and an international output indicator. We expect international growth and the exchange rate to have a significant impact on the Japanese stock market. Finally the different industry structure and different degrees of cyclicity can partly explain differences between risk factors and the stock market in the US and Japan. In chapter 1.1.2 we have suggested that Japan has a more cyclical industry structure than the US. However, the US has a larger financial sector than Japan. We suspect that the higher cyclicity of the Japanese economy may be reflected in larger coefficients between macroeconomic variables and the stock market as already supported in the cointegration analysis in chapter 3. The higher banking share in the US might show a higher sensitivity between the stock market and interest rate variables. Bank profits are partly related to the term-premium because short-term deposits of clients are often invested in longer-term bonds that yield a higher interest rate. Overall the objective of this chapter is to find an alternative explanation for the different stock market developments in the US and Japan.

³⁴ The additional variables were not available for the cointegration period since 1965. For that reason the non-linear analysis will cover a shorter period.

4.1 Introduction

Since the mid 1980s economists have reported on non-linear behaviour in financial variables such as stock prices or exchange rates. For a selection of relevant studies for the stock market see *inter alia* Scheinkman and LeBaron, 1989; Brock, Hsieh and LeBaron, 1991; Abhyankar, Copeland and Wong, 1997 and Brooks, 1998. The most popular applied non-linear model is the autoregressive conditionally heteroskedastic (ARCH) model developed by Engle (1982) and the extension of the model by Bollerslev (1986) to the so-called generalised autoregressive conditionally heteroskedastic (GARCH) approach. These models have been very useful in explaining changes in volatility (volatility clustering) that have been observed in asset returns.

Although these models are often described as non-linear models in the literature, technically speaking ARCH and GARCH models are dynamic linear models with an explicit treatment of time-varying heteroscedasticity. Therefore, these models are not non-linear models but observationally show similar behaviour to threshold models because the expected volatility changes over time. Even so ARCH and GARCH models are quite good in explaining the conditional variance, it has been found that they do not improve the out of sample forecasting power. Further debate as to whether the clustering enters the conditional variance, conditional mean or both remains open in the literature (For a selection of relevant studies see *inter alia* Granger, 1991; Lundbergh and Teräsvirta, 1998).

However, in our empirical analysis we will only model non-linear behaviour in the conditional mean. It is important to note that in this thesis we refer to non-linear models as regime switching smooth transition regression (STAR) models (see Chan and Tong 1986, Granger and Teräsvirta 1993). We will therefore apply STAR models that have an

observable transition variable and a transition function that governs the transition process between two different fundamental relationships. By fundamental relationship we understand a linear relationship between macroeconomic variables and the stock market. For instance, the relationship between the stock market and a macroeconomic variable such as the interest rate could be different in periods of very large negative stock returns (during a crash) or very large positive stock returns (overheating stock market). However, the model is non-linear because we do not only have the two different relationships but a combination of both in-between. In our example, for every stock return between the extremes (crash or overheating stock market) a STAR model attaches a weighted combination of the relationships during the extreme periods. As the combination of both regimes is governed by a non-linear function, like an exponential or logistic function, the resulting combinations of both regimes are non-linear. The advantage of STAR models is that a smooth transition between regimes can be estimated and heterogeneity in investors' beliefs gives reason to suspect such a transition (for discussions see Peters 1994).

The aim of this chapter is to investigate the question of whether there are periods of different relationships between macroeconomic variables and the stock market during runs of positive returns (bull market) and runs of negative returns (bear market) as well as large returns and small returns (limits to arbitrage). The ARCH and GARCH kind of models have been used to model time varying conditional variance. In contrast, the two regime Markov-switching model (Hamilton, 1989a) has been used to model business cycle expansions and contractions where the regime-switching behaviour is described by a probabilistic process (ARCH, GARCH and Markov-switching models will be explained in more detail in chapter 4.2). Therefore, the regime changes are determined by an unobservable state variable which is modelled as a Markov chain.

However, smooth transition autoregressive (STAR) models are more flexible than Markov-switching models and can describe regime-switching governed by an observed transition variable (for a discussion see Franses and van Dijk, 2000). Thus a logistic transition function is ideally suited to model regime-switching behaviour between positive returns (bull market) and negative returns (bear market), whereas an exponential transition function best suits switching behaviour between large returns and small returns (for a discussion see McMillan, 2001b). Apart from the advantage of an observable transition variable, STAR models allow for a combination of both regimes and thus intermediate states are possible, whereas in a Markov-switching framework the stock market must be in a single regime in every period. For empirical applications of STAR models in finance see *inter alia* Sarantis (1999, 2001), Franses and van Dijk (2000), McMillan (2001b) as well as Aslanidis (2002). Generally, those papers have found non-linear behaviour between macroeconomic variables and the stock market that better describes the in-sample behaviour, whereas the out of sample forecasting power has shown a mixed picture.

We will extend our variable set and apply the outlined STAR model framework as an alternative to our long-term equilibrium approach investigated in the previous chapters. We expect different stock market behaviour during the stock market boom periods (Japan 1980s and US 1990s) and the crisis periods (Japan 1990s and US 2001/2002). To our knowledge a STAR model has not been applied to the Japanese stock market and in particular the comparison of the US and Japan might shed some more light on the commonalities and differences in those two countries.

4.2 Review of empirical literature

In this section we will give a brief overview of the relevant empirical literature. It should be stressed that the aim is not to provide a complete account of the literature on non-linear models, but rather to give an introduction to this area while focusing on smooth transition regime switching models in finance.

Although it has been long recognised that asset returns show non-linear behaviour, the autoregressive conditionally heteroskedastic (ARCH) model of Engle (1982) was the first to model this non-linearity. When looking at a long time series of asset returns like the stock market, a basic observation about asset return data is that large returns (of either sign) tend to be followed by more large returns (of either sign). Thus, asset return volatility tends to be serially correlated. The ARCH framework models the conditional variance as a distribution of past squared innovations. It therefore models the changes in variance as a function of time:

$$\sigma_t^2 = \omega + \alpha(L)\eta_t^2 \quad (4.2.1)$$

Here $\alpha(L)$ is a polynomial in the lag operator. Furthermore ω and $\alpha(L)$ must be positive to keep the conditional variance positive (Campbell, Lo and MacKinlay, 1997). The ARCH model considers the variance of the current error term as a function of the variances of the previous time period's error terms and relates the error variance to the square of a previous period's error. In order to model persistent movements in volatility without estimating a very large number of coefficients, an autoregressive moving average model (ARMA model) is assumed for the error variance. Such a model is called a generalized autoregressive conditional heteroskedasticity (GARCH, Bollerslev(1986))

model. Therefore a GARCH(1,1) model is an ARMA(1,1) model for squared innovations whereas a ARMA(1,1) model has homoskedastic shocks. In contrast, the shocks of GARCH(1,1) are themselves heteroskedastic. Although ARCH and GARCH models are often described as non-linear models in the literature, technical speaking these models are dynamic linear models with an explicit treatment of time-varying heteroscedasticity. Therefore, these models are not non-linear models but observationally show similar behaviour to threshold models because the expected volatility changes over time.

While ARCH and GARCH models implement the non-linear dynamics in the conditional variance, it can also be introduced in the conditional mean part of the underlying process³⁵. This can be done by defining different states or regimes and model the dynamic behaviour of asset returns depending on the current regime. In this class of models there are three main types.

First, the smooth transition autoregressive (STAR) models and secondly the self-exciting threshold autoregressive (SETAR) models. Both models assume that the regimes can be determined by an observable variable and that the regimes that have occurred in the past as well as the present are known with certainty. The advantage of the STAR model is that it is more flexible as it allows for a smooth transition between the regimes, whereas the SETAR model implies a sudden switch (for a discussion see Franses and van Dijk, 2000).

The third class of model is the so-called Markov switching model and assumes that the regime cannot de facto be observed but is determined by an underlying stochastic process. As a result, one can never be certain that an individual regime has occurred at a point in

³⁵ There also exists an extension of the ARCH model that is called ARCH-M. In an ARCH-M model the conditional mean depends on the conditional variance. For an example of a GARCH-M model see Black and Fraser (1995).

time and only a probability can be assigned to a particular regime to have happened at a point in time. For our empirical analysis, the major advantage of a STAR model is that it allows for a continuum of states between the two extremes (Teräsvirta 1998). We believe that changes in the stock market are influenced by changes in the behaviour or belief of many different investors and it is very unlikely that all stock market participants react simultaneously to a macroeconomic signal. With a large number of investors that change their behaviour at different times due to heterogeneous beliefs, a smooth transition between the extremes is likely (Aslanidis 2002).

Heterogeneity in investors' beliefs can arise from different risk profiles, different investment horizons, different institutional dependence or geographical location (for discussions see Peters 1994). In chapter 1.1.2 we have discussed the different institutional ownership structures in the US and Japan. While the Japanese market is dominated by institutional investors, the US stock market ownership is more balanced between institutional and private investors. Assuming different behaviour of private and institutional investors, we might expect the transition between regimes to be smoother in the US because of the more balanced forces between institutional and private investors.

Hamilton (1989a, 1989b, 1990) and Sclove (1983a, 1983b) developed the non-linear Markov-switching model that is able to capture asymmetries in the conditional mean of a time series. This model identifies which of the regimes has happened at a point in time by attaching a probability to the occurrence of an individual regime. Changes in regime are determined by an unobservable state variable which is typically modelled as a Markov chain. Furthermore, the individual regime is characterized by its mean value, duration and regime persistence. Thus the asymmetries are captured by differences of these characteristics in different regimes. For example:

$$x_t = \begin{cases} \alpha_1 + \beta_1 x_{t-1} + \varepsilon_{1t} & \text{if } s_t = 1 \\ \alpha_2 + \beta_2 x_{t-1} + \varepsilon_{2t} & \text{if } s_t = 0 \end{cases} \quad (4.2.2)$$

In this case, s_t is an unobservable two state Markov chain with some transition probability matrix P . It is important to note that s_t determines the regime at time t , not s_{t-1} . In both regimes, x_t is described by an AR(1) process, but the parameters (together with the variance of the error term) differ across regimes. Furthermore, the change in regime is stochastic and possibly serially correlated (Campbell, Lo and MacMinlay; 1997). Thus a shorthand notation is given by:

$$x_t = \alpha_{s_t} + \beta_{s_t} x_{t-1} + \varepsilon_t s_t \quad (4.2.3)$$

As the process s_t is assumed to be a first order Markov process, the current regime only depends on the regime one period ago. Hence, to complete the model, the transition probabilities of moving from one state to another have to be defined as follows (Franses and van Dijk, 2000):

$$\begin{aligned} P(s_t = 1 | s_{t-1} = 1) &= p_{11} \\ P(s_t = 2 | s_{t-1} = 1) &= p_{12} \\ P(s_t = 1 | s_{t-1} = 2) &= p_{21} \\ P(s_t = 2 | s_{t-1} = 2) &= p_{22} \end{aligned} \quad (4.2.4)$$

Therefore, the probability p_{ij} is identical to the probability that the Markov chain changes from state i at time $t-1$ to state j at time t and thus gives the probability that regime i at time $t-1$ is followed by regime j at time t . Furthermore, for p_{ij} to define proper probabilities

those should not be negative and $p_{11} + p_{12} = 1$ and $p_{21} + p_{22} = 1$. The unconditional probabilities of $P(s_t = i)$ for $i = 1$ and 2 respectively is given by using the theory of ergodic Markov chains for the two state Markov switching model (Hamilton, 1994):

$$\begin{aligned} P(s_t = 1) &= \frac{1 - p_{22}}{2 - p_{11} - p_{22}} \\ P(s_t = 2) &= \frac{1 - p_{11}}{2 - p_{11} - p_{22}} \end{aligned} \tag{4.2.5}$$

The appeal of the model from an economic perspective is that changes in regime are caused by factors other than the series we are modelling, as s_t determines the regime and not x_t . Furthermore, as s_t is unobservable, we hardly know which regime we are in, but after the occurrence we can identify which regime we have been in with some degree of confidence. Originally, Hamilton (1989b) applied this model to business cycles where state 1 can be associated with economic contractions and state 2 with economic expansions. He applied a Markov switching model to quarterly US GNP growth and found that contractions are sharper than expansions. Furthermore, it has been reported that the timing and duration of the regimes generated by the model correspond extremely well to the traditional business cycle dates of the National Bureau of Economic Research.

When looking at financial markets in a Markov-switching framework, one regime can be associated with rising prices and the other with falling prices. Engle and Hamilton (1990) make the case for exchange rates following long swings as they drift upward for a long period of time and then switch to a considerable period of time with a downward drift. In their studies they find evidence of the long swing hypothesis for quarterly data on the US Dollar to the German Mark and US Dollar to British Pound as well as US Dollar to French Franc exchange rates.

An extension of the original model has been made by Filardo (1994), where the transition probabilities are allowed to change over time. The model is then called time varying transition probability (TVTP) Markov switching model. Thus Filardo (1994) makes the transition probabilities a function of some exogenous leading indicator variables and this gives the model more flexibility to focus on further characteristics of the business cycle. In order to explain asymmetries in volatility exhibited by high frequency financial data, Hamilton and Susmel (1994) generalize the Markov switching model to the conditional variance and thus promote Markov switching models with ARCH effects. However, in this model the conditional mean part remains linear.

In contrast to Markov switching models, the threshold autoregressive model (TAR) allows for an observable switching variable s_t . This model was first advocated by Tong (1983) and assumes that the regime is determined by the value of the so called threshold variable s_t relative to the threshold value denoted c . When the threshold variable s_t is a lagged value of the time series itself, so that $s_t = x_{t-d}$, where d is the delay parameter ($d > 0$), the model is called a self-exciting threshold autoregressive model (SETAR). For example, when $d = 1$ and an AR(1) model is assumed in both regimes, a 2-regime SETAR model is represented by:

$$x_t = \begin{cases} \alpha_1 + \beta_1 x_{t-1} + \varepsilon_t & \text{if } x_{t-1} \leq c \\ \alpha_2 + \beta_2 x_{t-1} + \varepsilon_t & \text{if } x_{t-1} > c \end{cases} \quad (4.2.6)$$

The SETAR model requires that the border between the two regimes is given by a particular value of the threshold variable x_{t-1} (Franses and van Dijk, 2000). Thus the SETAR model as well as Hamilton's Markov switching model estimate a sharp switch

between regimes. The difference between both models is given by the mechanism of the regime switch. While in the SETAR framework the regime switch is deterministic, the Markov switching model exhibits a stochastic regime switch. In the financial literature, there are relatively few applications of SETAR models (Aslanidis, 2002). One of the exceptions is Kräger and Kugler (1993) who set up a three regime SETAR model for five different currencies against the US Dollar at weekly frequency. For all currencies they found statistically significant threshold behaviour and argue that those patterns might be expected in periods of managed floating exchange rates as has been the case during the 1980s. The main reason for this is seen in the monetary authorities' reaction to large appreciations or depreciations of a currency. This effectively leads to different behaviour for moderate and large changes in the exchange rate. Also Chappell, Padmore, Mistry and Ellis (1996) test for threshold behaviour at the ceiling and floor of the French Franc to the German Mark during the introduction of the Exchange Rate Mechanism (ERM) where Central Bank interventions have been taken to maintain the exchange rate within a band. An extension of the SETAR model incorporates ARCH effects and thus models the conditional mean in the SETAR framework, whereas the conditional variance is modelled in the ARCH part of the SETAR-ARCH model (Aslanidis, 2002). This has been first introduced by Tong (1990) and Li and Lam (1995) as well as Li and Li (1996) who have applied this model to the Hong Kong and Hang Seng stock indices. While the applied model in Li and Lam (1995) is a standard SETAR-ARCH model, Li and Li (1996) use a double threshold ARCH (DTARCH) model in their analysis. Both investigations do find evidence of asymmetries in the conditional mean as well as the conditional variance in the daily stock market returns of the Hang Seng and Hong Kong stock index.

In contrast to SETAR models, smooth transition autoregressive models allow for a easy transition between different regimes. Thus the specific value of a threshold variable in the

SETAR model is replaced by a transition function which changes smoothly from 0 to 1. The standard smooth transition regression (STAR) model (Lütkepohl and Krätzig 2004) has the form:

$$x_t = \phi' z_t + \theta' z_t G(\gamma, c, s_t) + \varepsilon_t, \quad \varepsilon_t \sim iid(0, \sigma^2) \quad (4.2.7)$$

In the case we use a logistic function as transition function, we have:

$$G(\gamma, c, s_t) = (1 + \exp(-\gamma(s_t - c)))^{-1}, \quad \gamma > 0 \quad (4.2.8)$$

The alternative of an exponential transition function is described by:

$$G(\gamma, c, s_t) = 1 - \exp(-\gamma(s_t - c)^2), \quad \gamma > 0 \quad (4.2.9)$$

In this model, $z_t = (w_t', y_t')$ represents a vector of explanatory variables whereas $w_t' = (x_{t-1}, \dots, x_{t-p})$ and $y_t' = (y_{1t}, \dots, y_{kt})$ represent vectors of exogenous variables. In addition, ϕ and θ are an $((m+1) \times 1)$ matrix with the parameter vectors of the linear and the nonlinear part respectively. The transition function $G(\gamma, c, s_t)$ depends on the transition variable s_t , the slope parameter γ and the vector of location parameters c . When $\gamma \rightarrow 0$, the logistic function approaches a constant of 0.5 and as a result the logistic STAR model approaches a linear AR model. On the other hand, when $\gamma \rightarrow \infty$, the transition becomes an abrupt step function. Thus the logistic STAR model nests the SETAR model as a special case. When $\gamma = 0$ in the exponential transition function, $G(\gamma, c, s_t) \equiv 1/2$, and thus the exponential STAR model nests a linear model again. On the contrary, when $\gamma \rightarrow \infty$, the exponential STAR model becomes another switching regression model with three regimes such that the outer regimes are identical and the middle regime is different from the other two.

While it is not obvious that the exponential STAR model can capture stock market behaviour, as it implies the same response to rising and falling markets, Teräsvirta (1994)

argue that exponential STAR models can have similar regime implications to the logistic STAR approach when almost all the observations are located to the right of the threshold parameter. If this happens, the effective distinction between logistic STAR and exponential STAR models is the shape of the transition function. As the logistic function is symmetric around the threshold, at a specific point $(s_t - c_L)$ the logistic function has a value $G_L = \mu$ and then $G_L = 1 - \mu$ at $-(s_t - c_L)$ with the derivatives equal at these two points (Aslanidis, 2002). Therefore, the logistic STAR model implies symmetric transition from regime 0 to 1 and from 1 to 0. However, for the exponential STAR model, the right hand half of the function does not have this symmetry. Especially as s_t moves away from c , the slope of the function is greater than that which occurs when s_t moves towards c (Öcal and Osborn, 2000). Hence, the asymmetry of the exponential function gives a corresponding asymmetry in the coefficients of the exponential STAR model and this is able to describe sharp bear markets and allow for smoother bull markets much better than the logistic STAR model. The STAR model was generally developed as a generalization of a switching regression model in the work of Bacon and Watts (1971). Chan and Tong (1986) introduced the original model in the non-linear time series literature whereas Teräsvirta and Anderson (1992), Granger and Teräsvirta (1993) and Teräsvirta (1994) have made the model very popular.

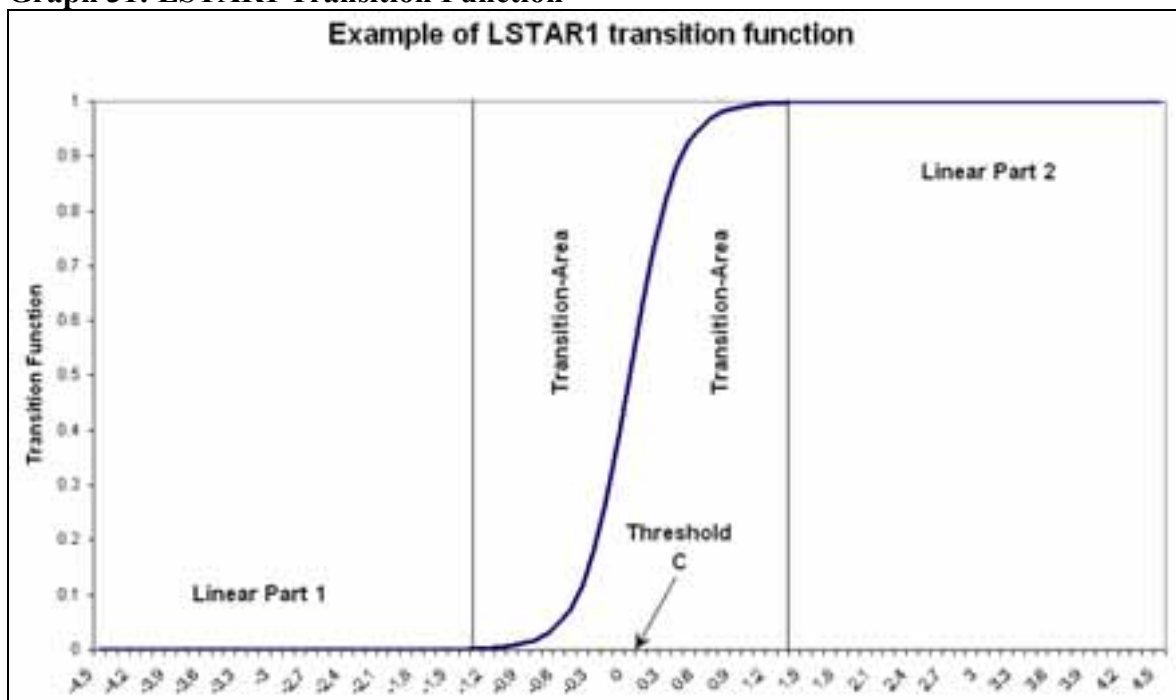
As an alternative to the logistic and exponential STAR model, the transition function can be modelled as follows:

$$G(\gamma, c, s_t) = \left(1 + \exp \left\{ -\gamma \prod_{k=1}^K (s_t - c_k) \right\} \right)^{-1}, \quad \gamma > 0 \quad (4.2.10)$$

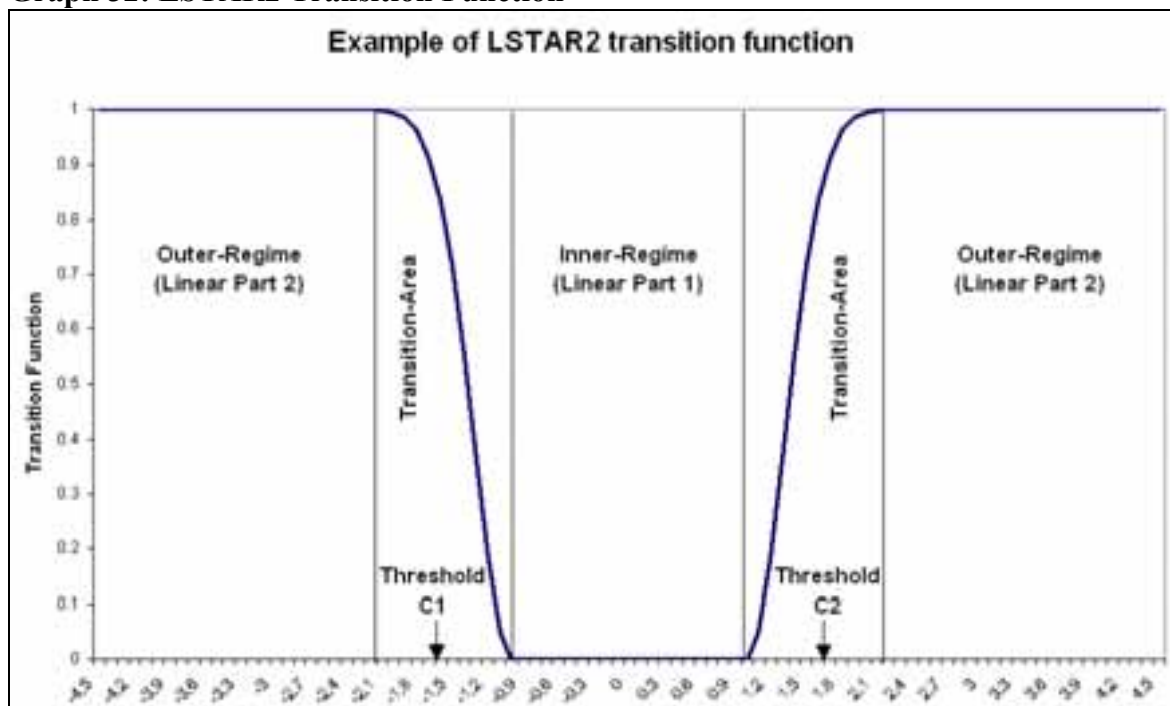
For $K=1$ the model is able to characterize asymmetric behaviour in rising and falling stock markets, if s_t measures stock market returns, and is then called LSTAR 1 model (effectively equivalent to a logistic STAR model). This is because the transition function

follows a logistic function as well (Maddala 1977). In the case of similar behaviour for very positive or very negative returns (outer regime) but a different behaviour in between (inner regime), $K=2$ is the relevant framework as described by Öcal and Osborn (2000) and van Dijk and Franses (1999). In this case it is called LSTAR 2 model (to some extent comparable to an exponential STAR model). The LSTAR 2 model is generally an alternative to the exponential STAR model. However, the LSTAR 2 model has the advantage of having one parameter more and thus being more flexible. The exponential STAR model has a major disadvantage in comparison to the LSTAR 2 model because when $\gamma \rightarrow \infty$, the model becomes linear for the transition function being zero at $s_t = c_1^*$ and unity otherwise. As a result, when γ is large and $c_2 - c_1$ is at the same time not close to zero, the exponential STAR model is not a good alternative to the LSTAR 2 model. In this case a LSTAR 2 model is preferable (for a discussion see Lütkepohl and Krätzig 2004). The charts below show a typical LSTAR1 and LSTAR2 transition function.

Graph 31: LSTAR1 Transition Function



Graph 32: LSTAR2 Transition Function



On the empirical side, STAR models have found many applications to macroeconomic time series. For instance Granger and Teräsvirta (1993) apply a STAR model to the relationship between US GNP growth and leading indicators while Skalin and Teräsvirta (1999) use a STAR approach to examine the Swedish business cycles. However, in the finance literature most empirical applications have only emerged recently. One of the exceptions is Sarantis (1999) where the author applies a STAR model to analyse non-linear behaviour in the G-10 exchange rates on a monthly frequency. The idea is that there are periods of appreciating and depreciating exchange rates during the 1980 to 1996 period where two distinct regimes are expected to be at work. In the STAR framework, the results show a smooth transition between the regimes and support the hypothesis of smooth transition autoregressive behaviour. Franses and van Dijk (2000) apply STAR models to the weekly return of the Dutch Guilder and do find nonlinear behaviour of the currency. McMillan (2001b) applies logistic and exponential STAR applications to model the US stock market in a multivariate framework on a monthly frequency. The author finds

evidence of possible nonlinear threshold behaviour between stock market returns and interest rates, both long and short-term. McMillan (2002) as well as Aslanidis (2003) apply exponential and logistic STAR models to UK stock market returns on quarterly frequency and again find evidence of nonlinear behaviour. McMillan (2002) reports evidence of nonlinear relationship between the FTSE and dividend yield, 3-month T-bill as well as industrial production, whereas Aslanidis (2003) finds a nonlinear relationship between the FTSE and lags of the FTSE, the S&P500 as well as UK GDP.

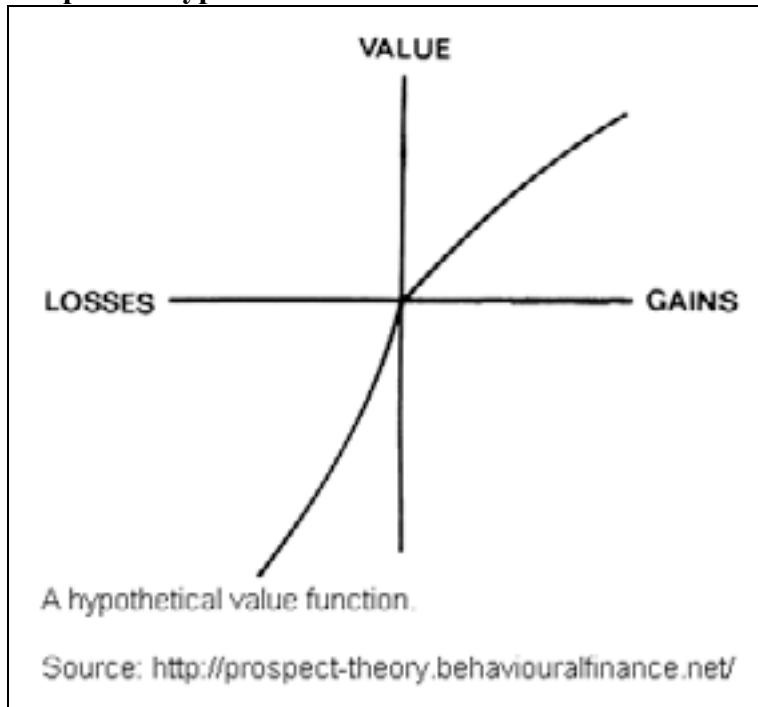
4.3 Behavioural Finance and non linearity

In recent years the traditional financial and economic theory has been enriched by the consideration of psychology and human behaviour. In contrast to traditional economic theory of rational utility-maximizing economic agents, behavioural finance postulates irrationality or non-standard preferences of at least some investors that result in non-standard behaviour (Campbell 2000).

A good starting point to explain the idea of behavioural finance is embedded in the well known prospect theory developed by economics Nobel laureate Daniel Kahneman (for a general discussion of the prospect theory see Kahneman and Tversky 1979). In general, prospect theory is an alternative to the traditional theory of expected utility-maximisation to explain rational behaviour under uncertainty (Neumann and Morgenstern 1947). The reason why we have not included behavioural finance theory in the chapter about asset pricing theory is because it starts with looking at anomalies in human behaviour and then tries to build a theory that fits the facts. Therefore, behavioural finance theory is a descriptive theory and forms models inductively compared to deductive theories that are formed from axioms (Thaler 1994a, 1994b).

Kahneman and Tversky (1979) have build prospect theory on the basic principles of perception and judgment that predict that humans perceptual apparatus has been created to evaluate changes and differences rather than absolute magnitudes. For that reason they propose that carriers of value are changes in wealth rather than the final state of wealth. Thus people's response depends on past and present experience that defines a reference point, as well as stimuli that are noticed in relation to this point (Helson 1964, Kahneman and Tversky 2000). As a result, prospect theory sees "value" as a combination of asset position (reference point) and the magnitude of change (positive or negative) from that point. Applying this idea to stock market investors, it means that investors' behaviour depends on the past stock market development (rising or falling market) as a reference point and the magnitude of change (small or large fluctuations). Furthermore, psychology predicts that psychological response is a concave function of the magnitude of physical change. Thus, the difference in value between a gain of 100 and a gain of 200 appears to be greater than the difference between a gain of 1100 and a gain of 1200 (Kahneman and Tversky 2000). Furthermore, the difference in value between a loss of 100 and a loss of 200 appears to be greater than the difference between a loss of 1100 and a loss of 1200. This means that the value function for changes of wealth is normally concave above the reference point and often convex below this point. In addition, the marginal value of gains and losses tends to decrease with the magnitude. It has also been found that the annoyance one experiences in losing a particular sum of money happens to be greater than the enjoyment of winning the same amount of money. For stock market investors this means that risk attitudes are different in falling and rising markets. The chart below shows such a hypothetical value function:

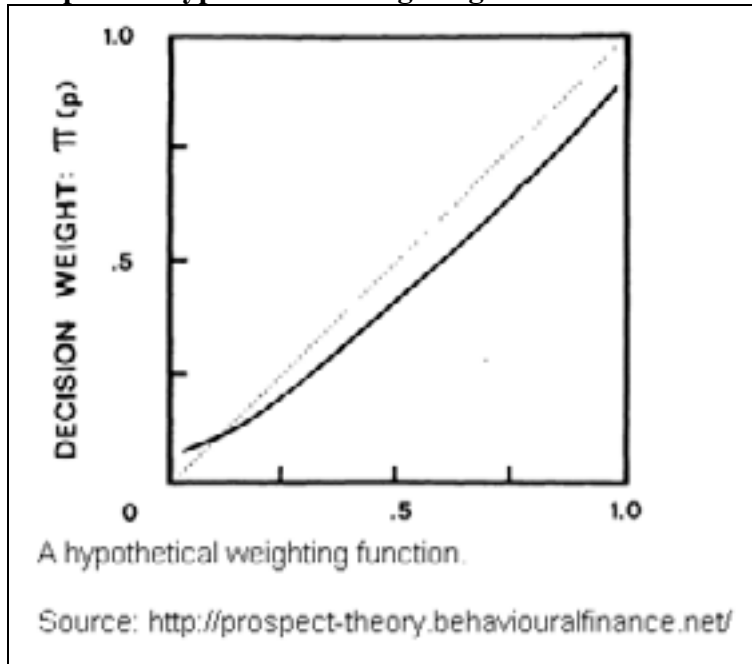
Graph 33: Hypothetical Value Function



The above value function satisfies the properties of reference point dependents, concave for gains, convex for losses and steeper for losses than for gains. In stark contrast to the utility function, the value function is steepest at the reference point.

Prospect theory applies decision weights as multipliers for the value of an outcome. Those decisions weights are derived from individual preferences as well as subjective probabilities. Generally it has been found that for low probabilities, individuals' decision weights are larger than the corresponding probabilities. For instance, people tend to prefer a bet with 1% probability of winning 6000 USD over a 2% probability of winning 3000 USD (Kahneman and Tversky 2000). However, for larger probabilities, individual decision weights are smaller than the corresponding probabilities. The next chart shows a hypothetical weighting function:

Graph 34: Hypothetical Weighting Function



Another fact captured by prospect theory is that people prefer a 0,1% chance of getting 5000 USD over a 100% probability of getting 5 USD, whereas they prefer a certain loss of 5 USD over a 0,1% chance of losing 5000 USD.

Overall, prospect theory has shown that human beings are not necessarily making rational decisions only. As a result, decisions can also be made due to emotions. Furthermore, the value and weighting function give reason to suspect non-linear behaviour in many economic relationships due to human behaviour.

The theoretical explanation of non-linear conditional mean behaviour in financial markets can be based on the idea of noise traders and informed traders' interactions. In the framework of efficient markets, it is not necessary that all participants in the market are equally well informed. There can be irrational noise traders or momentum players (Hong and Stein 1998) who do not quote prices equal to fundamentals. The efficient market hypothesis (EMH) only requires that there is sufficient smart money to recognise that the

price of the asset will eventually equal the fundamental value and step in accordingly (Cuthbertson 2000). However, if there exists some herd behaviour or there are many noise traders (Shleifer 2000) and we assume trading costs (Dumas 1992 and 1994), smart investors or arbitrage traders will only step in after the mis-pricing has moved above a certain threshold. Thus fundamental deviations must be large enough for arbitrageurs to get involved (He and Modest, 1995). As a result, the stock market behaviour close to the fair price might be different from prices that are further away from fundamentals due to different interactions between noise traders and informed traders. This gives reason to suspect two regimes for stock market valuation measures such as the price-earnings ratio or the dividend-yield. One regime is close to the fundamental value (of the price-earnings ratio or dividend-yield) and the other regime is further away from fundamental value. The inner regime that is close to the fundamental value allows for noise and momentum traders. However, in the outer regime that is further away from fair value, fundamental traders force the market back to the inner regime that is close to fundamental value.

Shleifer and Vishny (1997) have analysed the limitations of arbitrage. The authors argue that in reality arbitrage is usually conducted by relatively few professional traders, who are highly skilled and combine their knowledge with resources of outside investors to take large positions. Hence, brains and resources of arbitrage are separated by an agency relationship in such a case. Usually the money comes from banks or wealthy individuals with only limited knowledge of individual markets, and is then invested by highly skilled arbitrageurs. Furthermore, arbitrage is risky and not capital free since a security must be bought before it can be sold and stock borrowing costs can be very high. In general if stock markets are volatile, the arbitrageur is faced with the problem that the share prices could move even further away from their fair price and the arbitrage opportunity results in losing money. When the arbitrageur manages other people's money and these people do not know

or understand exactly what he or she is doing, they will only observe them losing money when stock prices move further away from their fundamental prices. In such a case, the investors might infer from this loss that the arbitrageur is not as good as they previously thought and stop providing him with more capital. Therefore, when arbitrage requires capital, arbitrageurs can become constrained even when they have the best opportunities. This is the case when the mis-pricing they have bet against gets even worse. As shown before, in behavioural finance Kahneman and Tversky (1979) have shown non linear risk aversion in human decision making. Thus, they have shown that subjective response to probability is non-linear. Assuming the majority of market participants are long only investors, this implies that stock market participants are likely to show different behaviour in rising markets, where they tend to have gains, compared to falling markets where they are more likely to have losses.

Furthermore, Lola Lopes (1987) identifies the major emotions that influence investors' risk-bearing over time. It is found that hope and fear can play a dominant role in the decision-making process. Thus an investor might be driven by loss aversion or greed as long as the overall financial situation is favourable, whereas some sort of economic or political distress might change investors' behaviour to being driven by fear (Shefrin, 2000). As discussed above, Kahneman and Tversky (2000) recognise that the difference between a loss of 100 and a loss of 200 appears greater than the difference between a loss of 1100 and a loss of 1200, unless the larger loss is intolerable. This indicates that there might be a threshold, where people are forced to realise losses and the overall loss aversion is switching to limiting the damage. Lola Lopes (1987) distinguishes between risk-seeking investors who are motivated by the desire for potential and risk-averse investors who are motivated by the desire for security. She points out that investors are generally aware of both poles but attach different weightings to the two goals. However, she proposes that

investors' attitudes can change over time and in certain periods one prefers potential, whereas during other periods the same person prefers security. These theoretical considerations can also be used to motivate the application of smooth transition regression models, where we can distinguish between rising and falling stock markets.

4.4 Data selection, sources and construction of primary variables

In chapter 3, we have used a simple present value model to motivate our variable selection and in this chapter we will identify some additional variables that might impact stock prices. For the motivation of the originally used variables see chapter 3.4 whereas the additional variables will be motivated in this chapter.

Here, we extend our empirical analysis by making use of the following US variables: the real S&P 500 price (SP500), the S&P 500 dividend yield, real Industrial Production (IndProd), CPI, real M2, real ten year T-Bond yield, real 3 month T-Bill rate, real retail sales, OECD G7 leading indicator, YENUSD exchange rate, the corporate BAA risk spread over 10 year government bonds and the term spread measured between the 10-year bond yield and 3-month T-Bill rate. For Japan the real Nikkei 225, Nikkei 225 dividend yield, real Industrial Production, CPI, real M2, real ten-year bond yield, the real 3-month interest rate, real retail sales, OECD G7 leading indicator, YENUSD exchange rate, the corporate risk spread over 10-year government bonds and the term spread measured between the 10-year bond yield and 3-month interest rate are used.

The data has monthly frequency and the sample runs from January 1981 until June 2006 due to data availability. Since industrial production, M1, CPI and the retail sales time

series show strong seasonality, seasonally adjusted data were used. Sources of the data are outlined in the following two tables.

<i>US DATA SET</i>					
Variable	Name	Sample	Source	Code	SA* or NSA**
SPX	S&P 500 Stock Index	1981:M1-2006M6	Bloomberg/ Robert Shiller	SPX Index	NSA
SPX Dividend Yield	S&P 500 Stock Index Dividend Yield	1981:M1-2006M6	Robert Shiller home page	See Robert Shiller home page: www.econ.yale.edu/~shiller/data/ie_data.xls	NSA
IndProd	Industrial Production	1981:M1-2006M6	IMF	11166..CZF...	SA
CPI	Consumer Price Index	1981:M1-2006M6	IMF	11164..ZF...	NSA Will be SA
M2	Money Supply M2	1981:M1-2006M6	OECD	OEUSM001	SA
10Y	10 Year Interest Rate	1981:M1-2006M6	IMF	11161...ZF...	NSA
3M Rate	3 month t-bill rate	1981:M1-2006M6	OECD	OEUSR009	NSA
Retail Sales	US Retail Sales	1981:M1-2006M6	OECD	OEUSD003	SA
OECD	OECD G7 Leading Indicator	1981:M1-2006M6	OECD	OLEDG7	SA
YENUSD	YENUSD	1981:M1-2006M6	IMF	158.013	NSA
Corporate BAA Yield	US Corporate BAA Yield (Moody's)	1981:M1-2006M6	Datastream	FRCBBAA	NSA
* SA denotes seasonal adjusted data					
** NSA denotes not seasonal adjusted data					

<i>JAPANESE DATA SET</i>					
Variable	Name	Sample	Source	Code	SA or NSA
NKY	Nikkei 225	1981:M1-2006M6	Datastream	JAPDOWA	NSA
NKY Dividend Yield	Nikkei 225 Stock Index Dividend Yield	1981:M1-2006M6	Merrill Lynch Capital Markets	JPDivYield	NSA
IndProd	Industrial Production	1981:M1-2006M6	IMF	15866..CZF...	SA
CPI	Consumer Price Index	1981:M1-2006M6	IMF	15864...ZF...	NSA Will be SA
M2	Money Supply M2	1981:M1-2006M6	Bank of Japan	JPM2....A	SA
10Y	10 Year Interest Rate	1981:M1-2006M6	Bank of Japan/ Datastream	JPGOVGRT	NSA
3M Rate	3 month interest rate	1981:M1-2006M6	Eurostat	JPESTBIL	NSA
Retail Sales	Japanese Retail Sales	1981:M1-2006M6	OECD	OEJPD005	SA
OECD	OECD G7 Leading Indicator	1981:M1-2006M6	OECD	OLEDG7	SA
YENUSD	YENUSD	1981:M1-2006M6	IMF	158.013	NSA
Corporate Bond Yield	Corporate Bond Yield	1981:M1-2006M6	Bank of Japan / Datastream	JPQCBDMEA	NSA
* SA denotes seasonal adjusted data ** NSA denotes not seasonal adjusted data					

Most existing research relates to US data and very little is known about non-linear stock market behaviour in Japan. Thus the aim of this chapter is to investigate the differences and common patterns in both countries. Furthermore, we want to verify whether non-linear stock market behaviour can be found and if the same variables can explain aggregate stock market moves in the US and in Japan. This complements the research reported in chapter 3. In contrast to the cointegration model in chapter 3, the non-linear model is able to distinguish between positive and negative returns or large and small returns. As discussed

in chapter 1.1.1 and chapter 3.3, the US and Japanese stock market have experienced large price fluctuations over the last 40 years. In particular the 1980s in Japan and the 1990s in the US are characterised by large positive stock returns. On the other hand, the 1990s in Japan and the years 2001 and 2002 in the US showed large negative stock market returns. We expect different stock market behaviour in periods of positive and negative or large and small stock market returns.

The dividend yield is one of the new variables, as it has often been reported to have predictive power for future stock market returns. The idea that the dividend yield ratio can forecast future stock returns is as old as Dow (1920) who originally hypothesised this ability. The rationale behind that idea is that when dividends are high compared to prices, the discount rate and thus the expected return is high (and vice versa). Other authors who have found the dividend yield to forecast future stock prices well include Ball (1978), Rozeff (1984), Shiller (1984), Campbell and Shiller (1988a), Fama and French (1988, 1989), Fama (1990), Flood, Hodrick and Kaplan (1994), and Black, Fraser and MacDonald (1997),

In addition to traditional regressors, we have also selected retail sales as an independent variable for the stock market return model. The idea behind this selection is based on consumption based asset-pricing theory discussed in chapter 2.2.1. The theory predicts that risk corrections to asset prices are determined by the co-variance between consumption or marginal utility and the asset's payoffs. As aggregate consumption data is only available on a quarterly basis, we have used retail sales instead. It is clear that retail sales do not include durable goods, and industrial consumption is neglected as well. Nonetheless, retail sales should give a good approximation for the general consumption mood in the economy and we therefore apply this variable as a proxy for consumption. For instance Hansen and

Singleton (1982, 1983) have investigated a canonical consumption based model with a representative investor that has time separable power utility of consumption (C-CAPM). However, the findings show that this model cannot simultaneously explain the time variation of interest rates and the cross section of average returns on stocks and bonds (for a discussion see Campbell and Cochrane 2000). Also Wheatley (1988) rejects the C-CAPM for an international data set. While the C-CAPM has generally been rejected for the US, Hamori (1992) finds evidence in favour of the C-CAPM in Japan. Retail sales as approximation for consumption has been used in the literature before. For instance Burgstaller (2002) has modelled the relationship between retail sales and the aggregate stock market. The author finds a negative relationship between retail sales and the stock market in Austria, Japan and the US. Furthermore, it is argued that this is in line with the C-CAPM predictions and also supports the neo classical general equilibrium model of Ho and Hoon (1995).

As proxy for international economic growth we have used the OECD G7 leading indicator. The advantages of this variable are manifold. Especially Japan as an export-driven country might depend on international growth rather than domestic developments only. The OECD composite G7 leading indicator has been reported to predict future output (for a discussion see inter alia Nilsson 1987, Sensier, Artis and Osborn 2002, as well as Osborn and Sensier 2002). For stock market prediction, Lambrick (2006) has found evidence of the OECD leading indicator having predictive power for the Australian stock market. Furthermore, Sløk and Kennedy (2004) have shown that the OECD G7 leading indicator drives the risk premia, whereas for instance Burgstaller (2002) as well as Cauchie, Hoesli and Isakov (2003) find a positive relationship between OECD G7 industrial production and stock prices. As the OECD leading indicator is constructed out of international financial and macroeconomic factors, it could be argued that this implies colinearity with the other

included variables³⁶. However, it should be kept in mind that we use the G7 leading indicator and as such there will be only a minor overlap with our data set (there are another 5 countries in the G7 indicator). Further, we only use lagged values of the OECD leading indicator (as a result there is no perfect overlap).

In addition, the exchange rate can play a key role in an export-driven country like Japan. For this reason we also include the YENUSD exchange rate as an independent variable. It can be hypothesized that when the Japanese Yen depreciates against the USD, Japanese goods become cheaper in the US and Japanese exports should rise due to higher demand. As a result, Japanese corporate cash flows denominated in YEN should increase and share prices rise. For instance Mukherjee and Naka (1995) have found a positive relationship between YENUSD exchange rate and the Japanese stock market. Other authors who found the exchange rate to have forecasting power for stock prices include Brown and Otsuki (1990), Gjerde and Frode (1999), Hondroyiannis and Papapetrou (2001), Burgstaller (2002) and Järvinen (2000).

The corporate risk spread as a business cycle variable that can forecast stock market returns was first suggested by Fama and French (1989). We construct the risk spread as the difference between corporate bond yield with 10-year maturity and the treasury 10-year

³⁶ In the OECD G7 leading indicator, the US has a total weight of 42.4% and Japan of 19.5%. In Japan, the TOPIX accounts for 3.08% and Money supply for 19.87% in the Japanese OECD leading indicator. However, in the indicator the TOPIX is used as stock market variable and we use the Nikkei 225. For money supply the variables are different as well because we use M2 and the OECD leading indicator uses M2+CDs. Overall, technically there is no real overlap between the OECD G7 leading indicator and the variables we have used for the analysis in Japan. In the US, the stock market accounts for 3.77% and money supply for 35.35% in the US OECD leading indicator. The variables are the S&P500 and M2 for OECD and in our analysis. Thus the real overlap between the OECD G7 leading indicator and our variables are 1.59% for the S&P500 and 14.9% for money supply M2 in the US analysis. However, as we only use lagged values of the OECD leading indicator, there is no perfect relationship constructed in the analysis and one could only argue that the stock market has some autoregressive behaviour that we do not account for directly but indirectly by the OECD leading indicator. Furthermore, our analysis in the US finds a negative relationship with M2 lagged 12 month as well as a positive relationship with the OECD G7 leading indicator lagged 1 month and the S&P500. So again, there is technically no perfect overlap as the lag are very different and of positive and negative nature.

bond yield. Generally it has been found that a large risk spread predicts higher future stock returns, whereas a small risk spread points to smaller future stock market returns (For discussions see Fama and French (1989) and Black, Fraser and Macdonald (1997)).

Another business cycle variable that has been found to be able to forecast future stock market returns is the term spread. The term spread as a stock market variable was also first suggested by Fama and French (1989). We construct the term spread as the difference between 3-month Treasury bills and the 10-year Treasury bond yield. Generally it has been found that a large term spread predicts larger future stock market returns and vice versa (for discussions see inter alia Fama and French (1989) and Black, Fraser and Macdonald (1997)).

4.5 Plots of time series, mean, standard deviations and autocorrelations

In a first step we examine plots of the time series, mean and standard deviations (for mean, standard deviation, kurtosis, skew and Jarque-Bera probabilities see table 36 and 37 on pages 257 and 258).

Secondly, in table 38 and 39 (on pages 258 and 259) we show the cross correlations between the different time series in the US and Japan. In the US we find a positive correlation between the risk premium, YEN exchange rate, OECD leading indicator, 3 month t-bill rate and the stock market. The largest positive correlation is between the OECD leading indicator and the stock market. While the positive correlation between the risk premium, the OECD leading indicator and the stock market has been expected, the positive correlation between the 3 month t-bill rate and the stock market has not been

expected. However, the 3-month t-bill rate is closely linked to the Federal Reserve (FED) central bank rate. As policy makers tend to set interest rates countercyclical, FED funds rate might be high during booms and low during recessions. As a result we might find a positive correlation between short-term interest rates because the stock market does well during booms and poorly during recessions. Furthermore, we find negative correlations between retail sales, the 10-year bond yield, money supply, industrial production, CPI, the dividend yield, the term-spread and the stock market in the US. The largest negative correlation is reported between the dividend yield and the stock market. This is not as expected, but might be explained by the following. Dividends tend to be relatively stable in the short-run as the dividend policy is not set on a daily basis but at the annual general meeting of a listed company. Furthermore, corporations have to decide whether to use excess capital for dividends or share repurchases. As a result, dividends are managed and might be smoothed (for a discussion see Grullon and Michaely 2002). Therefore, the short-term fluctuations in the dividend yield are solely caused by stock price fluctuations. As a result, a positive share price move causes the dividend yield to fall, at least in the short-term. Hence, over short periods the dividend yield and share price returns must be negatively correlated. However, over longer periods we still expect a positive correlation between stock returns and the dividend yield. Furthermore, the negative correlation between the 10-year bond yield, CPI and the stock market is as expected as well. On the contrary, the negative correlation between the term-spread and share prices is not as expected. However, most correlation coefficients are quite small and the regression analysis has to prove the statistical significance of the coefficients before we can make further conclusions. In Japan we find a positive correlation between retail sales, OECD leading indicator, money supply, industrial production, the 10-year bond yield, the YEN exchange rate and the stock market. As in the US, the highest positive correlation exists between the OECD leading indicator and the stock market. Furthermore, the positive

correlation between industrial production and the stock market supports our hypothesis that stock prices are correlated with output. This has also been supported by the cointegration analysis in chapter 3. The positive correlation between the 10-year bond yield and stock prices is unexpected and might be caused by the deflationary period in Japan as we have explained in chapter 3.8.1. Furthermore, we report negative correlations in table 39 (on page 259) between the dividend yield, CPI, 3 month t-bill rate, the risk premium, the term premium and the stock market. While the negative correlation between CPI, the dividend yield and the stock market is as expected, the negative correlation between the term premium, risk premium, dividend yield and the stock market is unexpected. However, as mentioned before, most correlation coefficients are quite small and the regression analysis has to prove the statistical significance of the coefficients before we can make further conclusions.

Finally, the plots of the time series give us an idea as to the statistical properties. It should be mentioned that all series are normalised on 100 for the start date January 1965, except for the dividend yield, interest rates, the risk spread and the term spread. The interest rate is used as R , thus equals one plus the interest rate. The graphs show the logarithm of the constructed data and the first difference (see graphs 35 to 49 on pages 259 to 266). All series seem to trend and appear to have high autocorrelations in levels. The first difference of the data seems stationary. So overall, we would expect the data to be $I(1)$.

4.6 Empirical Methods

4.6.1 Unit Root tests

In order to verify the stationarity of the variables we will apply the augmented dickey fuller test. For the smooth transition regression models that we will apply to our data set it is important that the variables are stationary. A detailed description of the augmented Dickey Fuller test can be found in chapter 3.6.1 of this thesis.

4.6.2 Non linear estimation procedure

In order to estimate the smooth transition auto regression model, we follow a specific modelling cycle described by *inter alia* Granger and Teräsvirta (1993), Franses and Dijk (2000) and Lütkepohl and Krätzig (2004). This modelling cycle incorporates three stages, namely specification, estimation and evaluation (see Eitrheim and Teräsvirta 1996 and Teräsvirta 1998). In this section we discuss the three different steps (we mainly follow Lütkepohl and Krätzig 2004 as we use their econometrics software JMulti³⁷ for the empirical investigation).

As a first step, an appropriate linear autoregressive model of order p [AR(p)] for the variables in question must be specified. Thus a general to specific strategy is used to set up the basis for the non-linear model (Granger and Teräsvirta 1993). A specific to general strategy starts with the number of lags that are selected by the lag-selection criteria and then the least significant variable is dropped out at each stage until all remaining variables are significant for the re-estimated model. One should bear in mind that a smooth transition autoregressive model nests a linear model and the underlying process could be generated

³⁷ For the econometrics software see: www.jmulti.com

by a linear model instead of the non-linear framework. Thus the specific to general method is appropriate to generate a first model for the underlying process and is also the basis for testing linearity against non-linearity. Although the lag structure of the linear model is not necessarily the adequate lag structure for the alternative STAR model, it generally provides a good approximation. Moreover, reducing the number of lagged variables increases the degrees of freedom and this can be important especially in the multivariate case.

Once an appropriate linear model is identified and estimated, linearity is tested versus non-linearity. As with other non-linear models, the STR model has the property of being only identified under the alternative, not the null hypothesis of linearity (see for instance Hansen 1996). The resulting identification problem in testing linearity in the STR context can be overcome by approximating the transition function by a Taylor expansion around the null hypothesis $\gamma=0$ in:

(the model has been described in detail in chapter 3.2.2)

$$x_t = \phi' z_t + \theta' z_t G(\gamma, c, s_t) + \varepsilon_t, \quad \varepsilon_t \sim iid(0, \sigma^2) \quad (4.6.1)$$

where

$$G(\gamma, c, s_t) = \left(1 + \exp \left\{ -\gamma \prod_{k=1}^K (s_t - c_k) \right\} \right)^{-1}, \quad \gamma > 0. \quad (4.6.2)$$

Usually it is assumed that $K=1$ and a third-order Taylor expansion is applied (for a discussion see Teräsvirta 1998). However, the test has also power against a LSTAR model with $K=2$ and can therefore be used for both, LSTAR1 and LSTAR2 models.

Now it is assumed that the transition variable s_t is an element in z_t and that $z_t = (1, \tilde{z}_t')'$,

where \tilde{z}_t is an $(m \times 1)$ vector. After merging terms and reparameterizing, the approximation yields the following auxiliary regression (Lütkepohl and Krätzig 2004):

$$x_t = \beta'_0 z_t + \sum_{j=1}^3 \beta'_j \tilde{z}_t s_t^j + \varepsilon_t^*, \quad t = 1, \dots, T, \quad (4.6.3)$$

Where $\varepsilon_t^* = \varepsilon_t + R_3(\gamma, c, s_t)\theta' z_t$ with the remainder $R_3(\gamma, c, s_t)$. The null hypothesis is $H_0 = \beta_1 = \beta_2 = \beta_3 = 0$ because each $\beta_j, j = 1, 2, 3$, is of the form $\gamma \tilde{\beta}_j$, where $\tilde{\beta}_j \neq 0$ is a function of θ and c . Hence this is a linear hypothesis in a linear model. Since $\varepsilon_t^* = \varepsilon_t$ under the null hypothesis, if an LM-type test is applied, we can apply the standard asymptotic distribution theory. The resulting test statistic has an asymptotic χ^2 -distribution with $3m$ degrees of freedom when the null hypothesis is valid (Lütkepohl and Krätzig 2004). However, in small and even moderate samples, the χ^2 -statistic can have a severe size distortions. For this reason the corresponding F - statistic is recommended instead. The econometrics software JMulti that we will use applies, as default, automatically the F – version of the linearity test.

In case linearity is rejected, the type of non-linear model must be specified. In the STAR framework we have two choices, namely $K=1$ or $K=2$ ($K=1$ leads to an LSTAR1 model and $K=2$ to LSTAR2). Again, the selection of the model can be based on the auxiliary regression we have used before:

$$x_t = \beta'_0 z_t + \sum_{j=1}^3 \beta'_j \tilde{z}_t s_t^j + \varepsilon_t^*, \quad t = 1, \dots, T. \quad (4.6.4)$$

The coefficient vectors $\beta_j, j = 1, 2, 3$, are functions of the parameters in:

$$x_t = \phi' z_t + \theta' z_t G(\gamma, c, s_t) + \varepsilon_t, \quad \varepsilon_t \sim iid(0, \sigma^2). \quad (4.6.5)$$

In the specific case that $c = 0$, it can be shown that $\beta_2 = 0$ when an LSTAR1 model is appropriate whereas if $\beta_1 = \beta_3 = 0$ an LSTAR2 model is selected (Teräsvirta 1994).

However, even if $c \neq 0$ it can be shown that β_2 is closer to the null vector than β_1 or β_3 when the null is an LSTAR1 model and vice versa for the LSTAR2 model. This gives us the following test sequence for LSTAR1 versus LSTAR2 in:

$$x_t = \beta'_0 z_t + \sum_{j=1}^3 \beta'_j \tilde{z}_t s_t^j + \varepsilon_t^*, \quad t = 1, \dots, T. \quad (4.6.6)$$

1. Test the null hypothesis $H_{04} : \beta_3 = 0$
2. Test $H_{03} : \beta_2 = 0 \mid \beta_3 = 0$
3. Test $H_{02} : \beta_1 = 0 \mid \beta_2 = \beta_3 = 0$.

In case the test of H_{03} yields the strongest rejection in terms of the p-value, the LSTAR2 model is selected, whereas otherwise the LSTAR1 model is preferred. Since all three hypotheses can simultaneously be rejected at conventional significance levels, the strongest rejection provides a valid model selection procedure (for a discussion see Täresvirta 1994 and Lütkepohl and Krätzig 2004). We will use the econometrics software JMulti to apply this test and choose between the LSTAR1 and LSTAR2 models.

If linearity is rejected against STR, the modelling cycle requires initial estimates for the parameters in the non-linear model, before using an optimisation algorithm to find the true parameters in the non-linear model. Good initial estimates are necessary to make the optimisation algorithm work well. The most popular way of obtaining initial values is by applying a grid search technique. When γ and c in the transition function are fixed, the STAR model becomes linear in parameters. Thus one uses different values of γ and c to calculate the remaining parameters ϕ and θ conditional on (γ, c_1) or (γ, c_1, c_2) for an LSTAR2 model. It is important to note that the fixed values of the transition function make

the STR model linear in the remaining coefficients and those can be estimated by an OLS regression (Aslanidis 2002). Furthermore the sum of squared residuals is calculated and the preferred initial values are given by the parameter combinations with the minimum sum of squared residuals. It should be noted that γ is not a scale free parameter and the exponent of the transition function is therefore standardized by dividing it by the K-th power of the sample standard deviation of the transition variable s_t (Lütkepohl and Krätzig 2004). This makes the slope parameter γ scale free and makes the construction of a grid search effective.

In the case where γ is large and the transition regression is close to a switching regression model, the estimation of γ becomes difficult in small samples. This is because determining the curvature of the non-linear STR model requires many observations in the neighbourhood of c or c_1 and c_2 respectively. It is rather unlikely that such clusters can be found in small samples (Bates and Watts 1988, Teräsvirta 1994, 1998). The problem is that the standard deviation estimate of $\hat{\gamma}$ becomes large. The resulting small value of the t – ratio does not, in that case, suggest redundancy of the non-linear component $\hat{\gamma}$. It should be also noted that the identification problem mentioned earlier invalidates the standard interpretation of the t – ratio as a test of the hypothesis $\gamma = 0$ (Lütkepohl and Krätzig 2004).

Once initial values are found, the parameters of the STR model can be estimated by using conditional maximum likelihood. The log-likelihood is maximized numerically; the econometrics software JMulti uses the iterative BHGS algorithm with numerical derivatives for this purpose (for a discussion of the optimisation algorithm see Hendry 1995).

4.6.3 Diagnostic and Forecasting tests

As with linear models, the estimated STAR model must be evaluated before it can be used for forecasting purposes. For this reason we will perform some misspecification tests for non-linear STR models in order to evaluate the estimated model. In general the non-linear misspecification tests are generalisations of the corresponding tests for the evaluation of linear models.

One important feature that must be tested for is the absence of autocorrelation in the errors. The test for no autocorrelation used for STAR models is a specific form of the Lagrange multiplier (LM) test developed by Godfrey (1978, 1988). Assume that $M(z_t; \psi)$ is at least twice continuously differentiable with respect to the parameters in the sample space and the model:

$$x_t = M(z_t; \psi) + \varepsilon_t, \quad t = 1, \dots, T, \quad (4.6.7)$$

With $\varepsilon_t = \alpha' v_t + \mu_t$ and $\alpha = (\alpha_1, \dots, \alpha_q)'$, $v_t = (\varepsilon_{t-1}, \dots, \varepsilon_{t-q})'$, where $\mu_t \sim iid N(0, \sigma^2)$.

The null hypothesis of no-error autocorrelation against the alternative of autocorrelation of at most order q in ε_t is $\alpha = 0$ (Lütkepohl and Krätzig, 2004). As the STR model satisfies the differentiability condition for $\gamma < \infty$, the Godfrey LM test for the STR model as discussed in Teräsvirta (1998) can be applied. The test regresses the residuals $\tilde{\varepsilon}_t$ of the estimated STR model on the lagged residuals $\tilde{\varepsilon}_{t-1}, \dots, \tilde{\varepsilon}_{t-q}$ and the partial derivatives of the log-likelihood function with respect to the parameters of the model are evaluated in maximizing $\psi = \tilde{\psi}$. The test statistic is given by:

$$F_{LM} = \{ (SSR_0 - SSR_1) / q \} / \{ SSR_1 / (T - n - q) \}, \quad (4.6.8)$$

Where n is the number of parameters in the model, SSR_0 is the sum of squared residuals of the STR model and SSR_l the corresponding sum from the auxiliary regression shown above (Lütkepohl and Krätzig, 2004). The test has an approximate F-distribution with q and $T-n-q$ degrees of freedom under the null hypothesis. It should be noted that the F-version of the test is preferable to the corresponding χ^2 - statistic based on the asymptotic distribution theory due to severe size distortions in small and moderate samples.

Another test that can be performed is the Jarque-Bera normality test. Lomnicki (1961) and Jarque and Bera (1987) build their non-normality test on the skewness and kurtosis of a distribution where the following hypotheses are tested:

$$H_0 : E(\varepsilon_t^s)^3 = 0 \text{ and } E(\varepsilon_t^s)^4 = 3 \quad \text{vs.} \quad H_1 : E(\varepsilon_t^s)^3 \neq 0 \text{ or } E(\varepsilon_t^s)^4 \neq 3 \quad (4.6.9)$$

where ε_t^s denotes the standardized true model residuals $\varepsilon_t^s = \varepsilon_t / \sigma_u$ while the standardized estimation residuals are denoted by $\hat{\varepsilon}_t^s$. The resulting test statistic is given by:

$$JB = \frac{T}{6} \left[T^{-1} \sum_{t=1}^T (\hat{\varepsilon}_t^s)^3 \right]^2 + \frac{T}{24} \left[T^{-1} \sum_{t=1}^T (\hat{\varepsilon}_t^s)^4 - 3 \right]^2, \quad (4.6.10)$$

where $\left[T^{-1} \sum_{t=1}^T (\hat{\varepsilon}_t^s)^3 \right]$ is the estimator for skewness and $\left[T^{-1} \sum_{t=1}^T (\hat{\varepsilon}_t^s)^4 - 3 \right]$ is the estimator

for kurtosis of the distribution. The test statistic follows an asymptotic $\chi^2(2)$ - distribution and the null hypothesis is rejected if JB is large and thus a normal distribution is rejected as well (for a discussion see also Lütkepohl and Krätzig 2004).

It will be of further interest to test whether there is remaining conditional heteroskedasticity (ARCH) in the estimated non-linear model. One way of testing for remaining ARCH effects in the estimated model is by applying the ARCH LM test. This test is based on fitting an ARCH(q) model to the estimated residuals:

$$\hat{\varepsilon}_t^2 = \beta_0 + \beta_1 \hat{\varepsilon}_{t-1}^2 + \dots + \beta_q \hat{\varepsilon}_{t-q}^2 + \mu_t \quad (4.6.11)$$

where $\hat{\varepsilon}_t (t=1, \dots, T)$ is the residual series whereas the standardized residuals are obtained by dividing by the standard deviation:

$$\hat{\varepsilon}_t^s = (\hat{\varepsilon}_t - \bar{\hat{\varepsilon}}) / \tilde{\sigma}_u. \quad (4.6.12)$$

The test is verifying the null hypothesis:

$$H_0 : \beta_1 = \dots = \beta_q = 0 \text{ vs. } H_1 : \beta_1 \neq 0 \text{ or } \dots \text{ or } \beta_q \neq 0. \quad (4.6.13)$$

An LM test statistic for this problem can be derived by the coefficients of determination R^2 of the regression:

$$\hat{\varepsilon}_t^2 = \beta_0 + \beta_1 \hat{\varepsilon}_{t-1}^2 + \dots + \beta_q \hat{\varepsilon}_{t-q}^2 + \mu_t. \quad (4.6.14)$$

The resulting LM statistic is given by:

$$ARCH_{LM}(q) = TR^2. \quad (4.6.15)$$

The test statistic has an $\chi^2(q)$ - distribution if the null hypothesis of no conditional heteroskedasticity holds (Engle 1982). Generally speaking, large values of the test statistic indicate that H_0 is false and indicates that there might be remaining ARCH effects in the residuals (Lütkepohl and Krätzig 2004).

Since we will use the estimated model for forecasting, it is important to have a statistic that can compare the forecasting power of the different models with each other. Two commonly used statistics for this purpose are the mean absolute error (MAE) and the root mean squared error (RMSE).

The mean absolute error (MAE) is defined as:

$$MAE = \frac{1}{n} \sum_{j=1}^n abs(\hat{\varepsilon}_{t+j}). \quad (4.4.16)$$

Whereas the root mean squared error (RMSE) is defined as:

$$RMSE = \left(\frac{1}{n} \sum_{j=1}^n \hat{\varepsilon}_{t+j}^2 \right)^{1/2}. \quad (4.6.17)$$

Here $\hat{\varepsilon}_{t+j}$ is the forecast error at time $t + j$ and n is the number of forecast periods. For the MAE and RMSE a small value close to zero indicates a good forecasting performance of the model. As a result, these two measures are useful for comparing different models with each other and give a good indication of the goodness of the forecast.

4.7 Empirical Evidence

In the following chapter we will apply the econometric methodologies explained earlier. First, we will apply unit root tests in order to verify the order of integration of the different variables. Second, we will specify an appropriate linear autoregressive model by applying a general to specific strategy. Third, we will test for non-linearity and model a non-linear model between the selected macroeconomic variables and the stock market. Finally, we will evaluate the non-linear results and perform an out of sample forecasting exercise.

4.7.1 Unit Root results

As a first step, unit root tests were performed for all variables in the US and Japanese data. The Augmented Dickey Fuller (ADF) test shows that all variables appear to be $I(1)$ except for the real 10-year yield³⁸ and the riskspread³⁹ in Japan and the termspread in the US which appear to be stationary in levels (see table 40 and 41 on pages 267 and 268). Where

³⁸ Theoretically, real interest rates should be stationary (Walsh 1987). Recent findings suggest real interest rates to be stationary when we account for structural changes (Perron and Vogelsang 1992) or regime changes (Bai and Perron 2003).

³⁹ The risk spread is expected to be stationary, but as others have found before (Li 2003, Bierens, Huang and Kong 2005), we find the US risk spread to be $I(1)$.

necessary, the variables are transformed into stationary series by differencing before including in the following VAR and non-linear analysis.

4.7.2 VAR results

As a next step, an appropriate linear autoregressive model of order p [AR(p)] for the variables in question must be specified. As discussed earlier, we use a general to specific strategy in order to set up the underlying VAR model for the non-linear model (Granger, 1993). In the general to specific strategy we start with the number of lags that are selected by the lag selection criteria and then the least significant variable is dropped out at each stage until all remaining variables are significant for the re-estimated model.

Since the term spread shows perfect colinearity with the long and short interest rates, we test their significance on the stock market separately and then apply the more significant one in the stock market model.

For the Japanese data set we allow for 6 lags in the VAR model since this is suggested by the automatic lag length criterion AIC. The general to specific approach is used to estimate the stock market model. In the linear regression model the international output approximation OECD G7 leading indicator, the real 10-year yield and the YENUSD exchange rate show positive relationship with the real stock market (see table 44 on page 270). These findings support the view that as an export-oriented country, Japan does depend to a large degree on its exchange rate and on global output. Also Brown and Otsuki (1990) as well as Mukherjee and Naka (1995) have found a positive relationship between the YENUSD exchange rate and the stock market. They argue that when the Yen depreciates against the USD, Japanese goods become cheaper in the US and assuming

price-elasticity, demand for those goods increase. Higher demand for Japanese goods then causes higher Yen denominated cash flows for Japanese companies.

The positive relationship with 10-year real interest rate is unexpected but should be seen against the backdrop of deflation and the close to zero nominal interest rate during the 1990s (For a discussion see Goyal and McKinnon 2003). Therefore an increase in the real interest rate could have been due to higher expected economic growth. Higher expected economic growth rates increased the chance of an ease in deflationary pressure and this was seen as a positive signal. Furthermore, international investors might be more driven by global real interests and not so much by the domestic real interest rate in Japan when investing in Japan. Thus higher real interest rates might indicate a more favourable economic environment with higher real growth rates in Japan and therefore attract international investors as well.

The positive relationship with the OECD G7 leading indicator is as our a priori expectation. Since the OECD leading indicator is constructed from international financial and macroeconomic factors, it can be argued that this implies colinearity with the other variables that we have used. However, it should be kept in mind that we use the G7 leading indicator and as such there will be only a minor overlap with our data set. Further, we only use lagged values of the OECD leading indicator. For instance Sløk and Kennedy (2004) show that the OECD G7 leading indicator drives the risk premia. Furthermore Burgstaller (2002) as well as Cauchie, Hoesli and Isakov (2003) find a positive relationship between OECD G7 industrial production and stock prices.

We allow for 12 lags in the VAR model for the US data set based on the automatic lag length criterion AIC. In the linear regression model the international output approximation

OECD G7 leading indicator and the risk spread show a positive coefficient with the real stock market, whereas money supply M2 shows a negative relationship with real stock market returns (see table 45 on page 273). These findings support the view that the US stock market is linked to international economic growth and that money supply has a medium-term negative effect, arguably due to higher inflation expectations. McMillan (2001b) as well as Humpe and MacMillan (2005) also found a negative relationship between money supply and the real stock market.

The positive relationship with the risk spread is expected and supports the positive relationship between returns and the riskiness of assets (For discussions see Fama and French 1989, Black, Fraser and MacDonald 1997 and Schwert 1990). Thus a higher risk premium is associated with higher future returns and vice versa.

4.7.3 Testing for non-linearity

In the next step, we test the linear model against non linearity. In the case of Japan, a LSTAR1 model is found to be the preferred model (see table 42 on page 268). The same test is applied to the US data set and the LSTAR1 model is again found to be the preferred model (see table 43 on page 269).

4.7.4 Non-linear model results

Since the non-linearity test supports the LSTAR1 model for the Japanese stock market, we begin by estimating this model. As can be seen in table 44 (on page 270), the threshold stock market return is estimated at -3.15% and the smoothing parameter gamma is found to be 41.14. In the lower return regime below minus 3.15%, the OECD G7 leading indicator and YENUSD exchange rate both show positive effects on stock market returns. The

positive effect of the OECD leading indicator and the YEN exchange rate on Japanese stock prices supports our expectations in chapter 4.4. In the upper regime above -3.15%, we find a positive effect of the real interest rate on real stock market returns. This finding is somewhat surprising because the DDM model suggests a negative impact of the discount rate on share prices. However, in the Japanese case a rising real interest rate can be associated with higher expected real growth or less inflationary pressure and thus having a positive effect on the stock market. Central banks tend to set the interest rate according to the output-gap. As long as the economy grows below the potential output, interest rates are set below the neutral interest rate (the neutral interest rate is supposed to be at the long-term growth rate of the economy) and as soon as the economy grows above the potential output, interest rates are set above the neutral rate (for a discussion see Björkstén and Karagedikli 2003 and Svensson 2006). Therefore, an increase in the interest rate below the neutral interest rate can be seen as a positive because economic conditions improve and give the central bank the confidence to increase interest rates. Thus the signal of higher future growth used to drive larger positive returns, whereas lower real interest rates have not been a source of large negative returns in Japan. We believe this effect is most eminent in Japan because interest rates have been at a very low level close to zero.

As an alternative we also estimate the LSTAR2 model for the Japanese market (see table 44 on page 270). The inner regime is found to be between 3.7% and 5.5% with an estimated gamma of 353. Here the out-regime shows a negative impact of OECD leading indicator and real interest rate whereas the middle regime shows a positive effect of OECD leading indicator, YENUSD and real interest rates. Thus the middle regime seems to be on the back of economic expansions, whereas the outer regimes seem to be much less driven by economic output and real interest rates. Therefore, the overall positive relationship with output and real interest rates remains, but with a much lower sensitivity in the outer

regimes. This indicates that very large positive or negative returns are more driven by noise or momentum traders than fundamental forces. Overall, the LSTAR1 and LSTAR2 model show comparable results. Both models predict a positive effect of the OECD leading indicator, YEN exchange rate and 10-year bond yields on stock prices in Japan. However, the coefficients in the LSTAR2 model are generally higher than in the LSTAR1 model. Furthermore, the OECD leading indicator and the 10-year bond yield have opposite signs in the two different regimes in the LSTAR2 model, whereas the same variables are only significant in one regime in the LSTAR1 model. As can be seen in graph 50 and 52 (on pages 271 and 272), the switching between regimes is relatively fast for both models. However, the LSTAR2 model shows faster regime-switching as indicated by the gamma parameter.

Since the non-linearity test supports the LSTAR1 model for the US stock market, we begin by estimating this model. As can be seen in table 45 (on page 273), the threshold stock market return is at -2.19% and the smoothing parameter gamma is estimated at 140.30. In the lower return regime below minus 2.19% the OECD G7 leading indicator and the risk spread show positive effects on stock market returns whereas M2 has a negative effect. This supports our expectations in chapter 4.4. The OECD leading indicator was supposed to have a positive correlation with earnings and should therefore have a positive effect on share prices. The negative effect of money supply was expected due to the fact that a high money supply can result in high inflation and this is negative for real share prices. Finally, a high risk spread indicates high risk aversion in the economy and is therefore supposed to predict higher future returns. In the upper regime above -2.19%, we find a negative effect of the risk spread on real stock market returns. Especially during the 1990s the risk spread declined in the US, whereas the stock market was characterised by very large positive returns (for the risk spread see graph 38 on page 261). Thus the long period of high

economic growth and low risk during the 1990s has supported stock market returns in the US. Here the effect of the risk spread has been marginally positive for large returns. As an alternative we also estimate a LSTAR2 model for the US market (see table 45 on page 273). The inner regime is found to be between 4.0% and 4.0% with a gamma of 1.28. This is a special case of the LSTAR2 model where both regimes are symmetric around a single threshold and this has often been modelled as an exponential smooth transition model (ESTAR). For a discussion see Lütkepohl and Krätzig (2004) and chapter 4.2. Here the out-regime shows a positive impact of the OECD G7 leading indicator and the risk spread, whereas the inner regime shows a negative effect of money supply M2. This supports our expectations in chapter 4.4. Overall, the LSTAR1 and LSTAR2 model show comparable results. Both models predict a positive effect of the OECD leading indicator and a negative effect of money supply on US stock prices. However, although the risk spread shows a positive effect in the LSTAR2 model and in the lower return regime of the LSTAR1 model, the coefficient becomes negative in the upper return regime in the LSTAR1 model. This is not as expected but might be explained by the 1990s where we have experienced a low risk spread and high equity returns in the US stock market.

Before we discuss our findings in more detail in chapter 4.8, we will first estimate the forecasting power of the different models in the next section.

4.7.5 Evaluation and forecasting results

For evaluation purposes, we follow McMillan (2002) and Aslanidis (2003) and report the AIC, SC, Jarque-Berra, R^2 , ARCH-LM and LM Godfrey test. On the basis of the AIC criterion, the LSTAR2 model is preferred, whereas according to the RMSE and MAE criteria, the LSTAR1 model shows the best in-sample fit for the Japanese data set. The

diagnostic tests indicate remaining ARCH effects, as we do not account for regime switching volatility, whereas remaining autocorrelation is not an issue (see table 44 on page 270).

In the US, the AIC, RMSE and MAE criteria prefer the LSTAR1 model that shows the best in-sample fit. As can be seen in graph 54 and 56 (on pages 274 and 275), the LSTAR1 model changes regimes relatively fast, whereas the LSTAR2 model switches slowly. The diagnostic tests do not indicate remaining ARCH effects or autocorrelation for the different models (see table 45 on page 273).

In the next step, we investigate the out of sample performance of the linear and non-linear models. The in sample period has been 1981M1 until 2004M6 and the out of sample period spans from 2004M7 until 2006M6. For Japan, the best out of sample fit, measured by RMSE and MAE, is achieved by the linear model, very closely followed by the LSTAR1 model (see table 44 on page 270). However, during the out of sample period the market has been in an uptrend and the advantages of the non-linear modelling during large negative returns could not have been tested. Thus, the model might still be superior to the linear model during periods when stock markets are falling. In the US, the best out of sample fit, measured by RMSE and MAE, is achieved by the LSTAR1 model (see table 45 on page 273). Thus, in and out of sample, the LSTAR1 model is superior for explaining US stock market returns.

4.8 Differences and commonalities in the US and Japan

In the above empirical analysis we have investigated non-linear behaviour between macroeconomic variables and the stock market. First of all, we extracted the significant

variables following a general to specific procedure. It is interesting to observe that the only variable that was significant for both markets is the OECD G7 leading indicator. Thus the US and Japanese stock market both react positively to an increase in the OECD G7 leading indicator. This supports our prognosis that the OECD G7 leading indicator, as a good forecasting variable for global output, should be able to predict stock prices as well. Furthermore, it is interesting to note that this indicator is only lagged by one month and thus stock prices react relatively fast to changes in the OECD G7 leading indicator. The size of the coefficient of the OECD G7 leading indicator is larger in Japan than in the US. This supports our view that the Japanese economy is more cyclical than the US economy (for a discussion see chapter 1.1.2). We think a further advantage of the OECD G7 leading indicator is the fact that it is available in quick time. By contrast, many output variables such as GDP or industrial production are reported with a relatively long lag and are often substantially revised later. As a result, the final figures for GDP tend to be released months after the relevant quarter has passed. Hence, the OECD leading indicator has major advantages over other possible variables. Our empirical analysis supports the finding of Lambrick (2006) who has found evidence of the OECD leading indicator to have predictive power for the Australian stock market. However, for the US and Japanese stock market we are the first to report a positive relationship between stock prices and the OECD G7 leading indicator.

In Japan, apart from the OECD G7 leading indicator, the YENUSD exchange rate and the real 10-year interest rate show significant forecasting power for the Nikkei 225. Our analysis supports the findings of Mukherjee and Naka (1995) who have found a positive relationship between the YENUSD exchange rate and the Japanese stock market. The hypothesis was that when the Japanese Yen depreciates against the USD, Japanese goods become cheaper in the US and Japanese exports should rise due to higher demand. As a

result, Japanese corporate cash flows denominated in YEN should increase and share prices rise. We had already expected that for an export-oriented country like Japan, global output and the exchange rate should play key roles for the stock market. Both variables are expected to have direct impact on domestic output and corporate profits denominated in YEN. Finally, the 10-year bond yield shows a positive effect on Japanese stock prices. This is not predicted by the present value model but supports our earlier findings from the cointegration analysis. Thus this finding supports our view that the incidence of deflation, that emphasises the zero lower bound on real interest rates, had severe negative effects on the stock market. As a result an increase in the real interest rate has been contemporaneous with higher economic growth. This in turn increased the chance of an ease in deflationary pressure and has therefore been seen as a positive signal for the market.

In the US, in addition to the OECD G7 leading indicator, we have found the risk-spread and money supply to be significant in our setting. As expected, the risk-spread has a positive effect on stock market returns, except for very large positive stock returns in the LSTAR1 model in the US. We believe this can be explained by the 1990s where stock market returns have been large and positive whereas the risk spread was relatively small (see graph 38 on page 261). However, the positive effect of the risk spread on stock market returns for the negative return regime supports that a low risk-spread indicates low risk aversion due to an economic boom and hence future expected returns are low. Furthermore, it supports earlier finding by Fama and French (1989) and Black, Fraser and Macdonald (1997). The negative impact of money supply on stock prices is likely to be related to the expectation that an increase in money supply might cause future inflation. Our empirical analysis supports earlier findings by Urich and Wachtel (1981) and Rogalski and Vinso (1977). Overall, it can be said that the US stock market is also driven by global output rather than domestic industrial production. However, it should be noted that the US

accounts for roughly one third of global output and is therefore the major driver of global output. Hence, the US will benefit from higher global growth but this does not mean that the US is as dependent on exports as Japan. It can even be argued that the large US deficit points to the opposite direction, namely that US growth is driven by imports and thus drives other countries' exports. Be that as it may, the OECD G7 leading indicator has at least the advantage of being available on time to be used as a forecast variable. Since the US is still the largest economy in the world, the US risk-spread has a significant impact on its domestic stock market. Arguably, in Japan the domestic stock market is more dominated by an international risk premium, as the economy is more export-oriented. The negative relationship with money supply supports prior expectations. Assuming different behaviour of private and institutional investors, we expected in chapter 4.2 that the transition between regimes would be smoother in the US because of the more balanced forces between institutional and private investors. However, this has only been supported for the LSTAR2 model whereas for the LSTAR1 model the transition is smoother in the Japanese model.

4.9 Contribution of this analysis to the existing literature

In the preceding analysis we have tested for non-linearity between selected macroeconomic variables and the stock markets in the US and Japan. In general, non-linearity between macro variables and the stock market has previously been analysed in the literature; however to our knowledge not with respect to the Japanese stock market. Therefore, one of our contributions to the existing literature is by including Japan in our empirical investigation. Furthermore, we are one of the first to have included the OECD G7 leading indicator and find this variable to be positively correlated with stock prices at a one-month lag. It is interesting to note that both countries, Japan as an export oriented and

the US as a less export oriented economy, show a positive effect of the global growth indicator on stock price returns. By contrast, in the cointegration analysis in chapter 3 we have included industrial production as main driver for earnings and cash flows. The cointegration analysis has supported that stock prices are positively related with industrial production. However, the non-linear analysis demonstrates that the OECD G7 leading indicator is better suited to model stock market returns in the US and Japan. In the general to specific approach in chapter 4.7.2, the OECD leading indicator has been selected whereas industrial production has been dropped because of its relative insignificance. Furthermore, in the US, we have been able to support findings in the existing literature that the risk spread has a positive relationship with stock market returns and that money supply has a negative effect. Only in the non-linear outer regime of the LSTAR1 model, the risk spread turns negative for stock returns, particularly when monthly returns are large and positive. Therefore, large positive returns that characterise positive momentum periods may be driven by over optimism that drives down the risk spread and at the same time drives up stock prices. As the transition function shows (see graph 55 on page 274), this has been the case in the US at the end of the 1990s. In contrast to the negative impact of money supply on stock prices in the non-linear model, money supply has a positive impact on share prices in the cointegration analysis in chapter 3, but is not statistically significant.

For Japan our results support findings in the existing literature that there exists a positive relationship between the exchange rate YENUSD and stock market returns. However, the positive relationship between the real 10-year bond yield and share prices which we observe has not been reported earlier in the literature. However, it supports our empirical findings in chapter 3, where we have found a positive effect of the discount rate on share prices in Japan between 1993M4 and 2004M6. We believe the main reason for the positive relationship is caused by Japanese deflation and the prolonged downturn. Therefore, one of

the greatest drags on the Japanese economy has been the onset of deflation and is therefore likely to have impacted stock prices as well (for a detailed discussion see chapter 3.8.1). Most of the existing literature only looks at Japan before the massive downturn started and this is also one of the reasons why we are one of the first to report this relationship. Finally, we find some evidence to support that non-linear models concerning the relationship between macroeconomic variables and the stock market provide better descriptions of the data, both in and out of sample, than comparable linear models.

4.10 Explanation for findings

In general, the US has been characterised by more frequent but milder economic contractions than Japan (McAdam 2003). Therefore, one of the reasons why the US empirical findings are, as theoretically expected, may be the fact that the economic development has been rather smooth since WWII, whereas this is not the case for the Japanese economy. In particular, Japan experienced a period of extremely high economic growth followed by one of the most severe and prolonged downturns in recent economic history. Furthermore, the onset of deflation in the late 1980s and the impact of a liquidity trap during the 1990s is the most likely cause for the economic relationships we have found in our analysis. Therefore, we believe that the positive relationship between the real 10-year bond yield and Japanese stock market returns is driven by the deflationary environment in Japan. As the effects of deflation and low economic growth were felt by investors, a higher real interest rate indicated higher expectations for future growth and the potential to escape the economic downturn as well as the deflationary environment. This view is also supported by our earlier findings in the cointegration analysis in chapter 3. For a detailed discussion about the deflationary period and the occurrence of a liquidity trap in Japan see chapter 3.8.1. Finally, we find the export driven economy of Japan to be more

sensitive to global output and the exchange rate than the more domestic-driven economy of the USA as expected in chapter 4.4.

4.11 Conclusion

The empirical investigation in this chapter has analysed non-linear relationships between macroeconomic variables and the stock market. Overall, we find a positive relationship between the G7 leading indicator and stock returns in the US and Japan. In contrast to the non-linear model, in the cointegration analysis in chapter 3, we have included industrial production as main driver for earnings and cash flows. The cointegration analysis had supported that stock prices are positively related with industrial production. However, the non-linear analysis demonstrates that the OECD G7 leading indicator is better suited to model stock market returns in the US and Japan⁴⁰. Furthermore, we can support a positive relationship between the risk-spread and share prices in the US, whereas money supply is found to have a negative impact on stock returns. In contrast to the negative impact of money supply on stock prices in the non-linear model, money supply shows a positive impact on share prices in the cointegration analysis in chapter 3, but is not statistically significant. The negative impact of money supply supports earlier findings by Ulrich and Wachtel (1981) and Rogalski and Vinso (1977). As expected, the risk-spread has a positive effect on stock market returns, except for very large positive stock returns in the LSTAR1 model in the US. We believe this observation is driven by the 1990s when stock market returns were large and positive whereas the risk spread was relatively small (see graph 38 on page 261). However, the positive effect of the risk spread on stock market returns for the negative return regime supports that a low risk-spread indicates low risk aversion due to an economic boom and hence future expected returns are low. Furthermore, it supports

⁴⁰ In the general to specific approach in chapter 4, industrial production was dropped because of its' relative statistical insignificance whereas the OECD G7 leading indicator was selected.

earlier findings by Fama and French (1989) and Black, Fraser and Macdonald (1997). However, in Japan one of our findings does not support theory or earlier research, namely a positive relationship between the 10-year bond yield and stock prices. However, it supports our empirical findings in chapter 3, where we have found a positive effect of the discount rate on share prices in Japan between 1993M4 and 2004M6. We think this may be related to the severe downturn in Japan since 1990. On the other hand, the positive relationship between the YENUSD exchange rate and Japanese stock returns supports earlier findings in the literature. For instance Mukherjee and Naka (1995) have found a positive relationship between the YENUSD exchange rate and the Japanese stock market. Assuming different behaviour of private and institutional investors, we expected in chapter 4.2 that the transition between regimes would be smoother in the US because of the more balanced forces between institutional and private investors. However, our empirical evidence indicates that this is only true for the LSTAR2 model whereas for the LSTAR1 model the transition is smoother in the Japanese model.

In the following chapter we will extend the analysis by applying non-linear estimation methodology to test a specific non-linear model of fundamental investors that interact with noise traders in the US and Japanese dividend-yield. Assuming that institutional investors are more fundamental driven investors whereas private investor tend to be more noise driven investors, we expect the results in chapter 5 to provide more insight into the interaction between noise and fundamental traders in the US and Japanese stock market.

4.12 Tables and Graphs

Table 36: US summary statistics

Variable	Mean	Std.Dev.	Skewness	Kurtosis	Jarque-Bera probability
LSPX	5.398260	0.561961	-0.0602	1.8246	0.0001
Δ LSPX	0.004623	0.043296	-0.8935	6.8567	0.0000
LIndProd	4.917440	0.226043	0.0584	1.6266	0.0000
Δ LIndProd	0.002262	0.005857	-0.0236	3.5071	0.1924
LCPI	5.110130	0.234556	-0.3104	1.8996	0.0000
Δ LCPI	0.002861	0.001413	1.9904	8.2056	0.0000
LR10Y	0.038902	0.018675	0.5773	3.0850	0.0002
Δ LR10Y	-0.000002	0.003911	0.1530	3.7533	0.0150
LR3mth	0.055204	0.027866	0.7279	3.8721	0.0000
Δ LR3mth	-0.000296	0.004250	-1.4725	12.1518	0.0000
LDivYield	0.939147	0.449886	-0.1115	1.9847	0.0010
Δ LDivYield	-0.002842	0.036548	0.5882	5.5639	0.0000
LRetailS	5.30161	0.037911	-0.1153	1.9590	0.0007
Δ LRetailS	0.004421	0.012786	-0.3458	10.0970	0.0000
RiskSpread	2.12954	5.39486	0.8796	3.1804	0.0000
Δ Risk Spread	-0.002590	0.164857	0.9156	8.4891	0.0000
LRM2	5.38997	0.376620	-0.0841	2.2707	0.0281
Δ LRM2	0.004744	0.003554	1.3044	9.1499	0.0000
LOECD	4.86892	0.157655	-0.2650	1.9108	0.0001
Δ LOECD	0.001699	0.005251	-0.2889	2.9577	0.1186
LYENUSD	4.35536	0.294198	-0.9492	2.6597	0.0000
Δ LYENUSD	0.001859	0.028543	0.5907	3.8105	0.0000
TermSpread	1.80382	1.23902	-0.2562	2.4531	0.0279
Δ TermSpread	0.008032	0.435188	0.6798	8.7727	0.0000

Table 37: Japanese Summary Statistics

Variable	Mean	Std.Dev.	Skewness	Kurtosis	Jarque-Bera probability
LNKY	5.17564	0.400090	0.2973	2.3608	0.0078
Δ LNKY	0.001697	0.058280	-0.4357	3.8495	0.0001
LIndProd	4.90636	0.130660	-1.0362	2.8680	0.0000
Δ LIndProd	0.001554	0.013200	-0.0209	3.4723	0.2396
LCPI	4.78964	0.076289	-0.7627	2.1642	0.0000
Δ LCPI	0.000792	0.004395	0.7799	4.7483	0.0000
LR10Y	0.030548	0.014917	0.0741	2.3472	0.0574
Δ LR10Y	-0.0000052	0.004504	0.2188	4.2827	0.0000
LR3Mth	0.030790	0.027762	0.2745	1.4957	0.0000
Δ LR3Mth	-0.000256	0.001768	-0.8868	9.2022	0.0000
LDivYield	-0.119315	0.343441	0.1171	2.6269	0.2902
Δ LDivYield	-0.001046	0.071511	-0.9309	13.1896	0.0000
LRRetailS	4.95654	0.156535	-0.7766	2.1581	0.0000
Δ LRRetailS	0.001264	0.003092	0.0358	3.8819	0.0069
RiskSpread	0.432686	0.363424	1.0290	5.1722	0.0000
Δ RiskSpread	0.000659	0.324511	-0.1624	6.5332	0.0000
LRM2	5.42720	0.373278	-0.7181	2.2156	0.0000
Δ LRM2	0.004171	0.002826	0.4605	1.7977	0.0000
LOECD	4.86892	0.157655	-0.2650	1.9108	0.0001
Δ LOECD	0.001699	0.005251	-0.2889	2.9577	0.1186
LYENUSD	4.35536	0.294198	-0.9492	2.6597	0.0000
Δ LYENUSD	0.001859	0.028543	0.5907	3.8105	0.0000
TermSpread	1.007600	0.902723	-1.0060	4.2246	0.0000
Δ TermSpred	0.005967	0.235720	0.5602	5.0109	0.0000

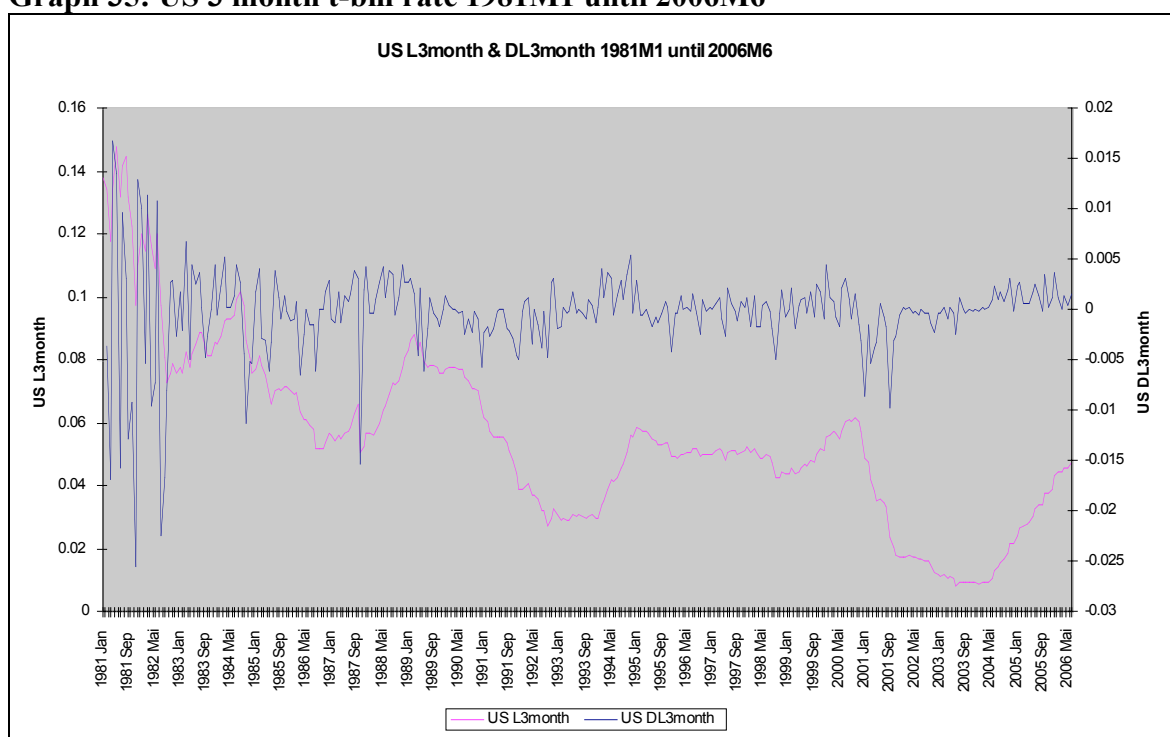
Table 38: US cross correlations

	LSPX	LRetail	L3M	L10Y	LOECD	LM2	LIndP	LCPI	LDivY	LYENS\$	Risk	Term
LSPX	1.000											
LRetail	-0.064	1.000										
L3M	0.028	-0.108	1.000									
L10Y	-0.109	-0.096	0.588	1.000								
LOECD	0.272	0.068	0.198	0.267	1.000							
LM2	-0.001	-0.035	-0.012	0.089	0.043	1.000						
LIndP	-0.141	0.229	0.031	0.040	0.243	-0.143	1.000					
LCPI	-0.101	-0.034	-0.045	0.112	-0.260	0.120	-0.259	1.000				
LDivY	-0.603	-0.063	-0.072	0.060	-0.327	0.059	0.029	0.123	1.000			
LYENS\$	0.051	-0.052	-0.088	-0.175	-0.003	-0.017	-0.099	-0.114	0.001	1.000		
Risk	0.060	-0.046	-0.334	-0.440	-0.371	0.001	-0.157	0.043	0.060	0.133	1.000	
Term	-0.028	0.010	-0.118	-0.007	0.176	-0.119	0.053	-0.212	0.057	0.157	0.014	1.000

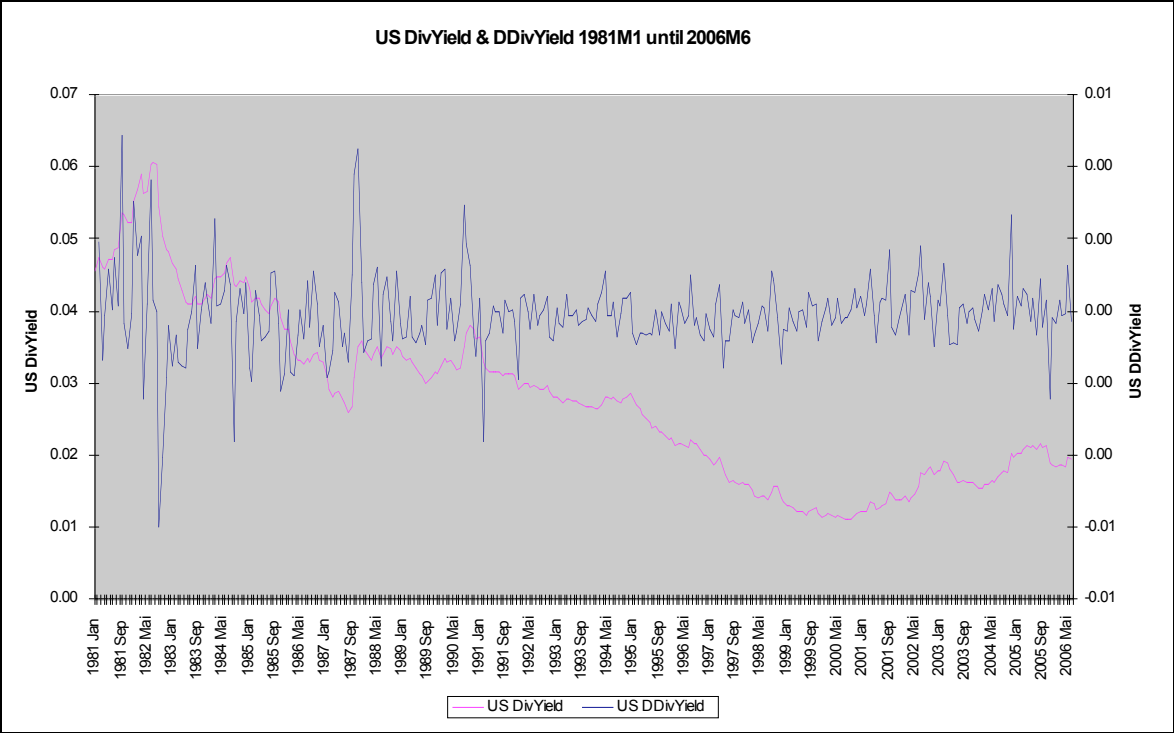
Table 39: Japanese cross correlations

	LNKY	LRETAIL	LOECD	LM2	LIndP	LDivY	LCPI	L3M	L10Y	LYENS	Risk	Term
LNKY	1.000											
LRETAIL	0.004	1.000										
LOECD	0.320	-0.076	1.000									
LM2	0.019	-0.047	0.061	1.000								
LIndP	0.040	0.126	0.052	0.021	1.000							
LDivY	-0.651	0.026	-0.264	0.003	0.019	1.000						
LCPI	-0.091	0.140	-0.096	0.018	-0.032	0.078	1.000					
L3M	-0.005	0.048	-0.011	0.063	0.107	0.053	-0.387	1.000				
L10Y	0.071	0.450	0.079	0.037	0.131	-0.090	0.051	0.121	1.000			
LYENS	0.067	0.015	-0.001	0.000	0.095	-0.039	0.076	-0.093	0.101	1.000		
Risk	-0.042	-0.057	0.126	0.111	0.012	-0.003	-0.080	0.087	-0.230	0.009	1.000	-
Term	-0.003	-0.013	0.124	0.150	-0.007	0.013	0.038	-0.109	0.094	0.035	-0.060	1.000

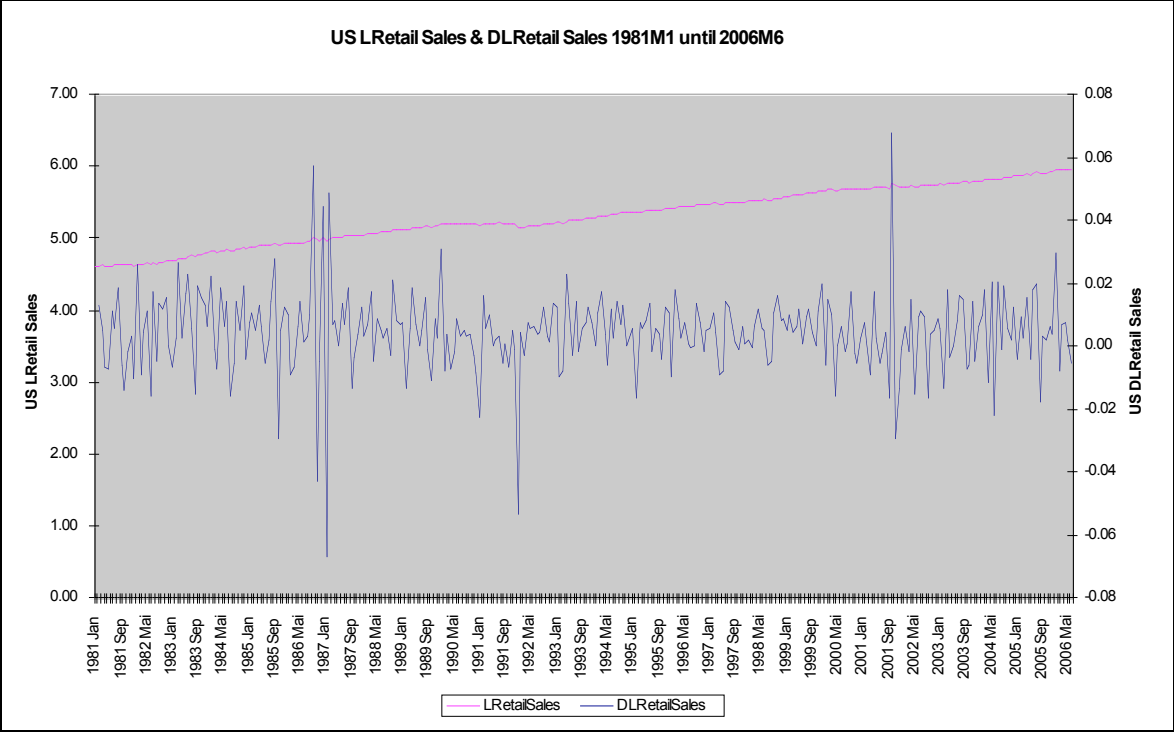
Graph 35: US 3 month t-bill rate 1981M1 until 2006M6



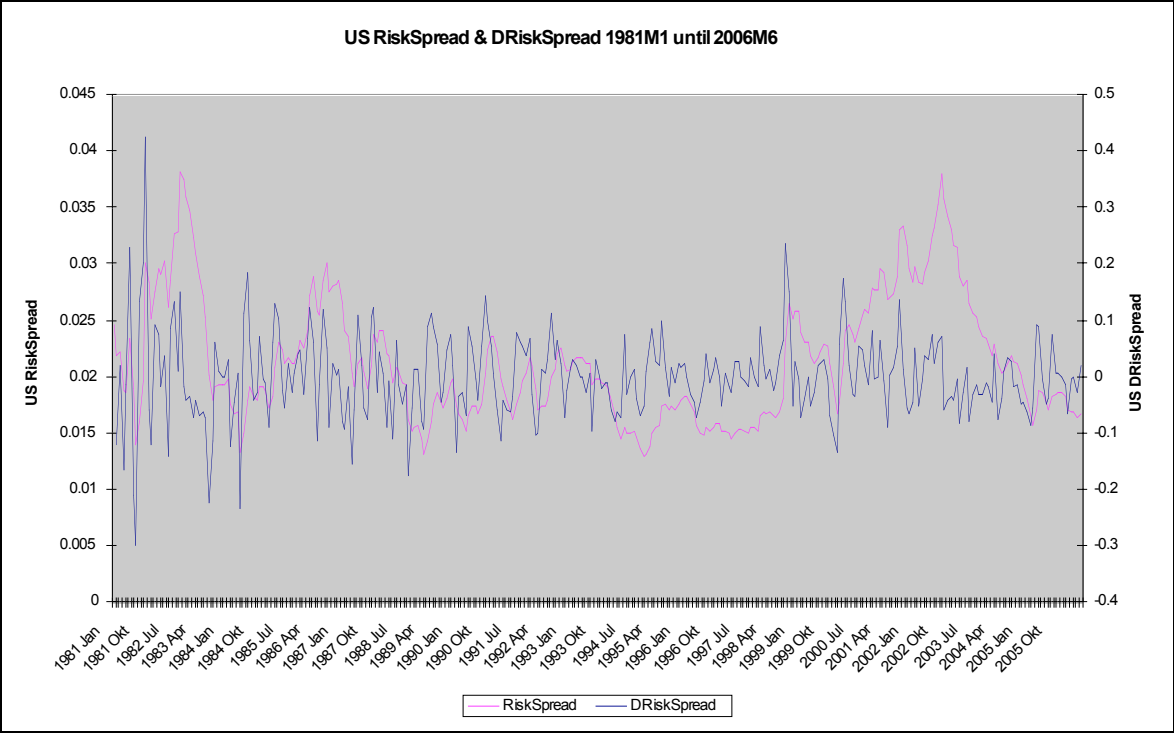
Graph 36: US Dividend Yield 1981M1 until 2006M6



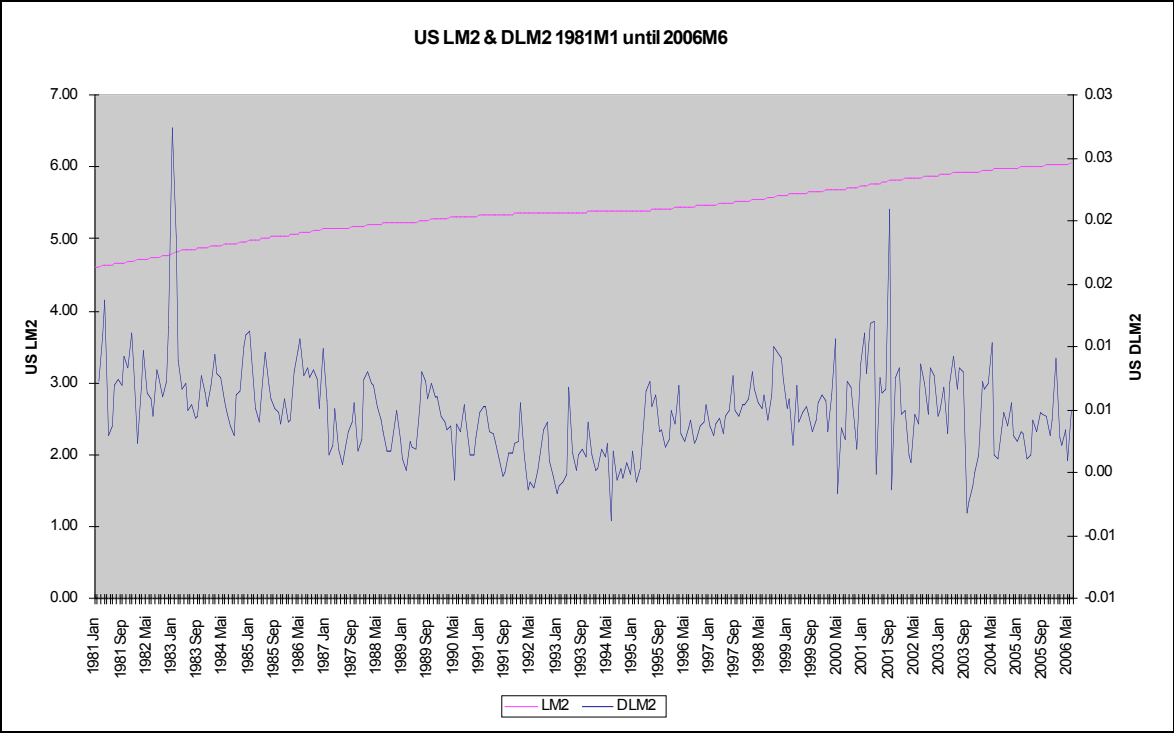
Graph 37: US Retail Sales 1981M1 until 2006M6



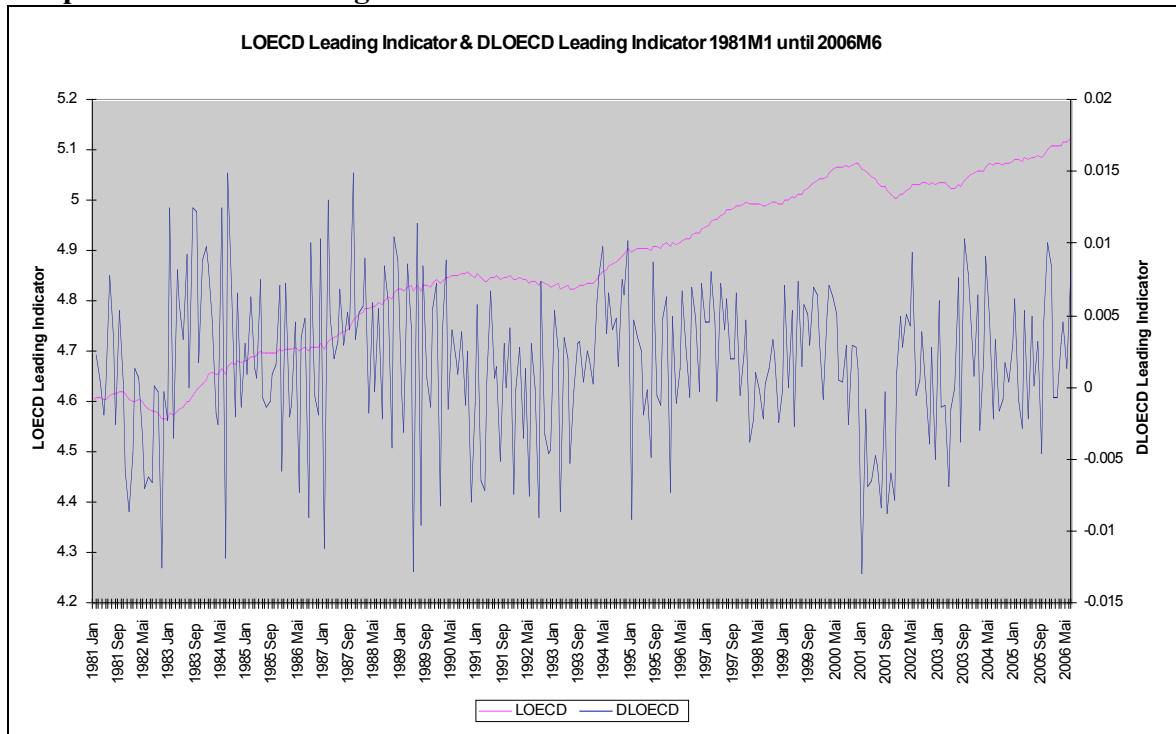
Graph 38: US Risk Spread 1981M1 until 2006M6



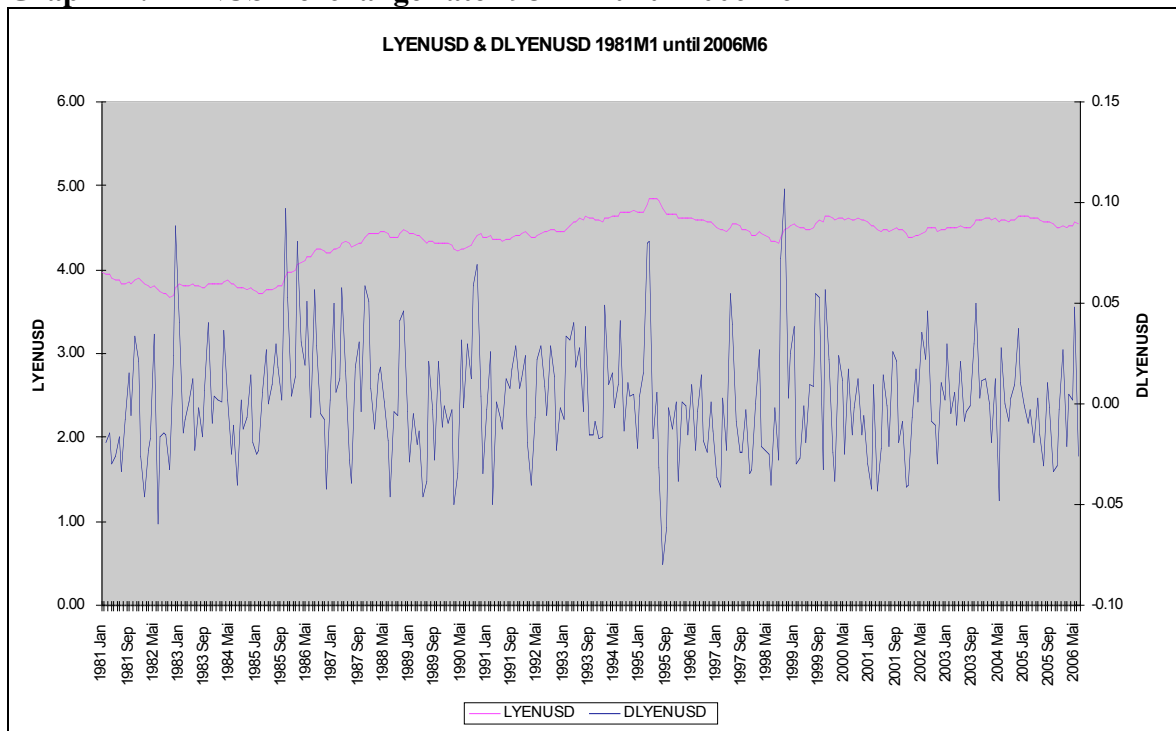
Graph 39: US M2 1981M1 until 2006M6



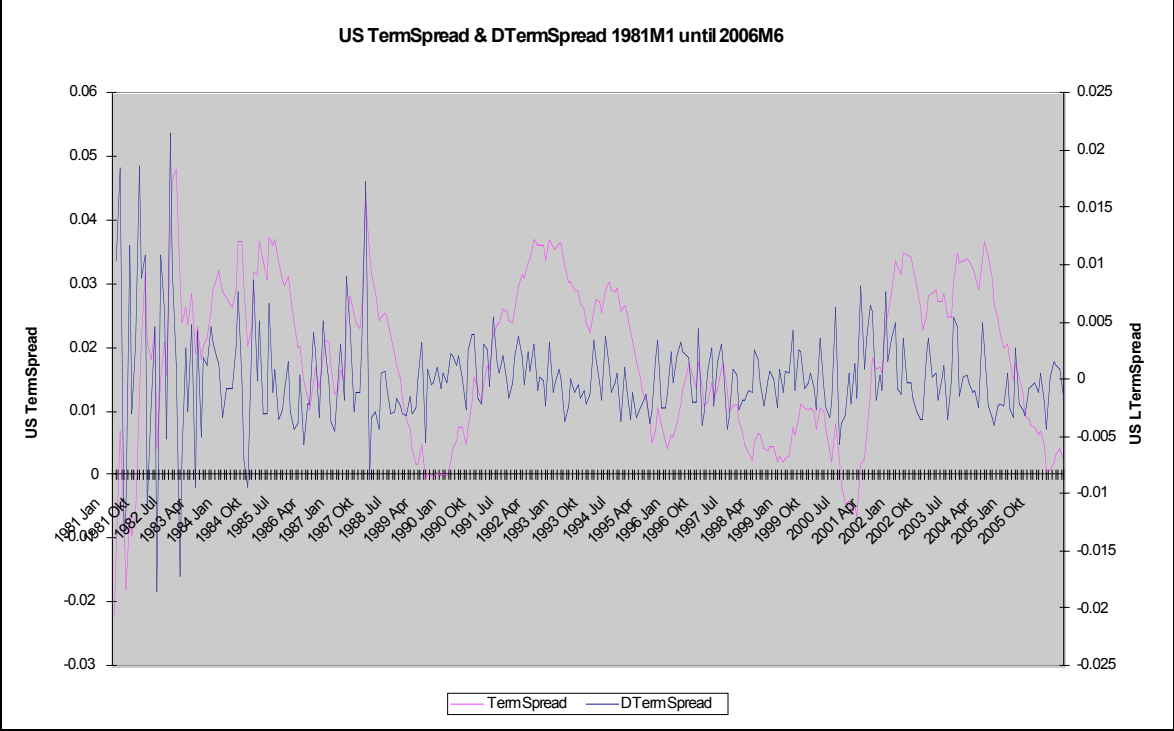
Graph 40: OECD Leading Indicator 1981M1 until 2006M6



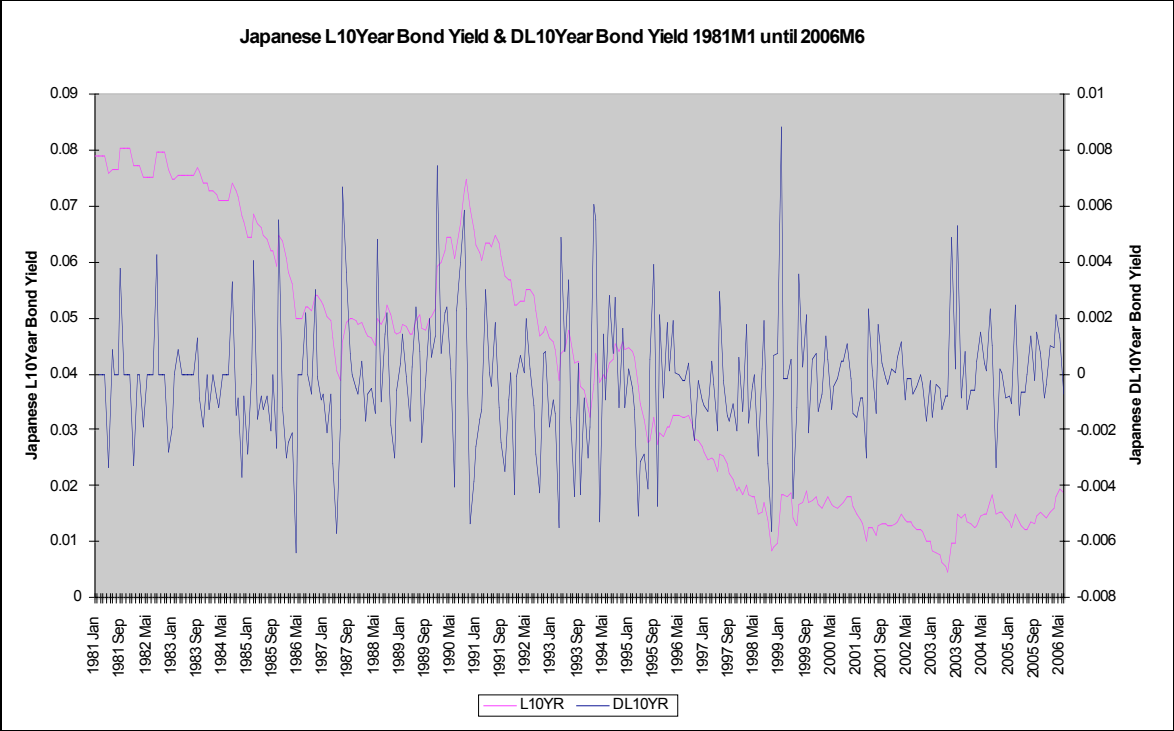
Graph 41: YENUSD exchange rate 1981M1 until 2006M6



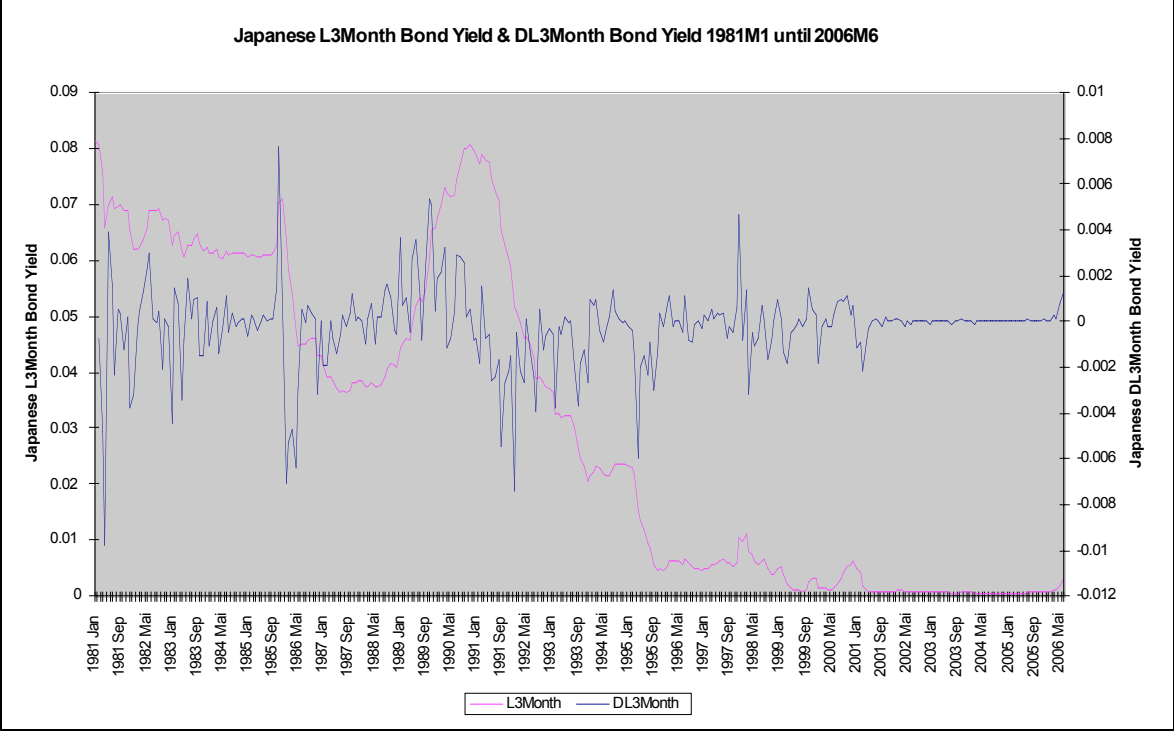
Graph 42: US Term Spread 1981M1 until 2006M6



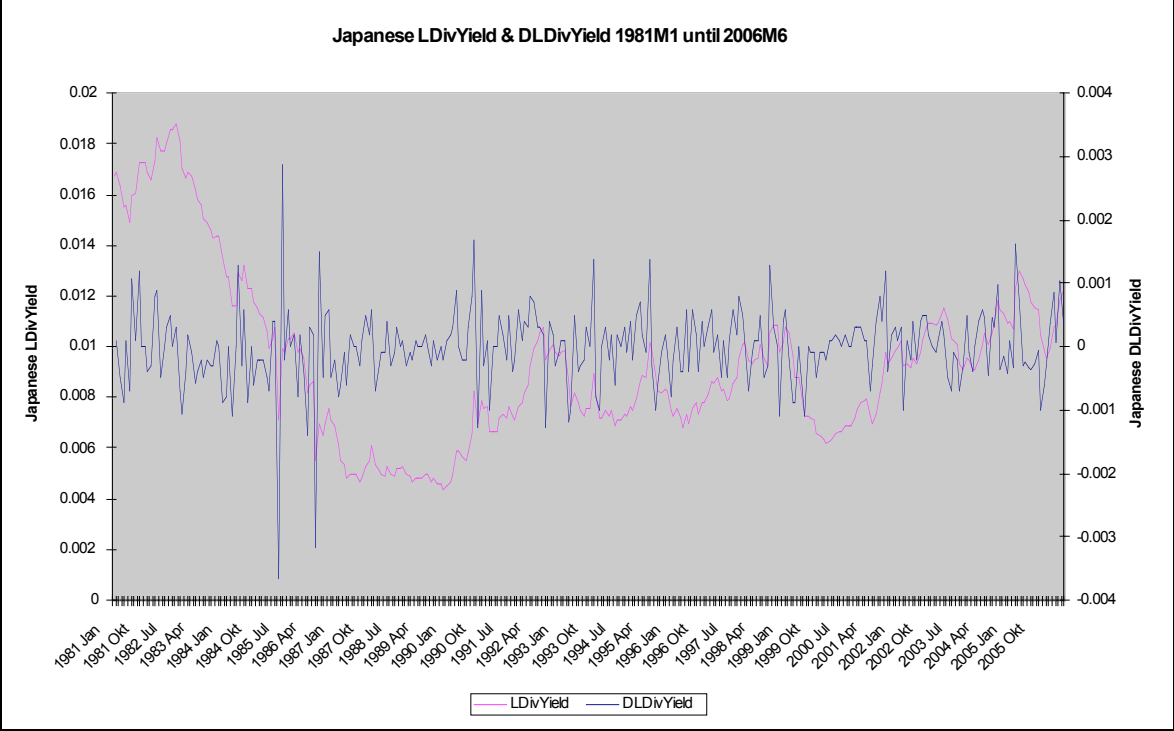
Graph 43: Japanese 10 year bond yield 1981M1 until 2006M6



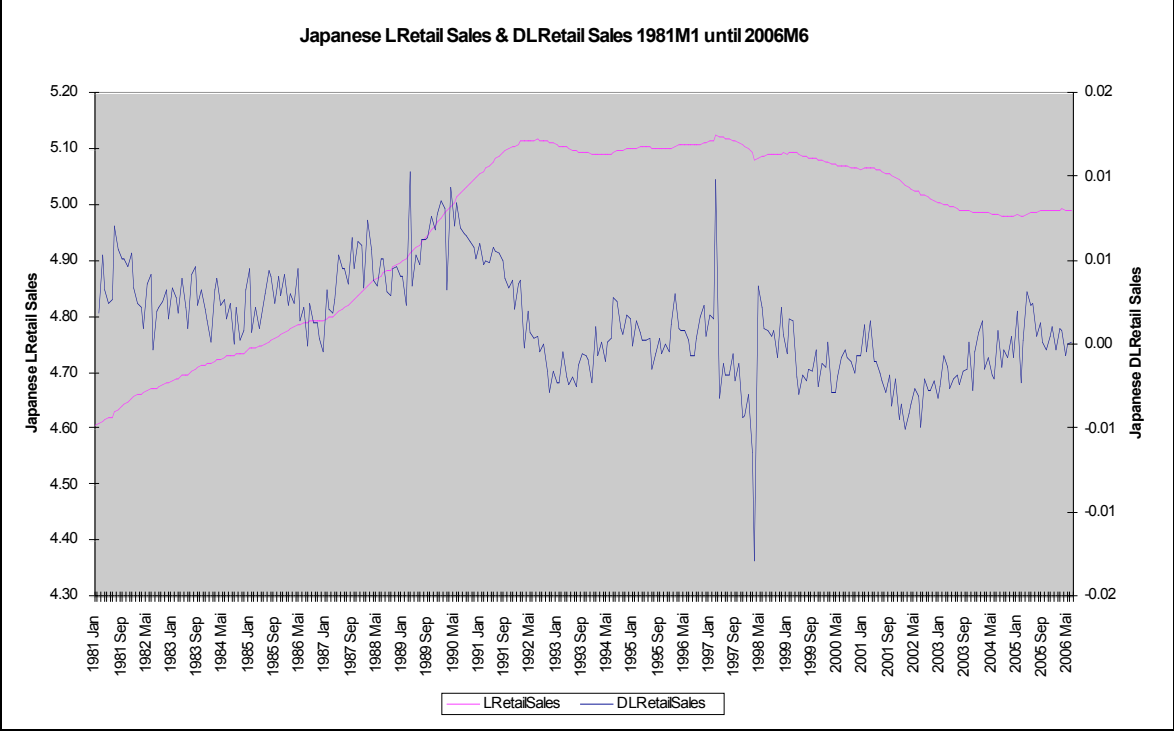
Graph 44: Japanese 3 month bond yield 1981M1 until 2006M6



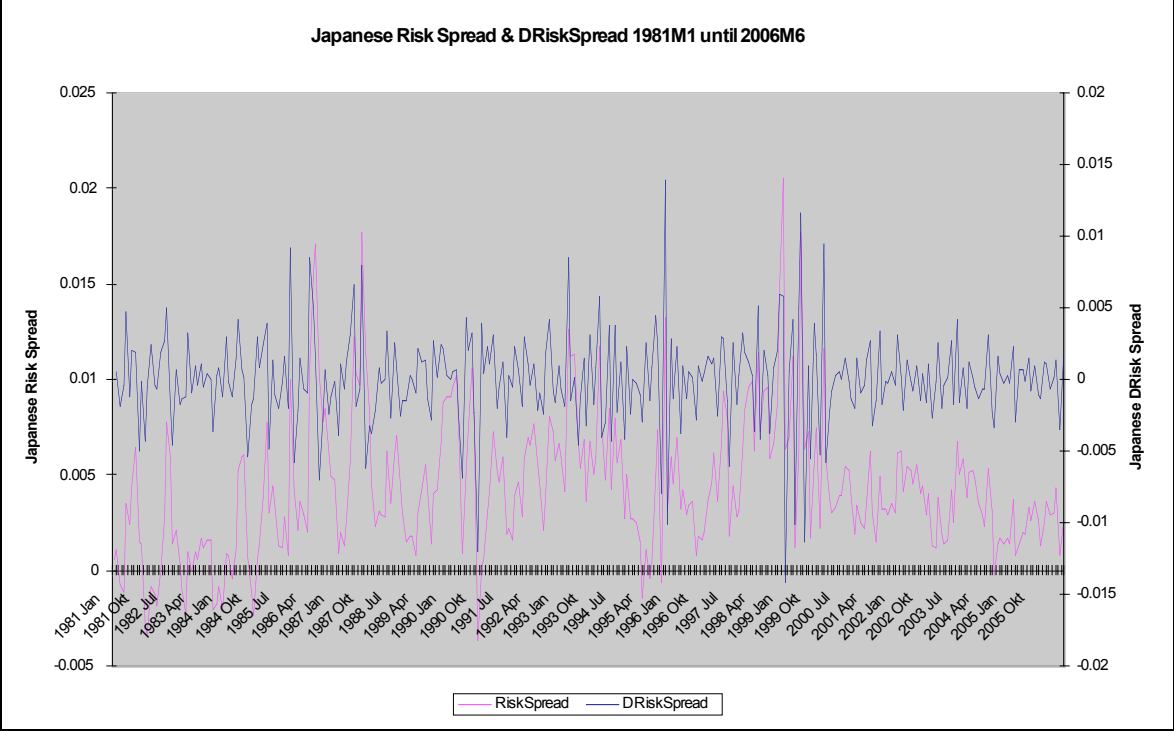
Graph 45: Japanese Dividend Yield 1981M1 until 2006M6



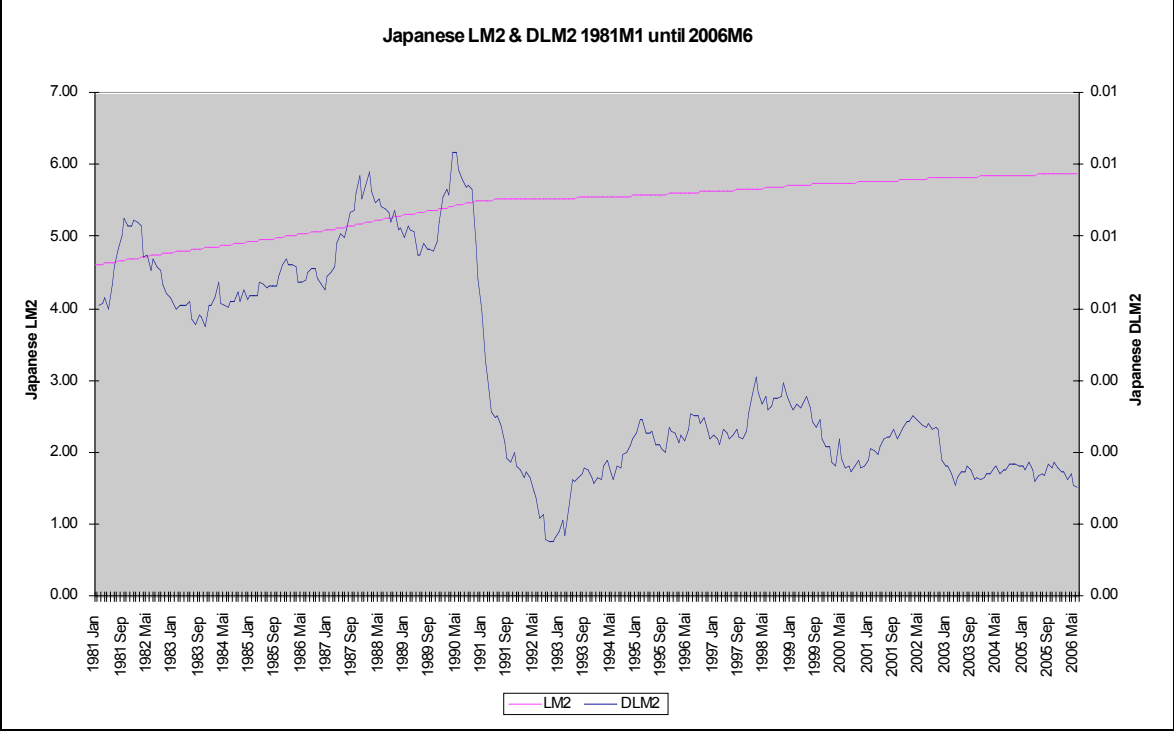
Graph 46: Japanese Retail Sales 1981M1 until 2006M6



Graph 47: Japanese Risk Spread 1981M1 until 2006M6



Graph 48: Japanese M2 1981M1 until 2006M6



Graph 49: Japanese Term Spread 1981M1 2006M6

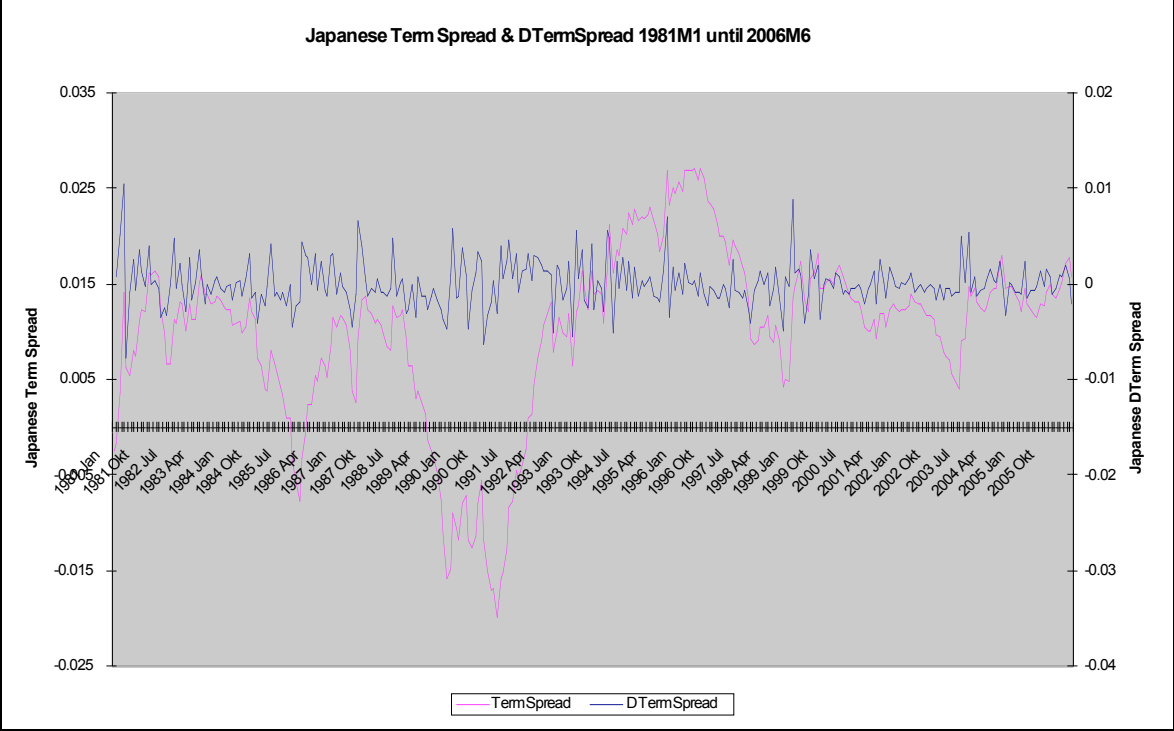


Table 40: Japanese Unit Root test

TESTS for Japan		Augmented Dickey Fuller Test (1981:M1 to 2006:M6)	
Trend/Constant			
Variable	Trend/Constant	Constant	None
LNKY (Lag)	-1.8491 (0)	-1.6689 (0)	0.3779 (0)
Δ LNKY (Lag)	-17.1165* (0)	-17.0784* (0)	-17.0916* (0)
LIndProd (Lag)	-2.3953 (4)	-2.2016 (4)	1.7204 (4)
Δ LIndProd (Lag)	-6.1634* (3)	-6.0813* (3)	-5.7959* (3)
LCPI (Lag)	-1.1526 (12)	-1.9672 (12)	1.2612 (12)
Δ LCPI (Lag)	-5.8555* (6)	-4.9209* (6)	-4.2498* (6)
LR10Y (Lag)	-5.6472* (0)	-2.6384* (0)	-1.4523* (0)
Δ LR10Y (Lag)	-18.4738* (0)	-18.4716* (0)	-18.5019* (0)
LR3Mth (Lag)	-2.3880 (1)	-1.3369 (1)	-1.3902 (1)
Δ LR3Mth (Lag)	-7.9900* (6)	-8.0299* (6)	-10.8204* (0)
LDivYield (Lag)	-1.7085 (0)	-2.0294 (0)	0.5159 (0)
Δ LDivYield (Lag)	-8.3155* (1)	-10.8997* (0)	-10.9350* (0)
LRRetailS (Lag)	-1.1725 (4)	-2.2040 (4)	0.7406 (4)
Δ LRRetailS (Lag)	-5.1020* (1)	-4.0140* (1)	-2.3379* (3)
RiskSpread (Lag)	-6.7779* (1)	-6.7545* (1)	-3.8487* (1)
Δ RiskSpread (Lag)	-12.0238* (4)	-12.0374* (4)	-12.0580* (4)
LRM2 (Lag)	-3.1357 (5)	-0.9131 (5)	-0.5612 (9)
Δ LRM2 (Lag)	-4.3912* (4)	-3.8401* (4)	-2.4040* (4)
LOECD (Lag)	-5.2696* (1)	-1.0654 (4)	2.1888 (1)
Δ LOECD (Lag)	-5.7247* (3)	-5.7202* (3)	-5.8986* (0)
LYENUSD (Lag)	-2.7551 (1)	-1.5600 (1)	1.1788 (1)
Δ LYENUSD (Lag)	-4.4079* (2)	-4.4100* (2)	-4.3233* (2)
TermSpread (Lag)	-2.4953 (0)	-2.4613 (0)	-1.3064 (0)
Δ TermSpred (Lag)	-17.3213* (0)	-17.3463* (0)	-17.3650* (0)
Notes: Asterik denotes significance at 10% level. In “()” we have reported the selected lag by the ADF test.			

Table 41: US Unit Root test 1981M1 until 2006M6

TESTS for US		Augmented Dickey Fuller Test (1981:M1 to 2006:M6)		
Variable	Trend/Constant	Trend/Constant	Constant	None
LSPX (Lag)	-2.1758 (0)	-0.3832 (0)	0.8769 (0)	
Δ LSPX (Lag)	-11.4973* (0)	-11.5099* (0)	-11.4457* (0)	
LIndProd (Lag)	-3.1109 (1)	-0.0992 (8)	3.3839 (8)	
Δ LIndProd (Lag)	-6.4805 (0)	-6.5060 (0)	-5.8103 (0)	
LCPI (Lag)	-1.2788 (6)	-3.2262* (6)	1.7893 (6)	
Δ LCPI (Lag)	-3.3881* (9)	-2.5784* (2)	-0.7256 (8)	
LR10Y (Lag)	-3.1203 (3)	-2.0613 (0)	-1.5052 (0)	
Δ LR10Y (Lag)	-7.0777* (1)	-7.0981* (1)	-7.1205* (1)	
LR3mth (Lag)	-2.1132 (7)	-2.1057 (7)	-1.8813* (7)	
Δ LR3mth (Lag)	-6.0687* (6)	-11.9314* (1)	-11.9665* (1)	
LDivYield (Lag)	-2.0990 (0)	-0.8774 (0)	0.5652 (0)	
Δ LDivYield (Lag)	-11.6135* (0)	-11.6608* (0)	-11.6379* (0)	
LRetailS (Lag)	-1.9492 (2)	-0.6103 (2)	8.4921 (2)	
Δ LRetailS (Lag)	-16.9042* (1)	-16.9222* (1)	-13.0835* (1)	
RiskSpread (Lag)	-2.8018 (2)	-2.8084* (2)	-0.8580 (2)	
Δ Risk Spread (Lag)	-13.0503* (1)	-13.0704* (1)	-13.0898* (1)	
LRM2 (Lag)	-2.1459 (8)	-1.2872 (8)	0.7351 (8)	
Δ LRM2 (Lag)	-4.4824* (1)	-4.4970* (1)	-4.4699* (1)	
LOECD (Lag)	-5.2696* (1)	-1.0654 (4)	2.1888 (1)	
Δ LOECD (Lag)	-5.7247* (3)	-5.7202* (3)	-5.8986* (0)	
LYENUSD (Lag)	-2.7551 (1)	-1.5600 (1)	1.1788 (1)	
Δ LYENUSD (Lag)	-4.4079* (2)	-4.4100* (2)	-4.3233* (2)	
TermSpread (Lag)	-3.6905* (0)	-3.5041* (0)	-1.7646* (0)	
Δ TermSpread (Lag)	-16.7253* (0)	-16.6971* (0)	-16.7238* (0)	
Notes: Asterik denotes significance at 10% level. In “()” we have reported the selected lag by the ADF test.				

Table 42: Linearity vs. Non-Linearity test Japan

TESTING LINEARITY AGAINST STR IN JAPAN					
Variables in AR part:		CONST OECD_log_d1(t-1) YENUSD_log_d1(t-5) r10yr(t-6)			
Sample range:		[1981 M1, 2004 M6]			
p-values of F-tests:					
transition variable	F	F4	F3	F2	suggested model
RNKY log_d1(t-1)	0.010144	0.42045	0.032406	0.018293	LSTAR1

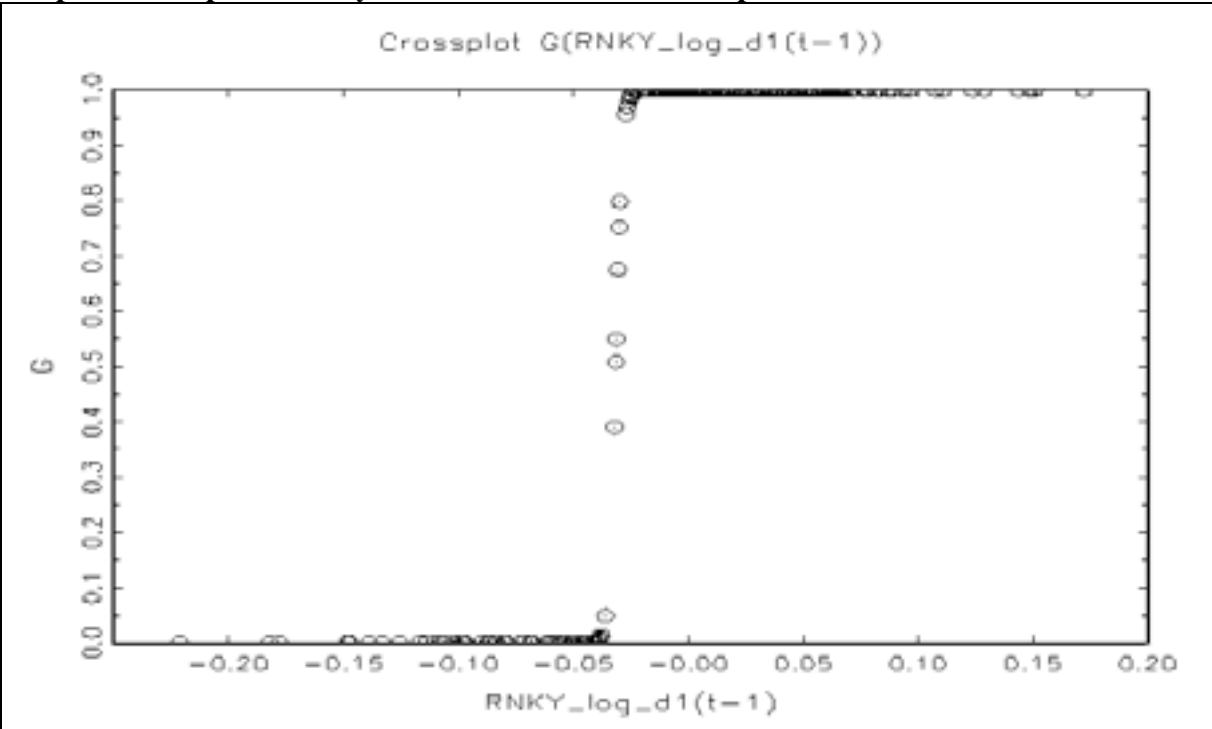
Table 43: Linearity vs. Non-Linearity test US

TESTING LINEARITY AGAINST STR IN THE US					
Variables in AR part:		CONST OECD_log_d1(t-1) riskspread_d1(t-6) M2_log_d1(t-12)			
Sample range:		[1981 M1, 2004 M6]			
p-values of F-tests:					
transition variable	F	F4	F3	F2	suggested model
RSPX_log_d1(t-1)	0.031514	0.40899	0.85052	0.0015825	LSTAR1

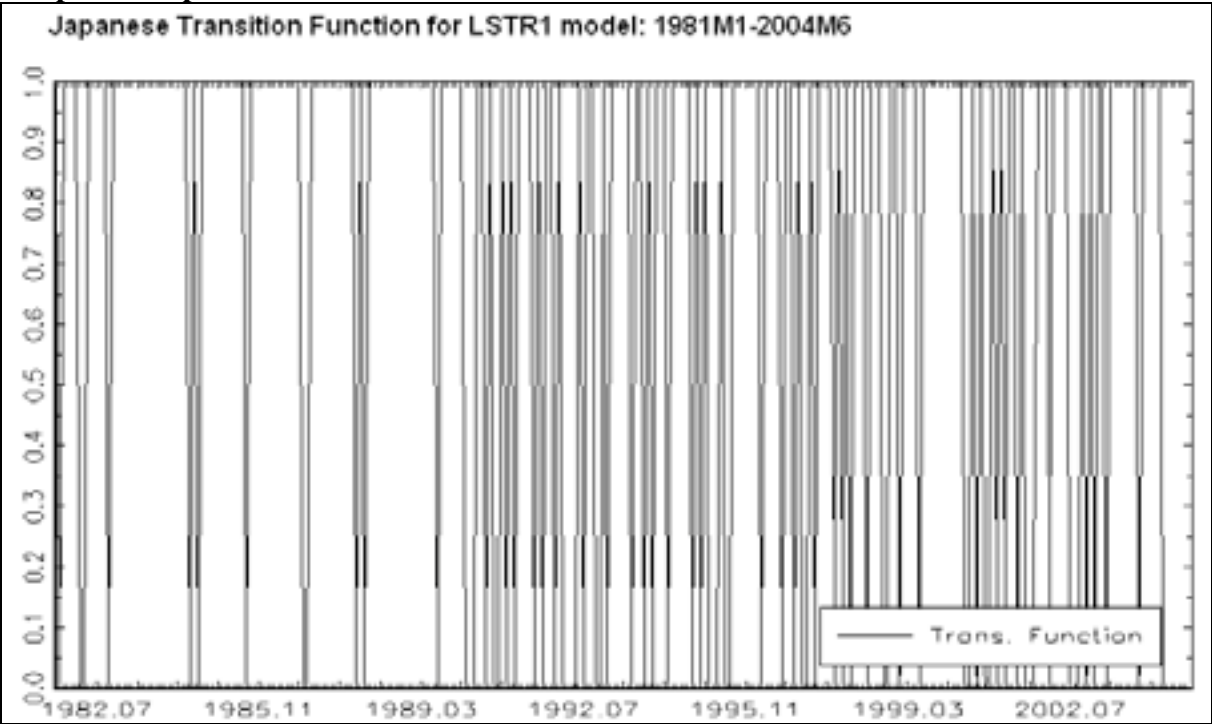
Table 44: Non-Linear estimation Japan

Japan 1981M1-2006M6					
		LSTAR1		LSTAR2	
Variable	Linear	Part1 (lower)	Part2 (upper)	Part1 (inner)	Part2 (outer)
Constant	-0.408 (0.241) {0.09} [-1.69]	0.0052 (0.0070) {0.45} [0.74]	-0.4512 (0.2704) {0.09} [-1.66]	-1.5794 (0.6952) {0.02} [-2.27]	1.2875 (0.7480) {0.08} [1.72]
OECD(-1)	3.258 (0.861) {0.00} [3.78]	3.84210 (0.9139) {0.00} [4.20]	Not significant	13.9466 (4.1268) {0.00} [3.37]	-11.4479 4.2217) {0.00} [-2.71]
YENUSD(-5)	0.205 (0.122) {0.09} [1.68]	0.2007 (0.1224) {0.10} [1.63]	Not significant	0.1941 (0.1199) {0.10} [1.61]	Not significant
R10YR(-6)	0.388 (0.234) {0.09} [1.66]	Not significant	0.4199 (0.2614) {0.10} [1.60]	1.4859 (0.6714) {0.02} [2.21]	-1.2075 (0.7225) {0.09} [-1.67]
γ		41.1393 (70.852)		353.0031 (801.0118)	
C1		-0.0315 (0.0066)		0.0371 (0.0018)	
C2				0.0548 (0.0039)	
AIC	-5.674	-5.6663		-5.6893*	
SC	-5.620*	-5.5725		-5.5575	
R-sq	0.0818	0.0965		0.1226*	
σ S.D. of resid	0.0582	0.0581		0.0571*	
Skewness	-0.1498*	-0.1636		-0.2037	
Kurtosis	3.7839*	3.9542		3.8877	
Jarque-Bera	7.8941* {0.0193}	11.3629 {0.0034}		10.8910 {0.0043}	
ARCH-LM(6)	22.2874* {0.0011}	23.9265 {0.0005}		26.8333 {0.0002}	
LM Godfrey(6)	{0.2304}	{0.3241}		{0.4125}*	
In Sample 1981M1- 2004M6					
RMSE	0.0582	0.0573*		0.0760	
MAE	0.0454	0.0438*		0.0582	
Out of Sample 2004M7- 2006M6					
RMSE	0.0476*	0.0482		0.0774	
MAE	0.0378*	0.0387		0.0659	
(Std. Dev.), {p - Value}, [t - Value], * denotes preferred model					

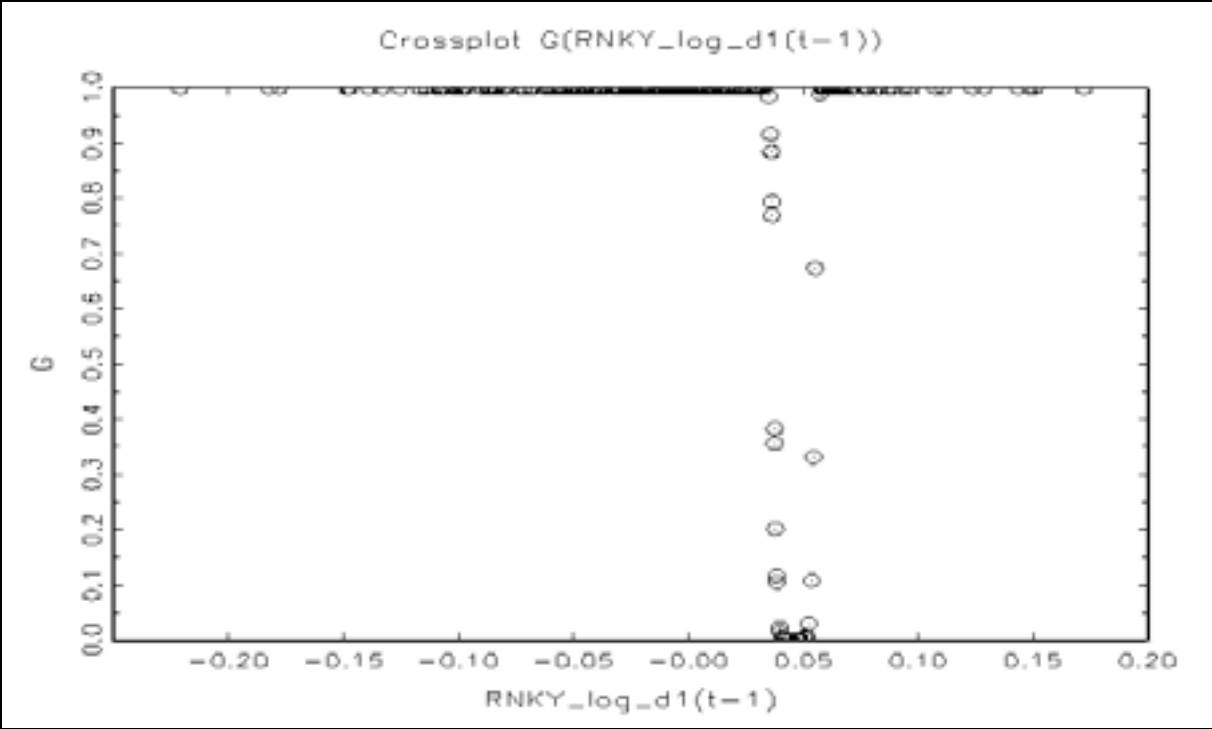
Graph 50: Graphical analysis of LSTAR1 model in Japan



Graph 51: Japanese Transition Function for LSTAR1 model



Graph 52: Graphical analysis of LSTAR2 model in Japan



Graph 53: Japanese Transition Function for LSTAR2 model

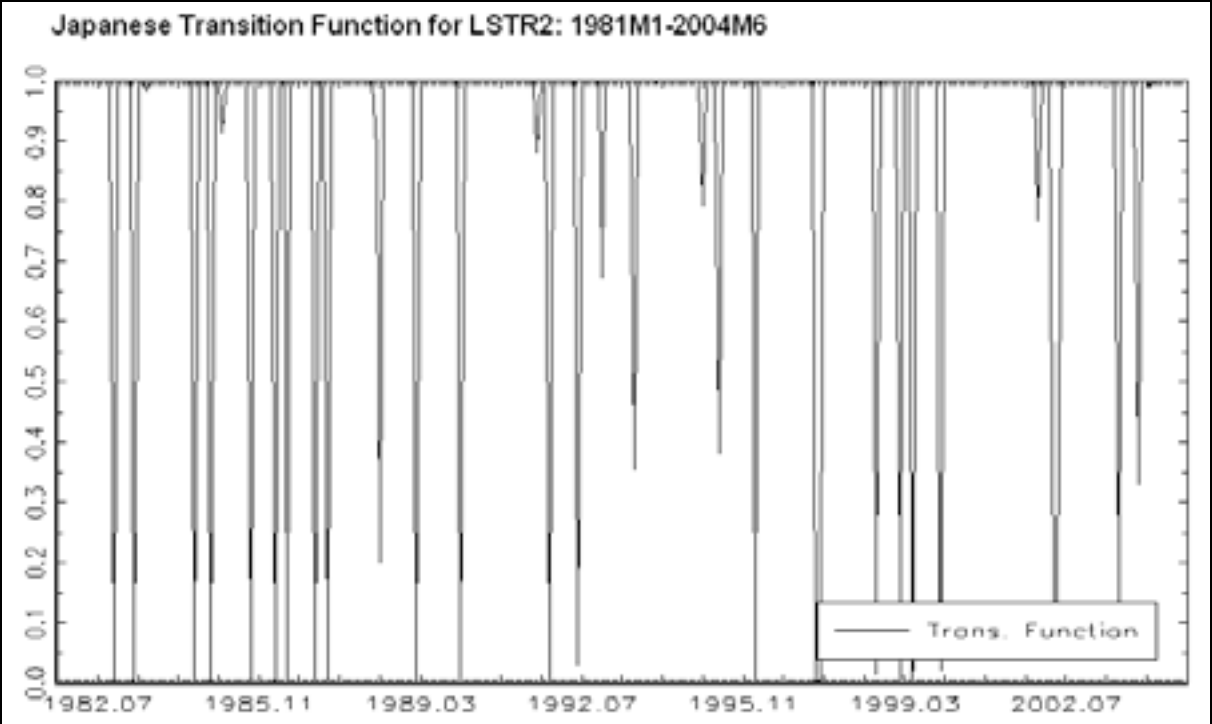
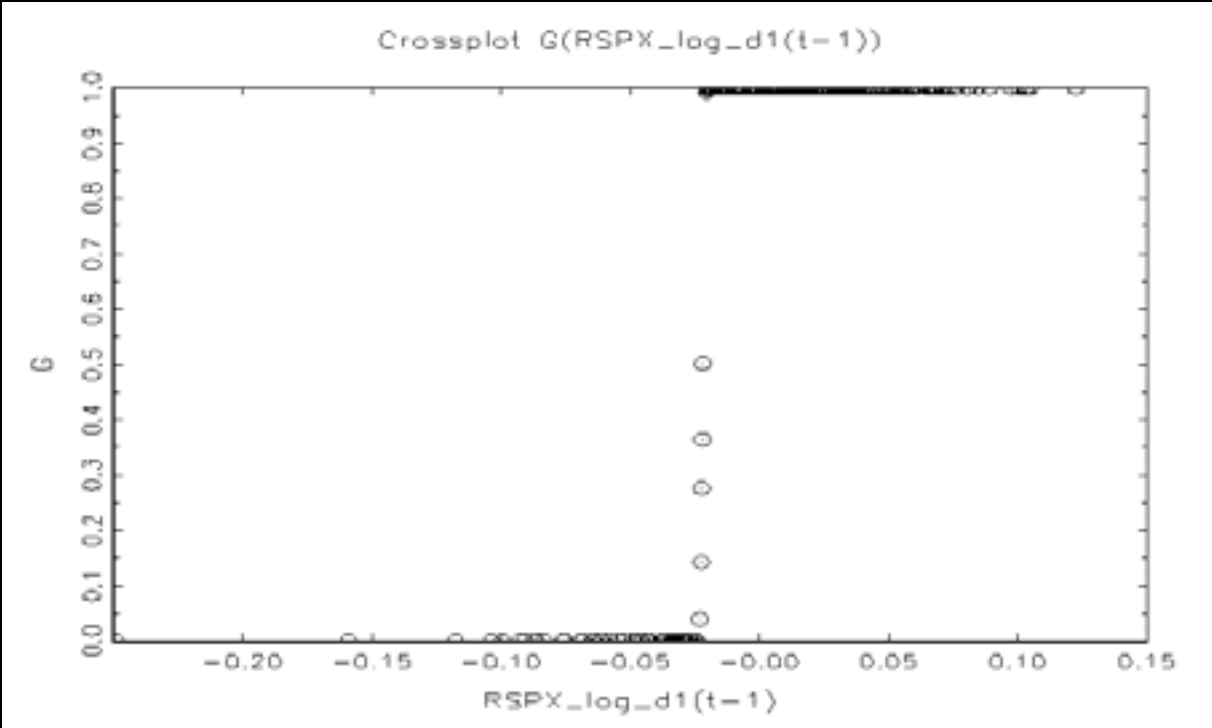


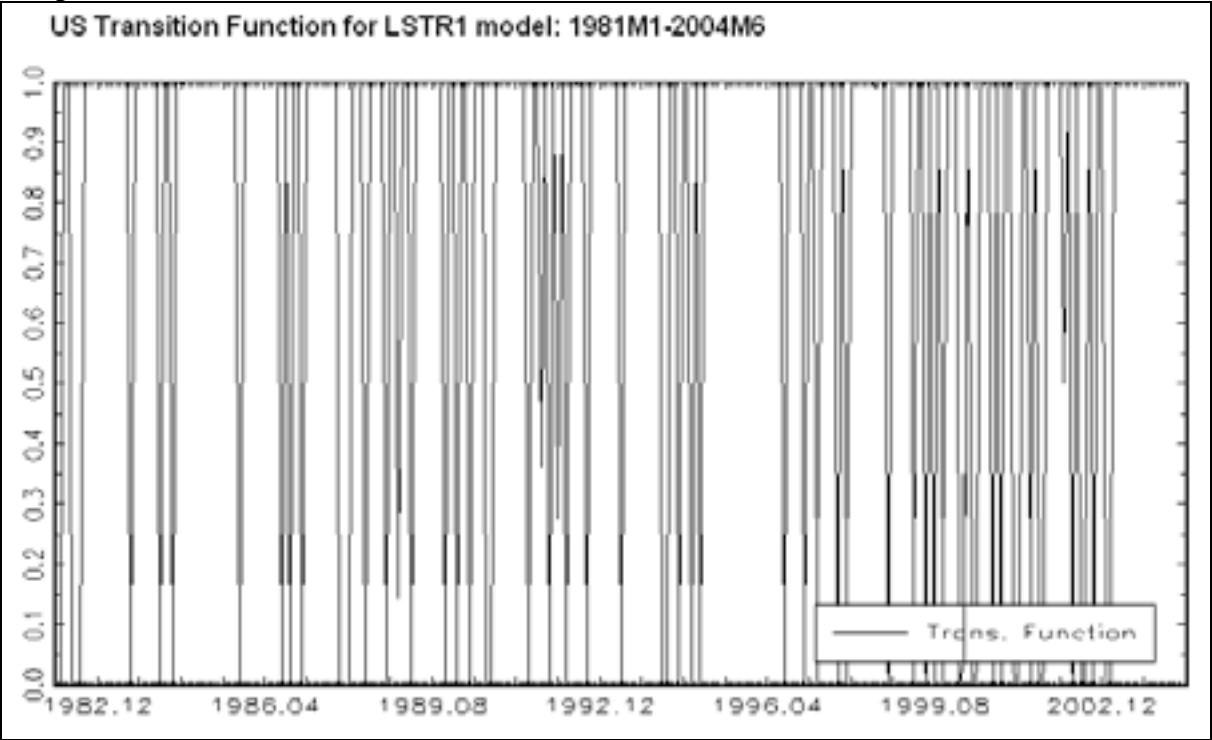
Table 45: Non-Linear estimation US

US 1981M1-2006M6					
		LSTAR1		LSTAR2	
Variable	Linear	Part1 (lower)	Part2 (upper)	Part1 (inner)	Part2 (outer)
Constant	0.010 (0.005) {0.02} [2.18]	0.0167 (0.0066) {0.01} [2.54]	-0.0068 (0.0065) {0.29} [-1.04]	-0.0003 (0.0119) {0.97} [-0.02]	0.0144 (0.0161) {0.36} [0.89]
OECD(-1)	1.066 (0.653) {0.10} [1.63]	1.122 (0.6600) {0.09} [1.70]	Not significant	Not significant	1.6512 (0.9360) {0.07} [1.76]
RiskSpread(-6)	0.031 (0.016) {0.06} [1.87]	0.1350 (0.0322) {0.00} [4.18]	-0.1434 (0.0375) {0.00} [-3.82]	Not significant	0.0570 (0.0230) {0.01} [2.48]
M2(-12)	-1.346 (0.754) {0.074} [-1.78]	-1.7131 (0.7541) {0.02} [-2.27]	Not significant	-1.3448 (0.7646) {0.07} [-1.75]	Not significant
γ		140.2973 (377.0777)		1.2800 (1.6192)	
C1		-0.0219 (0.0008)		0.0400 (0.0000)	
C2				0.0400 (0.0000)	
AIC	-6.2117	-6.2428*		-6.2018	
SC	-6.1583*	-6.1359		-6.0949	
R-sq	0.0343	0.0912*		0.0531	
σ S.D. of resid	0.0441	0.0435*		0.0444	
Skewness	-0.7638	-0.6394*		-0.7731	
Kurtosis	6.0423	4.8994*		5.9912	
Jarque-Bera	129.8968 {0.00}	58.7651* {0.00}		127.0786 {0.00}	
ARCH-LM(12)	5.6291 {0.9336}	5.0511 {0.9562}		4.6076* {0.9698}	
LM Godfrey(6)	0.7683*	0.6087		0.6766	
In Sample 1981M1- 2004M6					
RMSE	0.0441	0.0428*		0.0436	
MAE	0.0331	0.0328*		0.0329	
Out of Sample 2004M7- 2006M6					
RMSE	0.0217	0.0209*		0.0213	
MAE	0.0178	0.0169*		0.0173	
(Std. Dev.), {p - Value}, [t - Value], * denotes preferred model					

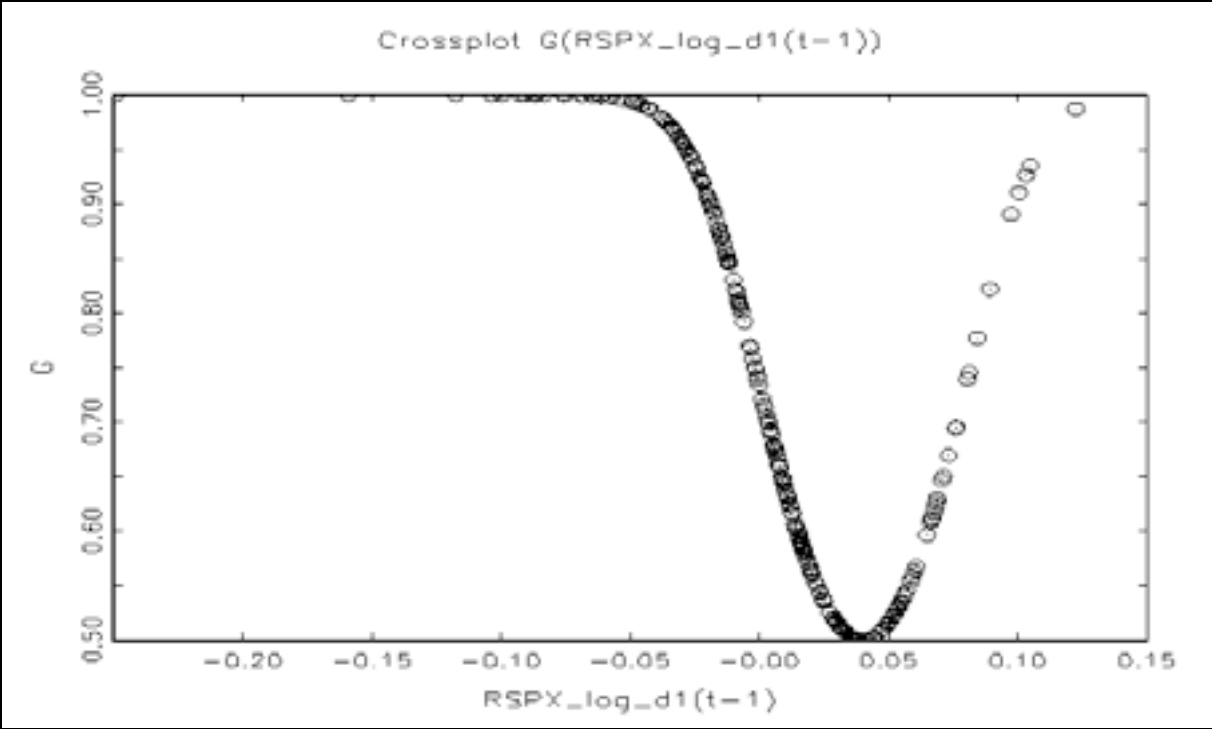
Graph 54: Graphical analysis of LSTAR1 model in the US



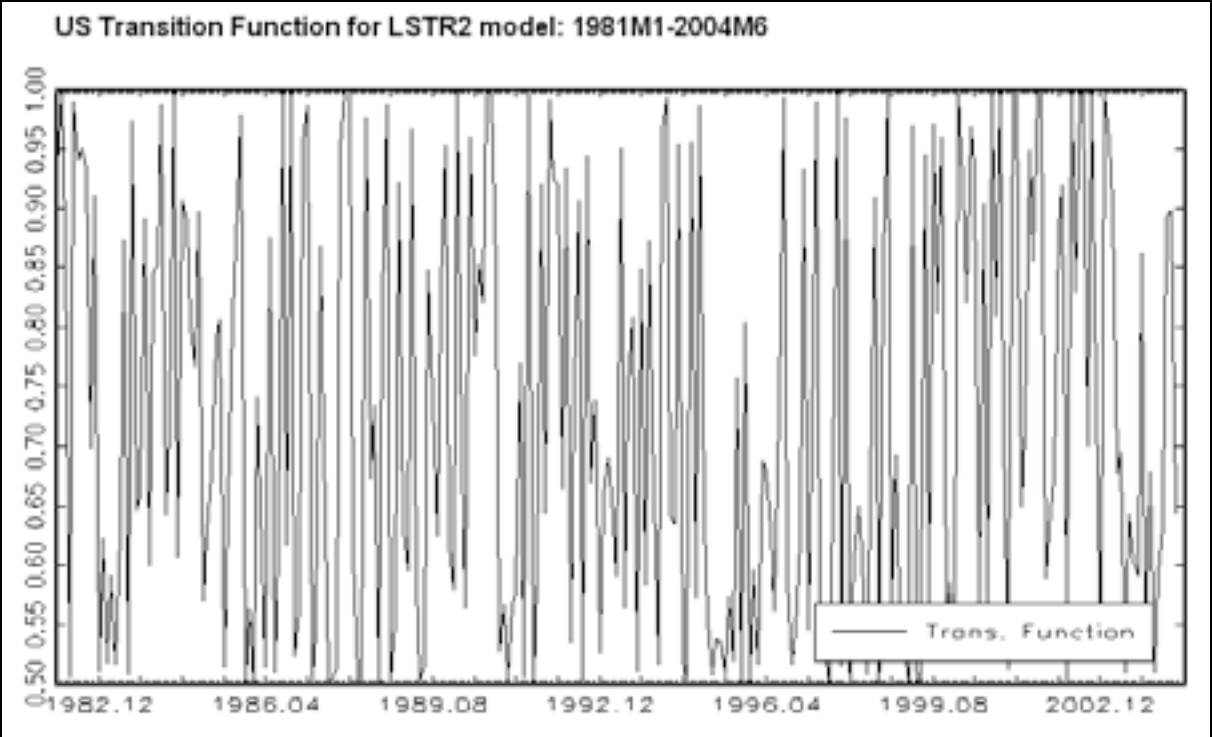
Graph 55: US Transition Function for LSTAR1 model



Graph 56: Graphical analysis of LSTAR2 model in the US



Graph 57: US Transition Function for LSTAR2 model



Chapter 5

5.0 Non-linearity in the Dividend Yield

In this chapter we will apply non-linear estimation methodology in order to test a specific non-linear model of fundamental investors that interact with noise traders in the US and Japanese dividend-yield. In contrast to the cointegration analysis in chapter 3 and the non-linear macroeconomic model in chapter 4, this chapter will investigate a univariate model of the dividend-yield.

In the cointegration analysis in chapter 3 we have supported the expected business cycle swings around the equilibrium vector. Furthermore, we found the expected relationships between macroeconomic variables and the stock market. As suggested by the PVM, we supported a positive relationship between industrial production and stock prices, whereas consumer prices and the 10-year bond yield had a negative impact on share prices in the US (for a discussion of the PVM model and the motivation of the different macroeconomic variables see chapter 2.4.8 and 3.4 respectively). In Japan the expected relationships could only be supported until March 1993 where we found statistical evidence of a structural break. After March 1993 the relationships change severely, as the discount rate and consumer prices show a positive effect, whereas money supply yields a negative effect on stock prices. We believe the structural break in Japan can partly be explained by the occurrence of a liquidity trap (for a discussion see chapter 3.8.1).

In the non-linear macroeconomic model in chapter 4, we could support non-linear behaviour between macroeconomic variables and stock market returns. More precisely, the US and Japanese stock market follow a different relationship with macroeconomic variables during periods of positive and negative returns or large and small returns. This is

an alternative explanation to the cointegration analysis for the historical stock market behaviour in the US and Japan. The US has experienced large positive returns during the 1990s and large negative returns between 2001 and 2002. By contrast, Japan suffered from large negative returns between 1989 and 2003 whereas the 1980s have been characterised by large positive returns. As a result, the different boom and bust periods in the US and Japan can be modelled by a smooth transition model for positive and negative returns or large and small returns. Generally, we have found a positive relationship between the OECD G7 leading indicator and stock returns in the US and Japan (for the motivation of the variables see chapter 4.4). Furthermore, we supported a positive relationship between the risk-spread and share prices in the US, whereas money supply is found to have a negative impact on stock returns. As expected, the risk-spread had a positive effect on stock market returns, except for very large positive stock returns in the LSTAR1 model in the US. We believe this can be explained by the 1990s where stock market returns have been large and positive whereas the risk spread was relatively small. In Japan one of the findings was unexpected, as we found a positive relationship between the 10-year bond yield and stock prices. However, it supported our empirical findings in chapter 3, where we have found a positive effect of the discount rate on share prices in Japan between 1993M4 and 2004M6. We think this has been caused by the severe downturn in Japan since 1990. Finally, the positive relationship between the YENUSD exchange rate and Japanese stock returns supported earlier findings in the literature.

In this chapter we will apply a non-linear estimation methodology again, in order to test a specific non-linear model of fundamental investors that interact with noise traders in the US and Japanese dividend-yield. The model is motivated by behavioural finance theory as explained in chapter 4.3. Assuming that institutional investors are more fundamental driven investors whereas private investors tend to be more noise driven investors, we

expect more insight into the interaction between noise and fundamental traders in the US and Japanese stock market. In chapter 1.1.2 we have reported that the Japanese stock market is dominated by institutional investors whereas the US stock market has a more balanced ownership structure between private investors and institutional investors. We may expect that the transition between regimes will be smoother in the US because of the more balanced forces between institutional and private investors. However, in chapter 4 this could only be supported for the LSTAR2 model whereas for the LSTAR1 model the transition was smoother in the Japanese stock market.

5.1 Introduction

The discussion about rational stock market bubbles in chapter 2.4.10 has shown that if the dividend discount model holds, dividends and share prices should be cointegrated and thus build a long-term equilibrium relationship. As discussed in chapter 2.4.9 and 2.4.11, there have been many studies that have investigated this relationship (for a discussion see inter alia Campbell and Shiller 1987, 1988b, Lee 1995, Sung and Urrutia 1995, Timmermann 1995 as well as Crowder and Wohar 1998). As there has not been explicit evidence in favour or against the cointegration hypothesis, some authors have allowed for non-linearity in the dividend to share-price relationship (for a discussion see inter alia Kanas 2005 and McMillan 2007). One possible reason cointegration has not been found is the possibility of non-linearity in the relationship between dividends and share prices (for more details see chapter 2.4.11). This can be interpreted as allowing for bubble-like behaviour, as there can be one mean-reverting regime and another momentum or random-walk regime in the non-linear model (McMillan 2007). In general it has been found that the log-dividend price ratio exhibits non-linear behaviour (for a discussion see inter alia Kanas 2005, Kapetanios,

Shin and Snell 2006 as well as McMillan 2007). The above mentioned authors have modelled the dividend yield in a STAR framework (for a discussion of STAR models see chapter 4.2). We argue that in practice investors will observe the dividend-yield rather than the log-dividend price ratio and we therefore analyse the possibility of non-linear behaviour in the dividend-yield.

5.2 Review of Empirical Literature

Our discussion here draws on the literature on bubbles in chapter 2.4.11 and the empirical literature on the present value model in chapter 2.4.9.

Furthermore, there are two highly relevant empirical papers about non-linearity in the dividend-price ratio.

The first one was written by Kanas (2003) and analyses non-linear cointegration between stock prices and dividends. In the paper, an alternate conditional expectation (ACE) algorithm is applied to stock prices and dividends to obtain a non-linear transformation (for a discussion of the ACE algorithm see inter alia Granger and Hallman 1991 and Meese and Rose 1991). The ACE algorithm is a non-linear transformation using a nonparametric technique. The transformed variables were then used to perform cointegration analysis. The author finds empirical evidence of non-linear cointegration between stock price and dividends in the US between 1871 and 1999.

The second paper was written by McMillan (2007) and applies non-linear ESTAR and LSTAR models to the log dividend-price ratio in thirteen countries including the G7 countries. The author applies unit root tests that allow for threshold behaviour and finds the

log dividend-yield to be stationary. Furthermore the paper concludes that an asymmetric ESTAR model does provide evidence of non-linearity. The dynamics of the log dividend-yield are characterised by an inner random walk regime, where the benefits from engaging in a trade do not outweigh the costs, and a reverting outer regime where engaging in a trade is profitable.

We will now test the same behaviour in the dividend yield for the US and Japan. However, we will look at a broader time horizon than McMillan (2007). As a first step, we will test for stationarity in the dividend-yield. If we can support that the dividend-yield is stationary, we will apply a non-linear LSTAR2 model. This model is able to estimate an inner regime where we expect momentum behaviour and an outer regime where we expect mean reversion behaviour of the dividend-yield (A LSTAR2 model is similar to an ESTAR model. For a discussion see 4.2). The momentum regime (inner regime) is re-enforcing and moving away from the long-term mean. This happens until the price deviations become large enough to enter the mean reversion regime (outer regime) where prices are forced back to the long-term mean. Therefore, an inner regime where trading costs outstrip the profits of a mean reversion trade allows for momentum or noise traders whereas in the outer regime fundamental investors get involved in mean reversion trades as costs are overcompensated by potential profits. In chapter 1.1.2 we have discussed the different institutional ownership structures in the US and Japan. We believe that the ownership structure or heterogeneity of investors' beliefs in general can cause interaction between different groups of investors. Peters (1994) has reported that heterogeneity in investors' beliefs can arise from different risk profiles, different investment horizons, different institutional dependence or geographical location. In contrast to the US stock market the Japanese stock market is almost completely dominated by institutional investors. As institutional investors are constrained by regulations and probably internal restrictions, the

typical investor behaviour might differ from private investors and this could impact the stock market behaviour in the US and Japan. For private investors it will be more difficult than for large institutional investors to collect large amounts of information and process the information properly. As a result, information asymmetries between private and institutional investors are quite likely. Assuming that noise traders are smaller and therefore less informed investors (typically private investors), large information asymmetries could make it more difficult for noise traders to survive. Therefore, we expect that the noise trader regime in the non-linear model between noise traders and fundamental traders is smaller in Japan than in the US.

5.3 Theoretical Considerations

The theoretical considerations for the model are based on behavioural finance (see chapter 4.2.3). Specifically, we will test whether the dividend-yield is stationary and whether we can find a non-linear model with an inner-regime that follows random-walk or momentum behaviour, whereas the outer-regime shows mean-reverting behaviour. An inner and outer regime is defined by the LSTAR2 model. For a discussion of the LSTAR2 model see equation 4.6.1 and 4.6.2 with $K=2$ in chapter 4.6.2. This model fits the idea of trading costs and other risks involved in mean-reversion trades (e.g. financing costs, borrowing constraints, clients' impatience when trades do not show immediate profits). For a discussion see chapter 4.3. As shown in chapter 2.4.8 the standard present value model can be used to calculate a fair share price by discounting future cash-flows to the share holders. Assuming that dividends are the cash-flows a shareholder receives for holding the stock, the fair share price should be equal to the future discounted dividends (see equation 2.4.80 in chapter 2.4.8). If there is no bubble and dividends are stationary in levels, stock prices

will be equal to market fundamentals and should also be stationary in levels. So in general, if dividends are stationary in n^{th} differences, stock prices should also be stationary in n^{th} differences (Gurkaynak 2005). This relationship breaks down in the presence of bubbles, as Diba and Grossman (1988b) point out that the bubble process is nonstationary regardless of how many differences are taken. This property can be tested econometrically. Therefore, a way to test for the existence of a bubble in the data, is to see whether stock prices are stationary when differenced the number of times that are required to make dividends stationary. This also imposes an equilibrium relationship between stock prices and dividends. Under the null hypothesis of no bubbles, dividends and stock prices should be cointegrated. For instance Diba and Grossman (1988a) have found dividends and stock prices to be integrated in levels, but stationary in differences. Furthermore, they have found strong evidence for cointegration between stock prices and dividends and interpreted these findings as indicating that a stock price bubble is not present in the data. Froot and Obstfeld (1991) propose a different kind of bubble where the bubble is tied to the level of dividends (for a detailed discussion see chapter 2.4.11). They propose a bubble term that follows:

$$B(D_t) = cD_t^\lambda. \text{ (See also equation 2.4.102 and chapter 2.4.11)}$$

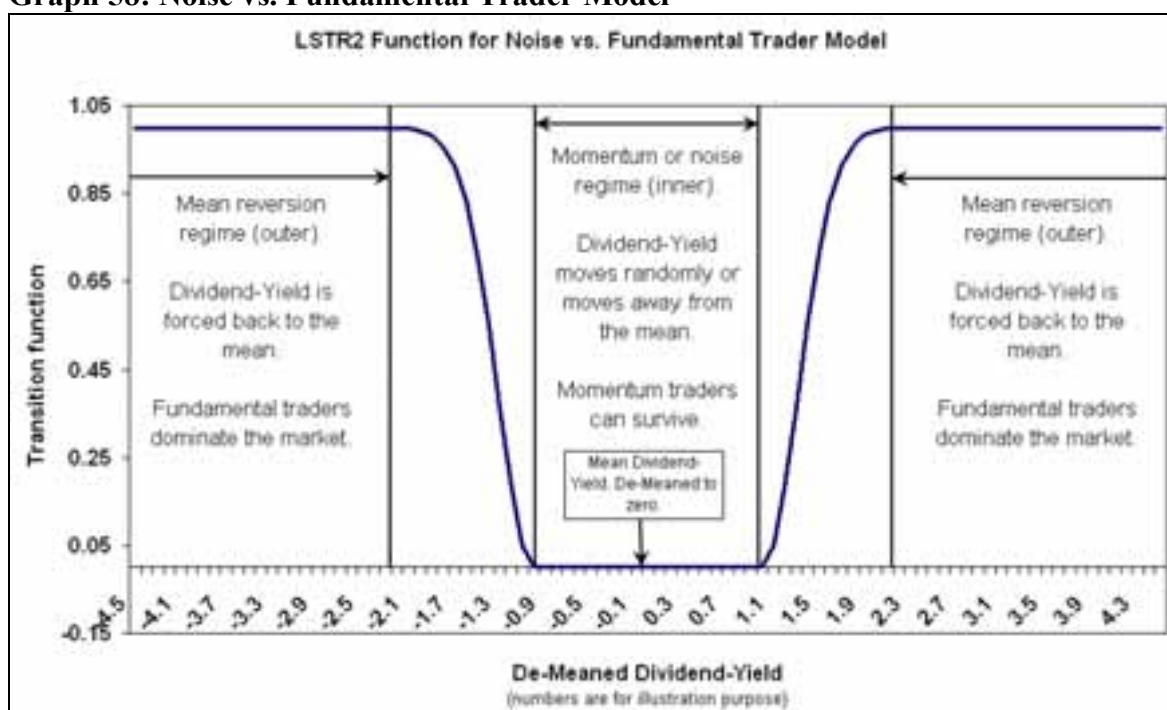
This bubble process depends completely on the level of dividends and is therefore not independent of the fundamental process. If such an intrinsic process exists, stock prices will be more sensitive to dividend changes than justified by a linear pricing model. Therefore, under the null hypothesis of no bubbles, prices are a linear function of dividends and the price/dividend ratio is approximately a constant. On the other hand, intrinsic bubbles impart nonlinearity into the relationship between stock prices and dividends. Froot and Obstfeld (1991) investigation shows that there exists a nonlinear relationship between

stock prices and dividends, but this is interpreted as a sign of bubbles because the model is assumed to be linear. We will allow for two regimes in the dividend-yield model and therefore incorporate non-linearity. As we allow for a momentum and a mean-reversion regime, bubble-like behaviour can be modelled. The momentum regime is re-enforcing and moving away from the long term mean until the price deviations become large enough to enter the mean reversion regime where prices are forced back to the long-term mean. For that reason, we expect a coefficient greater than 1 for the momentum regime whereas the coefficient in the mean reversion regime is expected to be smaller than 1.

The following diagram (graph 58 on page 284) illustrates the noise versus fundamental trader model in the dividend-yield. Assuming that the long-term mean of the dividend-yield is equal to the long-term fundamental value, the model investigates deviations from the long-term mean and the process of mean reversion. For this reason, the dividend-yield series is de-meant and the y-axis in the diagram shows deviations from the long-term mean dividend yield in percentage points. So a value of -2.5 means that the current dividend-yield is 2.5% below its long-term mean. On the left hand side is one of the two outer mean reversion regimes. In this regime we expect a coefficient smaller than one. This means that if the dividend yield falls far enough to be in this left hand side regime, mean reversion investors get involved. In this particular case, the very low dividend-yield indicates market overvaluation and fundamental (mean reversion) investors should be attracted to short the market until the dividend-yield moves back (reverts) to the middle regime (close to long-term fundamental value). In the middle regime, the dividend-yield is close to long-term fundamental value (the de-meant dividend-yield is therefore close to zero). In this case, the deviations from long-term fundamental value are too small to attract fundamental investors and the market can be dominated by noise or momentum traders. In the middle regime we therefore expect a coefficient close to one or greater. Between the

left hand side regime and the middle regime is a transition area where fundamental investors and noise traders compete with each other but none of them significantly dominates the market. As discussed before, heterogeneity in investors' beliefs give reason to suspect a smooth transition between extremes, rather than abrupt (for discussions see Peters 1994). The transition area accounts for this smoothing effect. On the right hand side is the second outer regime where we also expect a coefficient smaller than one. This means that if the dividend-yield is rising enough to be in the right hand side regime, fundamental (mean reversion) investors get involved again because of market undervaluation. Fundamental investors are attracted by the high dividend-yield to buy the market until the market moves back to the middle regime. Between the right hand side regime and the middle regime is a transition area where fundamental investors and noise traders compete with each other but none of them significantly dominates the market.

Graph 58: Noise vs. Fundamental Trader Model



Before we estimate the non-linear LSTAR2 model we test for stationarity in the dividend-yield. Evidence of stationarity supports the idea of no bubble in the dividend-yield. However, even if we find the dividend-yield to be stationary in levels, we will proceed and test for non-linear behaviour in the process of mean reversion.

5.4 Data selection, sources and construction of primary variables

For the analysis we use the aggregate dividend yield in Japan between 1965 and 2007 due to data availability, whereas for the US we use data between 1900 and 2007. The longer US data history gives us the opportunity to look at a broader horizon than in Japan. Furthermore, most papers have used long-term data in the US and this makes the findings comparable to earlier papers. All data is on monthly frequency and gives us a rich data set for the empirical investigation. It is important to note that most investigations have used the log dividend-price ratio. In particular if the present value model is used to motivate the study, it is important to use the logarithm of the fundamental process (e.g. dividend series) and the stock price as those should be cointegrated and the ratio of both variables therefore stationary (for further details see McMillan 2007). We want to make clear that we do not motivate our analysis at this point with the present value model. Instead, we argue that the dividend yield is a state-variable that indicates risk attitudes in an economy (see intertemporal asset pricing in chapter 2.4.3). Therefore, in a period of solid economic growth and high incomes, the dividend yield might be low as risk aversion might be very low during such a period. However, this implies that the expected future return should be low as well. In contrast, during a recession with high unemployment and falling incomes, the dividend yield might be high as risk aversion is high. As a result the expected future returns are high. Furthermore, many cross section investigations have found the dividend yield to have predictive power for stock market returns of individual securities. Many of

those studies have used the dividend yield as a factor. Thus those papers have used rolling 12-month dividends divided by the stock-price at the end of the period as variable (see for instance Ang and Peterson 1985, Ferson and Harvey 1991, Campbell and Hamao 1992, Mei 1992 as well as Goetzmann and Jorion 1995). We follow that route and also use 12-month trailing dividend payments divided by the aggregate stock price⁴¹.

<i>Dividend Yield Data Set</i>					
Variable	Name	Sample	Source	Code	SA or NSA
SPX Dividend Yield	S&P 500 Stock Index Dividend Yield	1900:M1-2007M1	Robert Shiller Homepage	http://www.econ.yale.edu/~shiller/data/ie_data.xls	NSA
NKY Dividend Yield	Nikkei 225 Stock Index Dividend Yield	1965:M1-2007M1	Merrill Lynch Capital Markets	JPDivYield	NSA

5.5 Plots of time series, mean and standard deviation

In a first step we show plots of the time series, mean and standard deviations (for mean, standard deviation, kurtosis, skew and Jarque-Bera probabilities see table 46 on page 298).

It is interesting to note that the average dividend-yield in the US with 4.36% is much larger than the average dividend-yield in Japan with 1.84%. By contrast, the standard deviation of the dividend-yield is almost the same in both countries. One of the reasons for the higher average dividend-yield in the US is the longer time horizon because dividend-yields were higher between 1900 and 1965 than 1965 and 2007 (see graph 59 on page 298).

⁴¹ We have also analysed the log dividend price ratio as well. However, the log dividend price ratio has not been found to be stationary during the analysed period and to simplify econometric matters we decide to use the dividend yield that has been found to be stationary in levels (for a discussion see chapter 5.6).

The plots of the time series give us an idea about the statistical properties. The dividend yield series seem to be stationary in levels (see graph 59 and 60 on pages 298 and 299). In the US the dividend-yield increased between 1900 and 1932 whereas it declined between 1932 and 2007. By contrast, in Japan the dividend-yield fell between 1965 and 1989 whereas it rose again between 1989 and 2007. In Japan this corresponds with the economic boom period between 1965 and 1989 that was followed by the crisis period between 1989 and 2003 (for a discussion see chapter 3.3).

5.6 Empirical Methods

First, we will apply the ADF unit root test to the data and then proceed with the non-linear analysis of the dividend yield (for a discussion of the ADF test see chapter 3.6.1). It should be noted that the critical values of the Dickey-Fuller test are not valid for a time series that exhibits threshold behaviour. However, in such a case the ADF test underestimates stationarity. As a result, if we accept the null that the dividend-yield is stationary in levels at standard significance levels using the ADF test, we will assume this result also holds where there is threshold behaviour. The correct critical values would have to be simulated and we will simplify econometric matters by using the standard critical values (for a discussion see Andrews and Ploberger 1994). However, we are aware of the fact that those are not entirely correct and will understate the stationary property of a time-series with threshold behaviour.

5.6.1 Unit Root test

As discussed above, in order to verify the stationarity of the variables we will apply the augmented Dickey Fuller test. For the smooth transition regression models that we will

apply to our data set it is important that the variables are stationary. A detailed description of the augmented Dickey Fuller test can be found in chapter 3.6.1 of this thesis.

5.6.2 Non linear estimation procedure

In order to model non-linear behaviour in the dividend-yield we will apply a LSTAR2 model. This model is able to distinguish between positive and negative deviations from the mean and suits the idea of a two regime switching model between noise traders and fundamental investors (for a detailed discussion of the LSTAR2 model see chapter 4.2.6.2)

5.7 Empirical Evidence

In this chapter we will look at the empirical findings in the US and Japanese dividend-yield. As a first step, we will apply a unit root test to the data in order to verify the stationarity of the data. In a second step we will apply the LSTAR2 model to the dividend yield in order to test for non-linear behaviour.

5.7.1 Unit Root results

As can be seen in table 47 and 48 (on page 299), there is evidence of the dividend-yield being stationary in the US and Japan. We would argue the dividend-yield should have a constant as it does not fluctuate around zero but rather a positive level. For this reason we proceed with the analysis assuming that the dividend-yield is stationary in levels. Stationarity of the dividend-yield in levels supports the cointegration hypothesis between stock prices and dividends and can be interpreted as evidence against bubbles in the dividend-yield. However, although the dividend-yield is found to be stationary, it may still exhibit non-linear dynamics in the process of reversion (McMillan 2007).

5.7.2 Non linear estimation results

We follow McMillan (2007) and de-mean the dividend yield in order to allow for mean reversion and negative momentum for dividend-yields below average⁴². As we want to test a specific model that incorporates a LSTAR2 framework, we start with using this model and compare it to the linear alternative. As can be seen in table 49 (on page 300), we are able to find a LSTAR2 model in Japan. As we have expected, the dividend-yield in Japan shows an inner-regime that exhibits positive momentum behaviour and an outer-regime with mean-reversion effects. More precisely, the dividend-yield coefficient in the inner-regime is relatively large and positive with 1.64 whereas the outer regime coefficient with -0.65 shows mean-reversion behaviour. The momentum effect in the inner regime is quite large as the current deviation of the dividend-yield from the mean is multiplied by 1.64 to get the expected deviation from the mean dividend-yield in the next period. In contrast, the mean reversion effect is not that strong as the current deviation of the dividend-yield from the mean is effectively multiplied by 0.99 in the outer regimes to get the expected deviation from the mean dividend-yield in the next period (see graph 61 on page 301). This supports the idea of noise traders or momentum players that can survive in the inner-regime where the costs as well as risk-return of arbitrage might not be favourable for fundamental investors.

However, in the outer-regime, fundamental investors come to the market to exploit the arbitrage opportunities and momentum traders will be forced out of the market until we re-enter the inner-regime. Although there is momentum behaviour in the inner-regime in Japan, the inner-regime is not very large and ranges between 3.38% and 4.41% from the

⁴² If we would not de-mean the dividend-yield we would only allow for positive momentum in the middle regime of the dividend-yield. Furthermore, the mean-reversion effect would only be the case for large positive returns whereas large negative returns would follow negative momentum.

mean dividend-yield. The position of the momentum regime is not as expected because it is not centered around zero (the mean dividend-yield). This momentum regime corresponds to the period 1965, late 1967 and early 1968. The remaining periods have been governed by the mean-reversion regime. This means that only during the later part of the 1960s the Japanese stock market was momentum driven. As discussed in chapter 3.3, stock market returns were extremely high during the 1950s and 1960s in Japan and this might have attracted momentum traders. In contrast, the economic boom period during the 1980s and the crisis period of the 1990s was not driven by the momentum regime in the non-linear model of the dividend yield.

In the US we find a similar picture to Japan. As can be seen in table 50 (on page 302), in the US we find an inner-regime that exhibits momentum behaviour and an outer-regime with mean-reversion effects as in Japan. More precisely, the dividend-yield coefficient in the inner-regime is positive with 1.02 whereas the outer regime coefficient with -0.23 shows mean-reversion behaviour. In contrast to Japan, the US inner-regime is much larger and ranges between -2.90% and 8.26% and exhibits momentum behaviour. We would argue that in the inner-regime in the US, arbitrage opportunities are not large enough to be explored and therefore noise traders might survive. The mean-reversion regime corresponds to the periods June and July 1932, March to July 1998, November 1998 to August 2001 and October 2001 to April 2002. In 1932 there was a stock market crisis caused by massive bond defaults that destroyed many savers' investments and was weakening the banking system (Geisst 1997). The Russian Government default on their government bonds in 1998 caused a stock market crisis with the failure of hedge fund LTCM. However, the stock market recovered relatively quickly in 1999 and made an all time high in March 2000. From March 2000 onwards the US stock market declined until

2002. So overall, the mean reversion regime seems to picking up periods of crisis that are followed by a fast stock market recovery.

In both countries the regime switches abruptly as the estimated gamma is quite large. As the gamma is larger in Japan than in the US, technically speaking this supports our expectation that the regime should change faster in Japan due to the dominance of institutional investors. However, the gamma is too large for both countries to make a relevant distinction. The diagnostic tests are mainly favourable to the non-linear model in the US and Japan. Only the ARCH LM test favours the linear model in the US and Japan. The Godfrey LM test for autocorrelation favours the linear model in the US whereas the SC criterion prefers the linear model in Japan. Hence, due to the ARCH LM test there is evidence of further non-linear behaviour in the relationship. This could for instance indicate non-linearity in the variance of the variable.

5.8 Differences and Commonalities in the US and Japan

In the preceding chapter we have analysed non-linear behaviour in the dividend yield of the US and Japanese stock market. Thus, we have verified whether there exists a momentum or random walk regime that interacts with a mean-reversion regime. Due to data availability and in line with the existing literature, we have used the dividend yield in the US since 1900, whereas the data only spans 1965 until 2005 for the Japanese case. First of all, we find that the dividend yield in the US and Japan follows a stationary process. Furthermore, both markets are characterised by two regimes. In Japan and the US, we do find an inner momentum-regime and an outer mean-reversion regime. One of the main differences between the US and Japan is that the US inner-regime is much larger than the Japanese inner-regime. Furthermore, the momentum regime in Japan is not centred around

the mean dividend-yield. Therefore, the window of opportunity for noise or momentum traders is much larger in the US than in Japan. Thus we support existing findings in the literature that have reported momentum profits in the US but not in Japan. The literature on momentum profits suggests that the different origin of the legal system might be responsible for the existence of momentum profits. More precisely, as discussed in chapter 2.2.1, Chui, Titman and Wei (2000) find evidence that countries with a common law origin like the US show strong momentum, whereas countries with a civil law origin like Japan show no momentum effects. The authors have argued that the absence of momentum in civil law countries like Japan might be explained by the greater risk of stock price manipulation. However, in Japan the dividend-yield has been shifting down for most of the analysed period, whereas the US has shown many mean reversion episodes. For that reason and the fact that we have used different periods, one should not make an exact comparison of the reported coefficients⁴³. Overall, we think that a two-regime switching model that incorporates noise and fundamental traders is a good alternative to the often suggested bubble theory in the US and Japanese stock market.

As an alternative to our interpretation, we believe the dividend yield might be linked to the interest rate level over time. Generally, an investor is faced with the decision whether to invest in stocks or bonds. For that reason, we think the dividend yield must be in competition with the bond yield (for a discussion see Durré and Giot (2005), Lander, Orphanides and Douvogiannis (1997) and Asness (2003)). Graph 63 and 64 (on page 304) show that the dividend-yield and the long-term bond yield in the US and Japan have shown some co-movement over time. Although this might be tentative; the long term-bond yield could be a long-term attractor for the dividend-yield. This would mean that an investor prefers stocks over bonds as long as the dividend-yield is higher than the bond yield and

⁴³ We have also tested the dividend-yield for stationarity since 1965 in the US. However, the dividend-yield did not appear to be stationary in levels since 1965.

vice versa. Thus the bond yield and dividend-yield might converge over time due to this dynamics. If this would be the case, the non-linearity might enter the long-term bond yield instead of the dividend-yield. Therefore, our model could be spurious if the true mean reversion effect is taking place in the bond yield. In this case the dividend-yield is simply following the bond yield. The long-term bond yield should be around the long-term trend growth of the economy. If there are longer term cycles or waves of productivity growth and thus economic growth, the GDP trend growth might see fluctuations over time. This would also lead to waves of optimism about future economic growth and hence the long-term bond yield would show that pattern too. So at the end of the day, the true non-linearity might stem from economic growth. Non-linear behaviour of economic growth has been reported by researchers (for a discussion see Hamilton 1989b).

Another point to make is the fact that payout ratios are not constant over time. As can be seen in graph 65 (on page 305), the Japanese payout ratio has declined since 1965. For that reason, the dividend-yield might underestimate the corporate development over time. Furthermore, in recent years many companies have preferred share buy backs instead of dividend payments. As a result, dividend-yields might be misleading. In the US, payout ratios have also been declining since the 1920s (see graph 66 on page 305). However, as in Japan, share buy backs have become very popular in recent years in the US and dividend-yields might be depressed. The non-linear behaviour we have found in the dividend-yield could also be caused by the fluctuations in the payout ratio. If this is the case, the payout ratio might show non-linear behaviour and the non-linearity in the dividend yield would be spurious.

5.9 Contribution of this analysis to the existing literature

We believe we have made a number of contributions to the existing literature. First of all, we have found the dividend-yield to be stationary over the analysed period in both countries. As the empirical literature is divided between papers that support stationarity and others that reject stationarity in the dividend-yield or log dividend price ratio, we add to the evidence in favour of stationarity. Furthermore, we support regime-switching behaviour in the dividend-yield and suggest a model of noise traders that interact with fundamental mean-reversion traders. There have been many attempts in the literature to model a bubble process in the dividend-yield, but we believe our noise trader versus mean-reversion investor model successfully describes the process and gives less room for the existence of bubbles. Furthermore, we think our model is better embedded in theoretical considerations and need not overcome the problem of when and how bubbles start or end, as the noise and momentum regimes coexist over time. Finally, we support findings in the literature that there might be more room for momentum profits in the US than in Japan.

5.10 Explanation for findings

We report that the dividend-yield follows a stationary process during the analysed period in the US and Japan. However, we are aware of the fact that the results are very much period-dependent and we cannot give a final answer to whether dividend-yields are stationary or not. In particular, dividend-yields have been shifting down in the US during the 1990s as well as in Japan during the 1980s and have not been moving back to their long-term means yet. Therefore, the future mean-reversion behaviour has still to be proven. In Japan we find a relatively small momentum regime and that supports the view that momentum profits are not likely to be found in Japan. One explanation for that finding is reported in the literature and states that civil law countries show less momentum profits

due to the higher risk of stock market manipulation. Finally, we have found both countries to follow a regime-switching process between noise traders and mean-reversion traders. This might be caused by the fact that both countries have experienced very large moves in stock prices and valuation ratios over the analysed periods. As a result, there should have been good opportunities to make profits for noise and mean-reversion traders over time.

5.11 Conclusion

In the preceding section we have investigated a regime-switching model between momentum traders and mean-reversion investors in the dividend-yield ratio for the US and Japanese stock market. First of all, we have found evidence that the dividend-yield is stationary in levels for the analysed period in the US and Japan. This supports the idea of no bubble in the dividend-yield. However, although the dividend-yield appears to be stationary in levels, we found non-linear behaviour in the process of reversion to the mean. Overall, we support two regimes in the US and Japan. The inner regime shows momentum behaviour whereas the outer regimes follow a mean-reversion process. Furthermore, we find the inner regime to be much smaller in Japan than in the US. As we believe that the inner regime in the US is favourable for momentum, the likelihood of momentum profits is larger in the US than in Japan. As expected, the momentum regime in the US corresponds to the boom period at the end of the 1990s and the stock market collapse between 2000 and 2002. However, against our expectations the boom period of the 1980s and the period of crisis during the 1990s in Japan was not governed by the momentum regime. By contrast, only the boom period of the late 1960s was driven by momentum traders in Japan. Overall, our findings complement our non-linear macroeconomic model in chapter 4 and the cointegration analysis in chapter 3.

In the cointegration analysis in chapter 3 we have supported the expected business cycle swings in the equilibrium vector. Furthermore, we found the expected relationships between macroeconomic variables and the stock market. As suggested by the PVM, we supported a positive relationship between industrial production and stock prices, whereas consumer prices and the 10-year bond yield had a negative impact on share prices in the US (for a discussion of the PVM model and the motivation of the different macroeconomic variables see chapter 2.4.8 and 3.4 respectively). In Japan the expected relationships could only be supported until March 1993 where we found statistical evidence of a structural break. After March 1993 the relationships change severely, as the discount rate and consumer prices show a positive effect, whereas money supply yields a negative effect on stock prices. We believe the structural break in Japan can partly be explained by the occurrence of a liquidity trap (for a discussion see chapter 3.8.1).

In the non-linear macroeconomic model in chapter 4, we could support non-linear behaviour between macroeconomic variables and the stock market. More precisely, the US and Japanese stock market follow a different relationship with macroeconomic variables during periods of positive and negative returns or large and small returns. This is an alternative explanation to the cointegration analysis for the historical stock market behaviour in the US and Japan. The US has experienced large positive returns during the 1990s and large negative returns between 2001 and 2002. By contrast, Japan suffered from large negative returns between 1989 and 2003 whereas the 1980s have been characterised by large positive returns. As a result, the different boom and bust periods in the US and Japan can be modelled by a smooth transition model for positive and negative returns or large and small returns. Generally, we have found a positive relationship between the OECD G7 leading indicator and stock returns in the US and Japan (for the motivation of the variables see chapter 4.4). Furthermore, we supported a positive relationship between

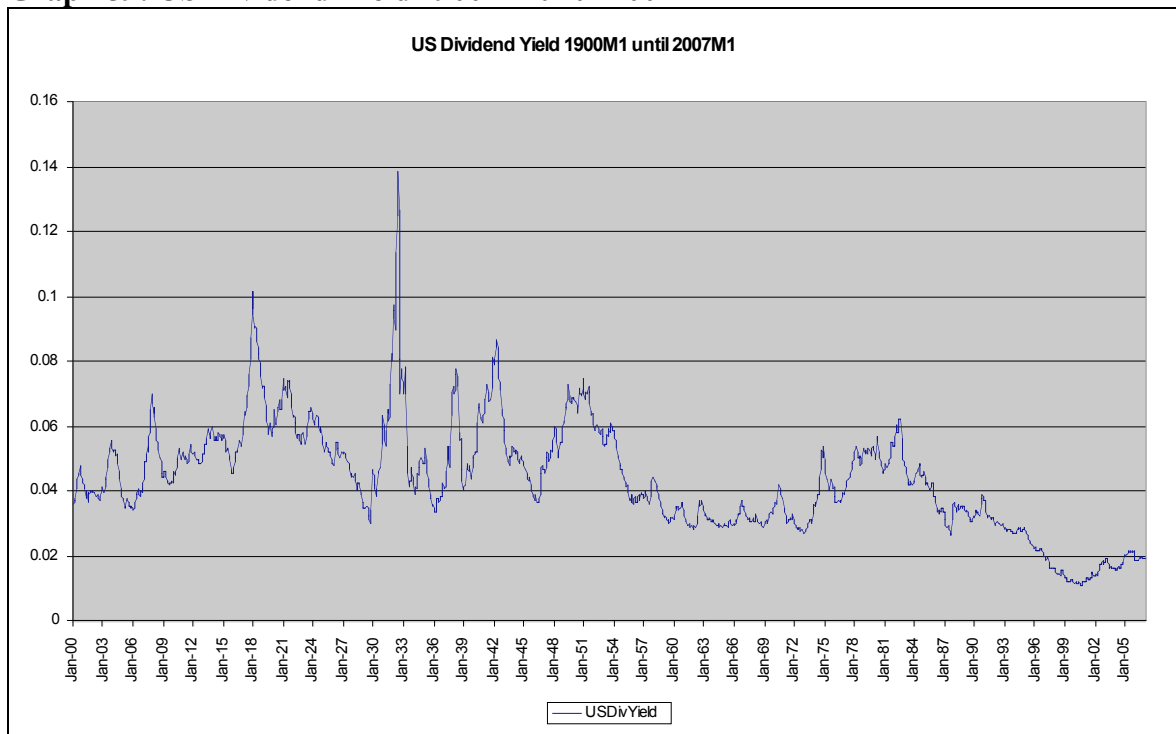
the risk-spread and share prices in the US, whereas money supply is found to have a negative impact on stock returns. As expected, the risk-spread had a positive effect on stock market returns, except for very large positive stock returns in the LSTAR1 model in the US. We believe this can be explained by the 1990s where stock market returns have been large and positive whereas the risk spread was relatively small. In Japan one of the findings was unexpected, as we found a positive relationship between the 10-year bond yield and stock prices. However, it supported our empirical findings in chapter 3, where we have found a positive effect of the discount rate on share prices in Japan between 1993M4 and 2004M6. We think this has been caused by the severe downturn in Japan since 1990. Finally, the positive relationship between the YENUSD exchange rate and Japanese stock returns supported earlier findings in the literature.

5.12 Tables and Graphs

Table 46: US and Japanese Dividend Yield summary statistics

Variable	Mean	Std.Dev.	Skewness	Kurtosis	Jarque-Bera probability
US Dividend Yield since 1900	0.043683	0.016662	0.6303	4.5724	0.0000
US Dividend Yield since 1965	0.031798	0.012006	0.2194	2.3758	0.0022
Japanese Dividend Yield since 1965	0.018424	0.014412	1.3857	3.8907	0.0000

Graph 59: US Dividend Yield 1900M1 until 2007M1



Graph 60: Japanese Dividend Yield 1965M1 until 2007M1

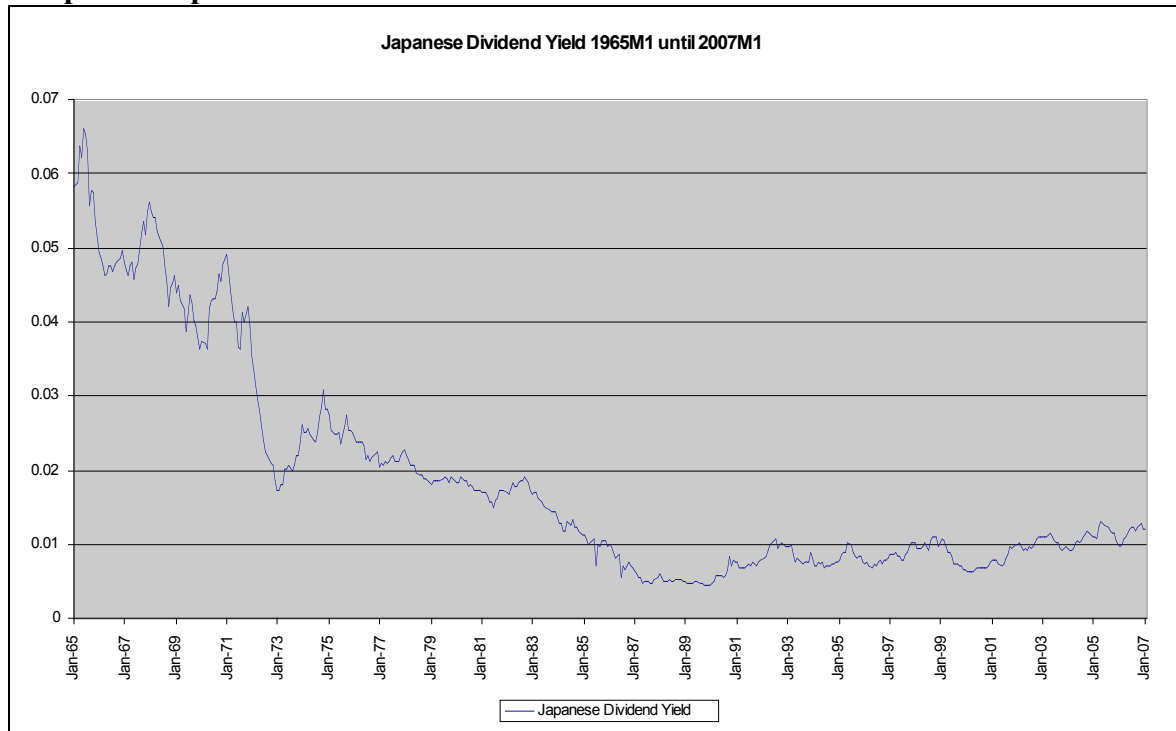


Table 47: Japanese ADF test for the Dividend Yield

TESTS for Japan		Augmented Dickey Fuller Test (1965:M1 to 2007:M1)		
Variable	Trend/Constant	Trend/Constant	Constant	None
NKY Dividend Yield (Lag)		-2.1460 (1)	-3.0291* (1)	-3.2180* (1)
Notes: Asterik denotes significance at 10% level. In “()” we have reported the selected lag by the ADF test.				

Table 48: US ADF test for the Dividend Yield

TEST for US		Augmented Dickey Fuller Test (1900:M1 to 2007:M1)		
Variable	Trend/Constant	Trend/Constant	Constant	None
SPX Dividend Yield (Lag)		-5.1937* (1)	-3.8513* (1)	-1.4844 (1)
Notes: Asterik denotes significance at 10% level. In “()” we have reported the selected lag by the ADF test.				

Table 49: Japanese Non-Linear Dividend Yield estimation

Japan 1965M1-2007M1			
		LSTAR2	
Variable	Linear	Part 1	Part 2
Constant	0.000 (0.000) {0.065} [-1.848]	-0.02438 0.0047 0.0000 -5.2080	0.02428 0.0047 0.0000 5.1854
NKY Dividend Yield (-1)	0.990 (0.003) {0.000} [287.043]	1.64135 0.1234 0.0000 13.3057	-0.65465 0.1234 0.0000 -5.3045
γ		2030.78 (5675380.18)	
C1		0.03380 (0.0731)	
C2		0.04419 (0.0814)	
AIC	-13.59152	-13.631*	
SC	-13.57476*	-13.572	
R-sq	0.9939	0.99429*	
σ S.D. of resid	0.0011	0.0011	
Skewness	0.3657	0.1962*	
Kurtosis	10.3757	10.1853*	
Jarque-Bera	1153.6496 (0.0000)	1087.4276* (0.0000)	
ARCH-LM(1)	12.7393* (0.0004)	15.8957 (0.0001)	
LM Godfrey(1)	3.0548 (0.0805)	2.9352* (0.0873)	
(Std. Dev.), {p - Value}, [t - Value], * denotes preferred model			

Graph 61: Graphical analysis of Japanese Non-Linear Dividend Yield model

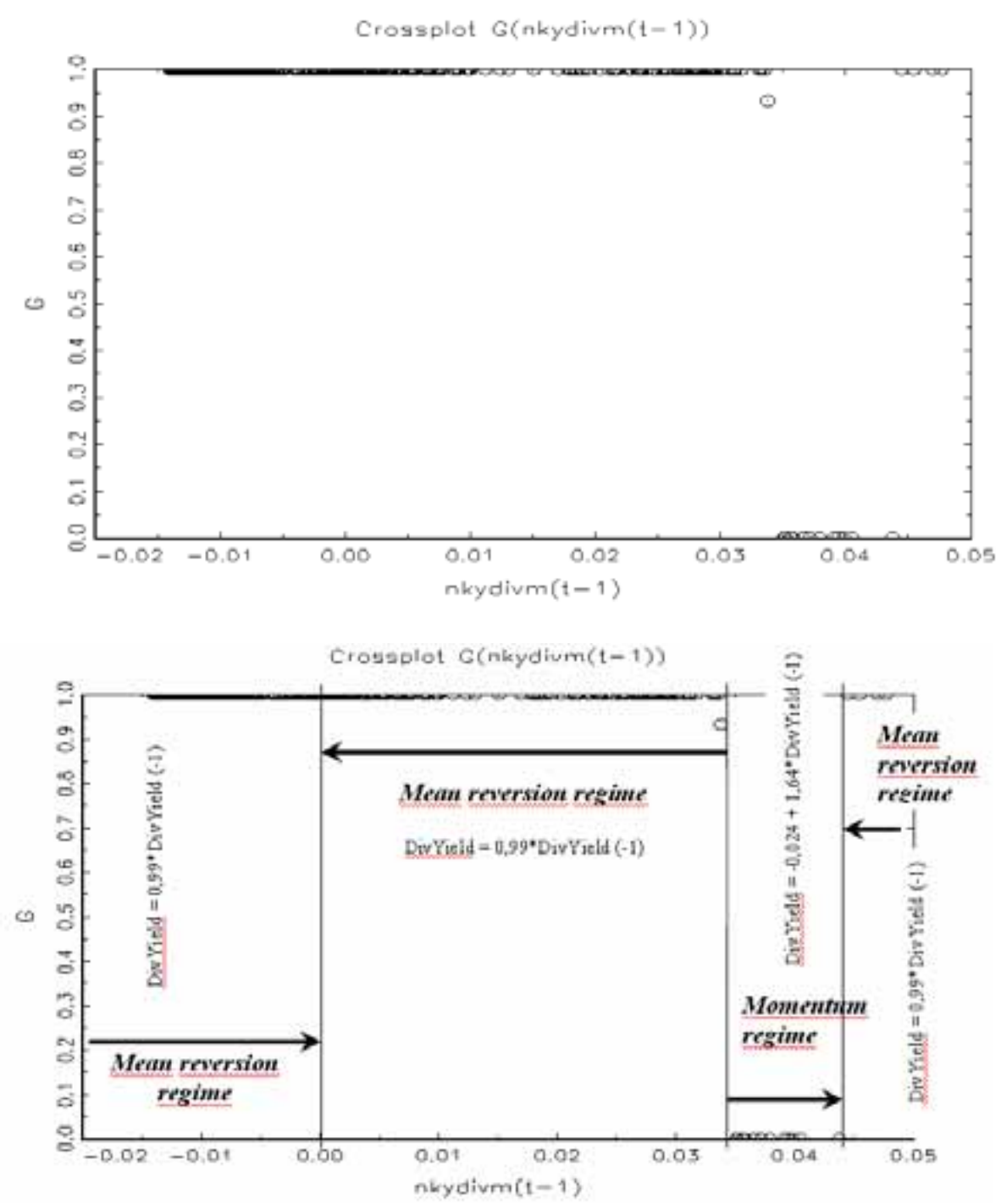
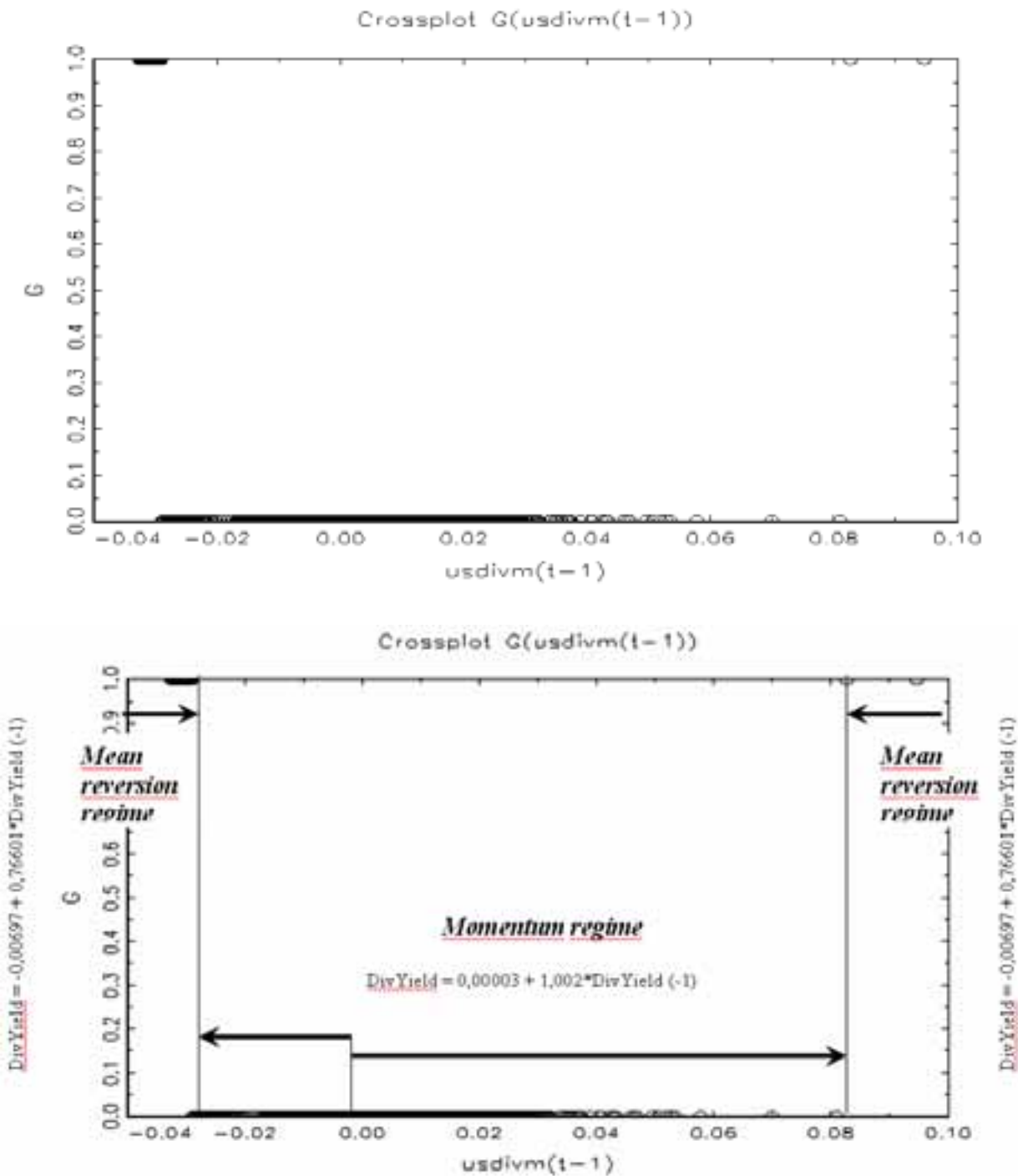


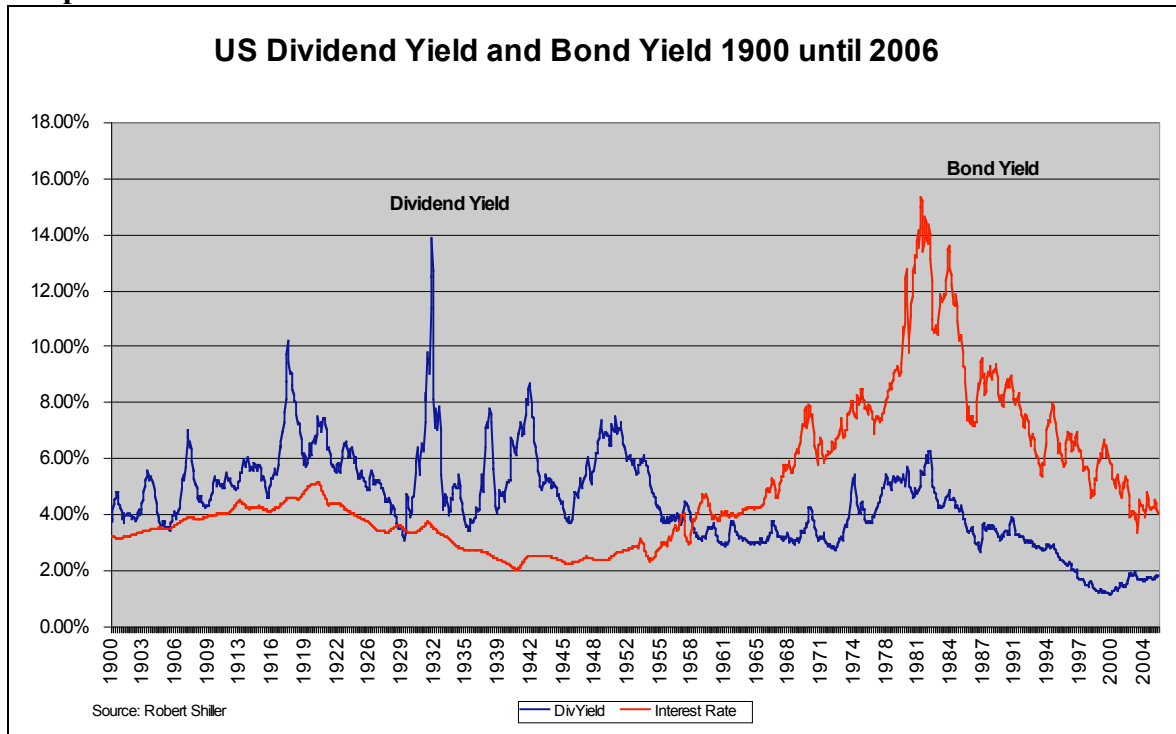
Table 50: US Non-Linear Dividend Yield estimation

US 1900M1-2007M1			
		LSTAR2	
Variable	Linear	Part 1	Part 2
Constant	0.000 (0.000) {0.863} [-0.172]	0.00003 (0.0001) {0.6658} [0.4320]	-0.007 (0.0005) {0.000} [-14.050]
SPX Dividend Yield (-1)	0.988 (0.004) {0.000} [223.555]	1.002 (0.004) {0.000} [226.198]	-0.23599 (0.015) {0.000} [-15.561]
γ		882.04905 (44951465.51)	
C1		-0.02900 (0.0362)	
C2		0.08263 (0.0904)	
AIC	-11.87401	-12.053*	
SC	-11.86597	-12.025*	
R-sq	0.9750	0.9792*	
σ S.D. of resid	0.0026	0.0024	
Skewness	-2.6466	1.1563*	
Kurtosis	78.3428	22.6050*	
Jarque-Bera	305193.64 (0.0000)	20849.21* (0.0000)	
ARCH-LM(1)	21.4178* (0.0000)	204.0249 (0.0000)	
LM Godfrey(1)	135.6227* (0.0000)	145.7181 (0.0000)	
(Std. Dev.), {p - Value}, [t - Value], * denotes preferred model			

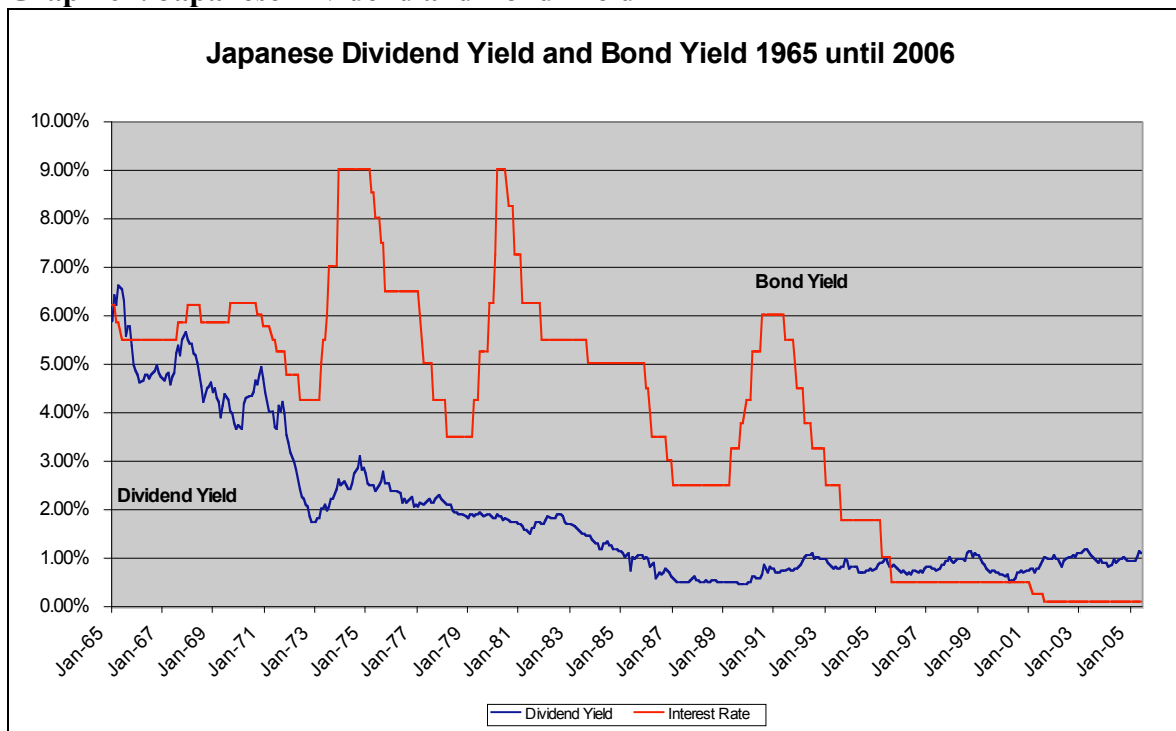
Graph 62: Graphical analysis of US Non-Linear Dividend Yield model



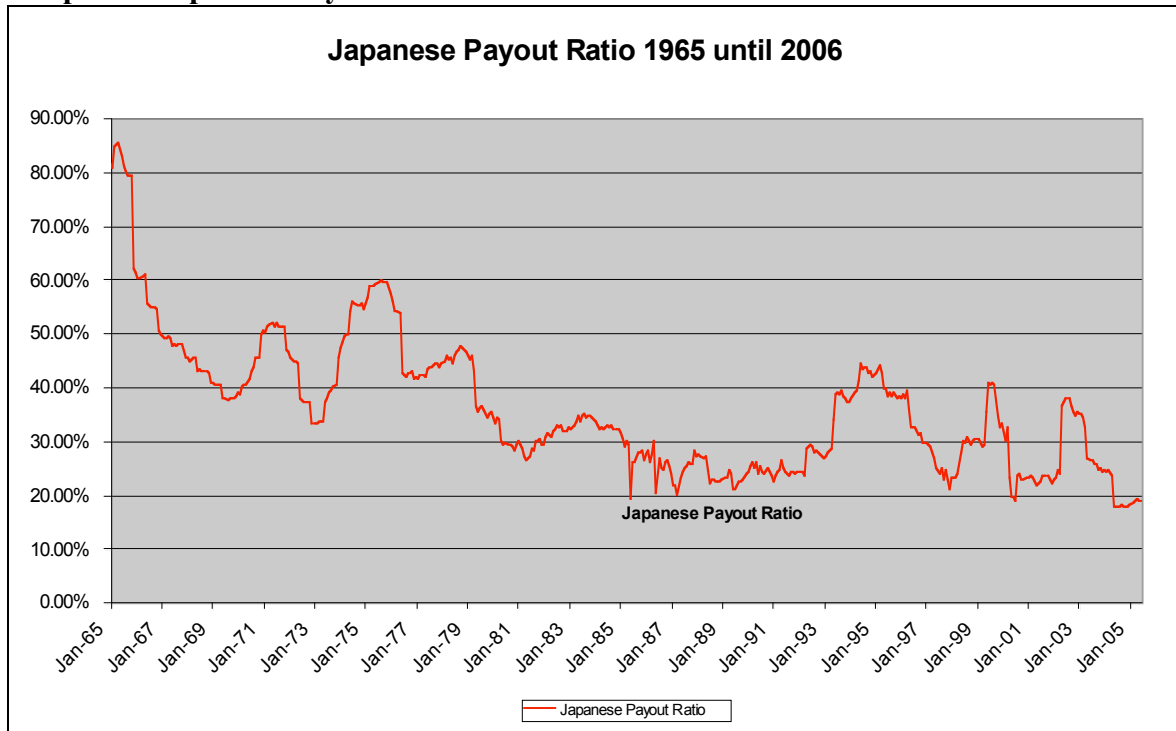
Graph 63: US Dividend and Bond Yield



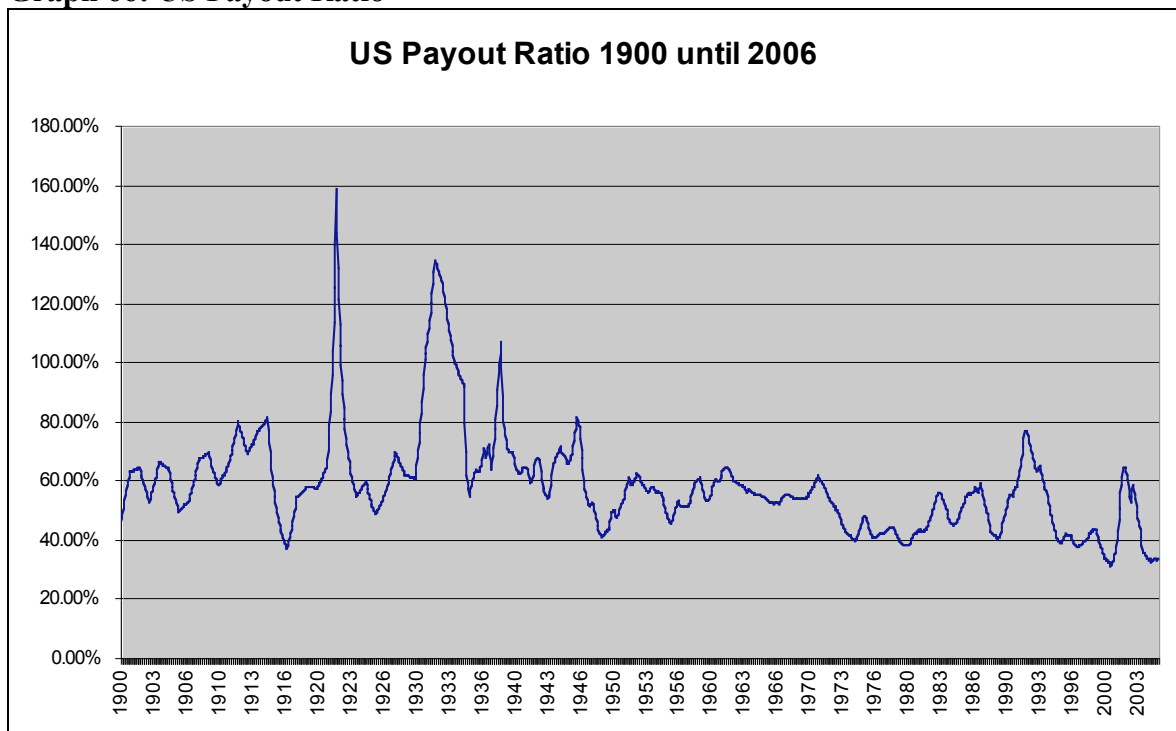
Graph 64: Japanese Dividend and Bond Yield



Graph 65: Japanese Payout Ratio



Graph 66: US Payout Ratio



Chapter 6

6.0 Conclusion and recommendation for further research

In the preceding empirical work reported in this thesis we have gathered evidence on the relationship between selected macroeconomic as well as financial variables and the stock market in the US and Japan.

In chapter 1 we set out the historical and institutional differences in the US and Japan. The differences in the economic development, the legal structure, ownership structure, industry structure and monetary policy gave us reason to suspect different stock market behaviour in the US and Japan.

In chapter 2 we discussed the theoretical and empirical literature that gave us the foundation for the empirical investigations.

In the cointegration analysis reported in chapter 3 we find a long-term equilibrium relationship between industrial production, consumer prices as well as interest rates and the US stock market. As discussed in chapter 3.4 this was in line with expectations. Cash flows and the discount rate are the main drivers of share prices as suggested by the PVM for share prices in chapter 2.4.8 and 2.4.9. Although the US relationship supported our expectations with a positive relationship as to industrial production and a negative relation of consumer prices and interest rates with the stock market, Japan turned out to be different. In Japan we have found a structural break during the early 1990s where the hypothesised relationship changed dramatically. We have ascertained that after the break, money supply and interest rates became more important for stock market movements and that this might be due to the severe downturn and the effects of deflation (for a discussion

see chapter 3.8.1). For further research we recommend estimating the money equation in the US and Japan in order to see whether there has also been a structural break in Japan during 1993.

In the non-linear macroeconomic model in chapter 4 we analysed possible non-linear behaviour between macroeconomic as well as financial variables and the stock market. This is an alternative explanation to the cointegration analysis for the historical stock market behaviour in the US and Japan. The US has experienced large positive returns during the 1990s and large negative returns between 2001 and 2002. By contrast, Japan suffered from large negative returns between 1989 and 2003 whereas the 1980s have been characterised by large positive returns. As a result, the different boom and bust periods in the US and Japan can be modelled by a smooth transition model for positive and negative returns or large and small returns. Overall we find the non-linear models to provide better in and out of sample fit than the relevant linear models. Generally, we found a positive relationship between the OECD G7 leading indicator and stock returns in the US and Japan. Furthermore, Japan shows more dependence on international variables than the US, as it is more export-driven (for the motivation of the variables see chapter 4.4). Further research could conduct econometric tests on the possibility of a structural break in the non-linear models as well. Since we find some evidence of remaining non-linearity in the non-linear models, future research could estimate a combined non-linear model that allows for non-linearity in the mean and the variance at the same time.

In the non-linear dividend-yield model in chapter 5 we tested a non-linear model of noise traders or momentum traders who interact with fundamental or arbitrage traders. Based on the model, we find evidence of regime-switching behaviour in the US and Japanese dividend yield. As expected, the momentum regime in the US corresponds to the boom

period at the end of the 1990s and the stock market collapse between 2000 and 2002. However, against our expectations the boom period of the 1980s and the period of crisis during the 1990s in Japan was not governed by the momentum regime. Furthermore, we can support findings in the literature which state that momentum profits are possible in the US but not in Japan, as we find the momentum regime to be very small in Japan compared to the US. Further research is needed to examine whether the size of the noise regime is generally correlated with momentum profits in individual countries. Furthermore, it may be investigated whether there is a relationship between momentum effects in the aggregate stock market and the profitability of momentum strategies of individual securities in a particular stock market.

Finally, we want to draw the attention of investors and policymakers to what has happened in Japan and to what we can do to mitigate the adverse effect of such a severe downturn. The structural break in Japan points to monetary policy being at least partly responsible for the prolonged downturn. In particular, the onset of persistent deflationary pressure and the occurrence of a liquidity trap may have probably caused the structural break. Therefore we warn policymakers and investors not to underestimate the potential damage caused by deflation and a liquidity trap. Furthermore, we do not even know if Japan will overcome the economic downturn and how the stock market can re-enter the normal relationship with other macro factors. The US economy during the 2001-2003 period was close to deflation and a potential liquidity trap. However, in contrast to Japan, companies and individuals were able to restructure very fast and did not stop investing or spending. Therefore, it is likely that the very quick and aggressive Federal Reserve policy that lowered interest rates massively and increased money supply sharply before deflation could gain traction saved the US economy from the disaster Japan has experienced. The ample supply of cheap money in the US during the early stage of the downturn fostered corporate restructuring

and avoided a prolonged economic slump. Finally, the well-functioning banking system in the US has held up even as corporate bankruptcies such as Enron or Worldcom have shaken the economy. The transmission mechanism between the monetary system that provided large amounts of cheap money and the banking system that could pass on this money to customers has never halted, and companies as well as individuals had access to money in order to invest or restructure.

Also private and institutional investors should watch monetary policy very closely, as the US and Japanese cases show that weak or successful recovery are not far removed from each other. We also think that the institutional settings in an economy may have a major impact on stock market behaviour. Therefore, the success of a stock market investment made during a recession might very much depend on the correct monetary policy carried out by policymakers. Further research should elaborate more on the interaction between monetary policy and stock market development. Monetary policy has successfully found and implemented counter-effective measures to fight inflation, whereas the risks of deflation are far less known and monetary measures to prevent or combat deflationary pressure are mainly untried.

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