CHAPTER 8

SUMMARY AND CONCLUSION

8.1 INTRODUCTION

The primary objective of this study was to develop and estimate a structural econometric model of the South African stock market, the Johannesburg Stock Exchange (JSE). The main purpose of the model is structural analysis, in other words to understand the impact of macroeconomic and other variables on the stock market and to evaluate the role of phenomena such as globalization, policy shifts and contagion. Finally, the model's forecasting ability was evaluated and compared to other stock market models.

8.2 MODELLING APPROACH

There are two alternative approaches that can be followed in modeling stock markets, namely technical analysis and fundamental analysis. Technical analysis builds on the belief that stock prices move in trends that persist. It believes that the patterns in financial markets repeat themselves and therefore their stock market models and analyses are aimed at capturing historical patterns which they then use to forecast the stock market. Technical analysts believe that when new information comes to the market, it is not immediately available to everybody but rather disseminated from professional investors to the aggressively investing public and then to the great bulk of investors. Therefore it is possible to outperform a buy-and-hold strategy with a trading rule based on historical price data.

This is in direct contrast to even the weak form of the efficient market hypothesis, according to which security prices adjust rapidly to reflect all new information (Reilly 1989:244). This means that if stock markets are efficient, share prices fully reflect all the relevant information, so that trading based only upon past data cannot be profitable since by the time information is publicly available it is already reflected by the share prices. It has been shown in this study that the South African stock market is operationally efficient[1], which means that share prices cannot be predicted on the basis of historical share prices alone and hence technical analysis is not the relevant approach to model the South African stock market.

In contrast with technical analysis, fundamental analysis focuses on determining the fundamental factors that drive the stock market and base any modeling on the structural and theoretically justifiable relationships between the stock market and economic variables. However, while economic theory should be able to explain the long-run trend of the stock market, the short-run movements are potentially driven not only by the variables dictated by theory but also by variables reflecting market sentiment as well as other factors such as political instability, emerging market crises, exchange rates etcetera (Jefferis and Okeahalam 2000). The influence of these short-run determinants can only be determined empirically (Harasty and Roulet 2000). The long-run behavior of stock prices are usually modeled based on the expected present value model and then the short-run fluctuations of the market around this long-run trend are determined empirically.

The technique of cointegration makes it possible to distinguish between the long-run equilibrium level or intrinsic value of the stock market and the short-run fluctuations around the equilibrium level by estimating both a cointegration equation and an error correction model (ECM). In the long-run or cointegration equation, the intrinsic value or long-run level of the stock market is modeled based on the relationship between the stock market and economic variables dictated by theory. According to the expected present value model, the most popular theory for modeling stock markets, stock prices are a function of future dividends discounted by a discount rate. In the error-correction model, short-run fluctuations around the long run equilibrium level and the speed of adjustment towards equilibrium are modeled. In the short-run, not only the economic variables dictated by theory but also variables reflecting market sentiment, important socio-political changes and other non-fundamental factors play a role. However, none of these relationships necessarily have to be symmetric. This study

[1] This is consistent with the conclusion of Thompson and Ward (1995) based on a survey of the literature on the efficiency of the JSE.

has described the potential causes of asymmetry and also tested empirically whether stock market behavior is asymmetric.

8.3 CONTRIBUTIONS OF THIS STUDY

This study has made three important contributions to the literature, namely to estimate a structural model for the South African stock market, to capture the asymmetric behavior of investors in this model and to estimate a Markov switching regime model of the South African business cycle which is used in the stock market model to capture the stock market asymmetry caused by investment behavior. First, it developed and estimated a structural model of the South African stock market. There is a wealth of literature modeling stock markets and examining the relationship between share prices and various economic factors, both theoretically and empirically. However, most studies use data for developed countries in their analyses and very little literature exists for the South African stock market. The main contribution of this study to the literature is the development of a structural model of South African stock market that was estimated econometrically using cointegration techniques and error correction modeling.

The second contribution of this study is to incorporate the potential asymmetric effects introduced by the risk and loss aversion of investors. Risk aversion refers to the tendency of rational investors to prefer certainty to risk *ceteris paribus* (Reilly 1989:10,255; Renwick 1971:400). Loss aversion, on the other hand, refers to the inclination of economic agents to be more sensitive to reductions in their levels of well-being than to increases (Bernartzi and Thaler 1995). Two explanations have been given in the literature on why investors' risk and/or loss aversion induces stock market asymmetry. First, Chalkley and Lee (1998) argues that risk aversion encourages economic agents to react promptly on receiving bad news, while it prevents them from acting quickly when receiving good news. A downturn in the relevant economic data (which influences the particular stock price negatively) may be indicative of other economic agents receiving bad news or it might be a random change, but in either case the cautious (i.e. risk averse) response is to act immediately as if the bad data is truly reflecting adverse conditions. In this case "bad" news (i.e.

adverse economic data), risk aversion and uncertainty about the information value of aggregate data work together, leading informed agents to quickly respond to the downturn in economic data and other agents to quickly respond to that response. Of course, there is also uncertainty about the interpretation of an upturn in economic data, but in this case risk (and loss) aversion works against reacting to such a signal since investors will wait until the "good" news is confirmed before they act on it.

It can therefore be expected that investors will react more reluctantly to an upturn in economic data and vice versa. When the behavior of these individual investors are aggregated it implies that the stock market will react quicker during good conditions or on good news or expectations, or put differently, that its adjustment to equilibrium will be slower during adverse economic conditions and faster during positive economic conditions. The "upturn" and "downturn" of data in the Chalkley and Lee (1998) framework originally referred to good or bad conditions as reflected in the state of the business cycle. Since stock prices are discounted future dividends and since real economic activity is one of the main determinants of dividends, an economic upswing (downswing) will cause higher (lower) dividends and an indicator of the state of the business cycle can therefore be used to measure the upturn or downturn in economic data.

The second explanation for asymmetric investor (and hence stock market) behavior is driven by the potential loss (profit) in and overvalued (undervalued) stock market. Following the same line of reasoning as Chalkley and Lee (1998), Phelps and Zoega (2001) and Siklos (2002) also hypothesized different speeds of adjustment but they introduced a different driving force for the asymmetry by redefining the good and bad news or conditions that prompts the asymmetric behavior of investors. Their theory on stock market asymmetry is based on the paradigm of the structural slump developed by Phelps (1967). A structural slump is characterized by a steep decline in share prices followed by a gradual rise in unemployment. A structural boom, on the other hand, entails a steep rise in share prices followed by a decline in unemployment. In the case of a structural boom, investors calculate that this signals a jump in future asset returns and, consequently, the valuation of these assets as reflected in the stock market. The resulting rise in the profitability of investment signals a falling unemployment rate. The boom ends when the productivity rise increases investment costs.

Theoretically, this scenario works symmetrically, but Phelps and Zoega (2001) argued that it might in practice work asymmetrically since other factors may influence the progress of the business cycle. The potential asymmetry was first evaluated empirically by Siklos (2002). His results showed that the relationships between the economy and the stock markets of the UK and the US were indeed asymmetric.

Although Siklos (2002) tested the stock market asymmetry based on the relationship between the stock market and unemployment, the asymmetry also holds for any other stock market model. If the stock market is undervalued it means that the market prices of shares are below their intrinsic value, so that a profit opportunity is created since investors can buy shares at the low current market price and eventually resell it at a higher price once the market has corrected the discrepancy between the market and intrinsic value. In contrast, when the stock market is overvalued market prices of shares are above the intrinsic values. Eventually the market will correct this discrepancy so that share prices fall, in which case investors will loose money. Since investors are loss averse it is more important to avoid the potential loss if the market is overvalued than to make the profit if the market is undervalued. Therefore, if investors are uncertain, they will react faster to an overvaluation that poses a potential loss than to an undervaluation that poses a potential profit.

The techniques of cointegration and error correction modeling are ideally suited for modeling different speeds of reaction of investors. In the error correction model, the adjustment to equilibrium is modeled and the speed of adjustment is estimated. Usually the coefficient measuring the speed of adjustment is assumed to be constant, but the model can easily be adapted to capture different speeds of adjustment in different circumstances. Econometrically, the two potential causes of asymmetric investor (and stock market) behavior have to be modeled differently. Siklos and Enders (2001) developed a threshold cointegration technique with which different speeds of adjustment can be modeled for overvalued and undervalued series. This test can be applied directly to under- or overvaluation of the stock market. However, this test is not applicable when the asymmetry is caused by different states of the business cycle and this type of asymmetry therefore has to be evaluated differently. In the case of asymmetry with respect to the state of the business cycle, a variable is needed that reflects the different states of the business cycle. In this study, the state variable was constructed using a Markov switching regime model of the South African business cycle. The Markov switching regime model can be used to simultaneously estimate the probability of the economy being in an expansion or recession and the expected economic growth rate.

The third contribution of this study is the estimation of the Markov switching regime model, which is in itself a significant contribution to the literature since no Markov switching regime model has been estimated for the South African business cycle yet. Apart from its use in the stock market model to capture the potential asymmetry, the Markov model can be used for two additional purposes. First, it estimates the data generating process (DGP) of the variable under consideration, which is real economic growth in this study. Second, it estimates a probability of the economy or business cycle being in either of two possible states, for example being in a recession or an expansion, for each period. Since this time series of probabilities reflects the likelihood of a recession or expansion, it can therefore be used to classify each observation into one of two regimes. For example, the economy is regarded as being in a low-growth (high-growth) or recession (expansion) regime or state if the probability of being in recession (expansion) is higher than the probability of being in an expansion (recession). In addition, the probabilities may be used to reflect the degree of certainty of economic agents regarding the state of the business cycle, if it is assumed that a recession probability of one (zero) indicates that the economic agent is absolutely certain that the economy will (not) be in a recession, while a probability of 0.5 indicates that a recession or expansion is equally likely and therefore there are no certainty regarding the state of the business cycle. In other words, the closer the recession probability is to zero or one, the higher the certainty regarding the state of the business cycle. On the other hand, the closer the recession probability is to 0.5, the higher the uncertainty regarding the state of the business cycle.

The estimated Markov-switching regime business cycle model can therefore be used not only to forecast economic growth, one of the most important macroeconomic indicators, but also to forecast the occurrence of recessions and expansions. The only indicator currently available to reflect recessions and expansions is that of the South African Reserve Bank, but their indicator is only available with a considerable time lag. It is therefore not useful for forecasting purposes at all. The Markov-switching regime indicator can fill this gap and will consequently be extremely useful for policy-makers, investors and producers that want to plan their economic decisions or actions.

To summarize, in this study a structural model of South African stock market incorporating both the fundamental factors driving stock prices as well as the influence of the risk aversion of investors were estimated. Cointegration techniques has been used to distinguish between the long-run behavior and short-run fluctuations of the stock market, allowing for the possibility that fundamental factors might drive the long-run behavior but that additional factors comes into play in the short-run. Two potential causes of asymmetric investor (and hence stock market) behavior have been evaluated. First, the Siklos and Enders (2001) threshold cointegration test has been used to evaluate asymmetric adjustment in under- and overvalued stock markets. Second, asymmetry with respect to the state of the economy has been evaluated, which necessitates the construction of a state variable. A Markov switching regime model has been developed to estimate the probability of the state of the economy, reflecting both the expected direction of the business cycle as well as the certainty regarding this expectation.

8.4 RESULTS

8.4.1 Structural Model

In this study, a structural model for the South African stock market was developed and estimated based on the expected present value model. Theoretically, several reasons exist that may cause asymmetric stock market behaviour. Two different cases of asymmetry has been evaluated, namely asymmetry conditional on (i) whether the stock market is over-valued or under-valued and (ii) the state of the business cycle.

The results have shown that neither the over- or under-valuation nor the direction of stock market movement causes stock market asymmetry. However, it has been shown that the speed of adjustment differs based on the state of the business cycle. Consistent with *a priori* expectations, the adjustment is significantly faster in recessions than expansions.

The results confirmed that the long-run level of the South African stock market is determined according to the expected present value model. Therefore, the long-run level of share prices are determined by discounted future dividends. In addition, the short-run fluctuations are caused by the short term interest rate, the rand-$US exchange rate, the S&P500 index, the gold price, forward-looking expectations of investors and a risk premium.

8.4.2 Comparative Performance

The cointegration model's performance in modeling and forecasting the level of the stock market was compared to that of the FM-VAR and random walk. Both the FM-VAR and random walk includes the lagged stock market index as explanatory variable. Consequently, both models closely follow the movements and trends in the stock market but with a lag. In other words, these models pick up all the turning points in the stock market but always with a lag and never contemporaneously. The cointegration model, on the other hand, sometimes deviates more than the FM-VAR and random walk from the actual stock price index. For example, the cointegration model deviates quite substantially from the actual stock market index during 1996, while the gaps between the FM-VAR and random walk models and the actual stock market are much smaller. However, unlike the FM-VAR and the random walk there seems to be no lag between the cointegration model and the actual stock market.

The cointegration model performs relatively well in *modeling* the stock market. It has the lowest root mean squared error (RMSE), root mean squared percentage error (RMSPE) and Theil's inequality coefficient (U). The cointegration model therefore outperforms the other two models in terms of these three criteria. Although the RMSE, RMSPE and U can be used to rank the performances of the models, it cannot be used to test whether the differences between the models are statistically significant.

Therefore Diebold and Mariano's (1995) sign (S_{1a}) and Wilcoxon signed-rank (S_{2a}) tests were also used to test whether the models' accuracy is statistically different. These tests require the specification of a loss function. In this study two symmetric loss functions, based on the errors and squared errors, and asymmetric linex loss functions with varying degrees of asymmetry have been used. According to the results all the models' accuracy are statistically different for a loss function based on the untransformed error terms according to both the sign and signed-rank tests. However, using any of the other loss functions there are no statistically significant differences in the accuracy of the models.

The *forecasting* accuracy of the three stock market models are compared using the RMSE, RMSPE and Theil's inequality coefficient (U) for the period from the first quarter of 2001 until the first quarter of 2003. According to the results, the cointegration model performs relatively well in forecasting the stock market. It has the lowest root mean squared error (RMSE), root mean squared percentage error (RMSPE) and Theil's inequality coefficient (U). The cointegration model therefore outperforms the other two models in terms of these three criteria. The null hypothesis that the random walk and cointegration model are equally accurate in forecasting the stock market is rejected against the alternative that they are not equally accurate. There are no statistically significant difference between the forecasting accuracy of the random walk and the VAR or between that of the VAR and the cointegration model using loss functions that are symmetric or nearly symmetric. However, the null hypothesis of equal accuracy of the cointegration and FM-VAR models is rejected with asymmetric loss functions in which the cost of overpredicting share prices is higher than that of underpredicting.

8.4.3 Profitability

Investors are investing in the stock market to maximize their profits following a basic strategy of buying when share prices are low and selling when they are high. In order to evaluate the usefulness of the cointegration stock market model for investors, the profitability of the different stock market models have been compared following this strategy. It was assumed that investors receive the short-term interest rate on their money while they do not hold the all share index and that the returns are reinvested according to the same strategy as the original investment. This was compared to the returns of a buy-and-hold the JSE all-share index strategy over the sample period as well as receiving the short-term interest rate on their money over the sample period. The modelling and forecasting accuracy of the models in the previous section, namely the cointegration, FM-VAR and random walk models, are compared in modelling the direction of the stock market. The simulated values of these models are used to calculate the implied predicted direction of the stock market. In addition, they are compared to one of the most popular models used by technical analysts, a 30-week moving average. It has been showed that the trading according to the cointegration model would have yielded a higher return than the return on the buy-and-hold strategy. In fact, the return yielded by the cointegration model is higher than that of all the other models except the moving average model. The cointegration model also outperforms all the models except the moving average in terms of the number or percentage of times that it correctly predicts the direction of the stock market.

8.5 Conclusion

The cointegration model of the South African stock market developed in this study made a contribution to the literature by establishing the factors that determine the level of the stock market in both the long-run and the short run, while capturing stock market asymmetry. The model can also be used to forecast the stock market. This will enable investors and policy makers to simulate the impact of changes in macroeconomic indicators on the future course of the stock market and accurate forecasts of the stock market could be used by economists to forecast other macroeconomic indicators that lag the stock market such as consumption and investment. In addition, forecasts of the stock market will predict the future direction of share prices and can hence be used by investors to construct profitable trading rules.

A suggestion for further research is to employ different approaches and techniques to capture stock market asymmetry. In this study, a linear cointegration relationship was established and the asymmetry was captured in the ECM by allowing different speeds of adjustment to equilibrium. In addition, tests for threshold cointegration indicated that the speed of adjustment is symmetric with respect to the direction of the stock market and whether the stock market is over- or undervalued. These results were obtained with quarterly data and one suggestion for further research is to determine whether the results differ with higher frequency data. As explained earlier (see section 6.1), the characteristics and behavior of stock prices have been found to differ substantially for high and low frequency data. Another suggestion for further research is to employ some of the newly developed non-linear cointegration techniques to test for nonlinearities in share prices. A final suggestion for extending this study is to model the error correction model with the Markov switching regime technique in order to allow the speed of adjustment to switch between two states. In this study the speed of adjustment was restricted to differ only based on the state of the business cycle, the under- or overvaluation of the stock market and the direction of the stock market. By employing a Markov switching regime model, the two (or more) states of the speed of adjustment term will be unrestricted and determined by the data instead of being imposed by the researcher.