A Decision Support System for the Modelling of Asset Prices, Option Prices, and Volatility: An Application of Artificial Neural Networks

Masterarbeit

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INTRODUCTION

The ability for precise forecasts of asset prices and option prices as trading decision support grants investment possibilities. Since the financial markets rise in complexity every day due to new products and a proceeding globalization, also the requirements on the tools are evolving with the same tendency. This is why the vast of new connections and market variables have created a demand for forecasting tools that can handle interrelationships between key factors in the market. This is why over the past 15 years Neural Networks became more popular and a new alternative forecasting tool to the standard economical and statistical approaches. [1]

Neural Networks are construction after the Model of the Neuronnet of the human brain which was an inspiration for a computer based simulated artificial Neural Network. These nets are used today in a vast of different scientific areas of expertise, like understanding the human brain and recognition of speech, but also to solve specific application problems in areas of engineering, statistics and business science, like financial forecasting. The advantage of the NNR is the non-parametric and nonlinear approach. Furthermore through a process called back-propagation (Bprob) learning algorithm, the Networks are able to learn patterns as described in chapter four.[2]

In the following paper artificial neural Networks are applied to create a decision support system for trading purposes. At the end of this work the reader should be able to applied a neural network and create a forecast for asset prices or volatility. The usefulness of the decision support system is determined by creating an economic feasibility study in chapter five. The economic feasibility is given if positive returns can be generated using the forecast as trading decision support. The economic study is split into three steps covering the two main fields of research, which are volatility and asset forecasting, plus a trading strategy combining the results.

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[1] Vgl. Dunis et al., p. 318
[2] Vgl. Rey et. al. , http://www.neuronalesnetz.de/

The first part is dealing with the brought idea of option trading, its influence factors and especially volatility. The decision support system (i.e. ANN) should be applied to forecast volatility. This forecasted volatility is then matched against the implied volatility of options to determine what option strategy is useful. In this paper the volatility forecast should be used to find mispriced options. As shown by Dunis and Huang (2002) significant retunes can be made by trading two-sided option strategies (long or short straddle) on the mispriced volatility. As described in chapter 3, this paper expanses this approach by using a one sided-option-strategy. However, a one-sided option strategy can only be used if the direction of the asset-price movement can be determined.

This leads to the second part of this paper which searches for the potential of ANN to forecast the asset-price movement and furthermore the assets price itself. The forecasted assets prices can then be tested in an economic feasibility study by fictively trading the assets long or short based on the forecasted prices (up or down) to determine the quality of the forecast. The quality is therefore not evaluated by a compare some to other statistical models or to statistical key factors, but by the economic value of the forecasts over time. The forecast is valid if over a data set the forecasts for time t+1 and the market spots for t+1 have the same path (up or down). This is shown by fictively selling the asset short, if the forecasted asset price P_{t+1} is smaller than the spot price P_t. If the forecasted asset price P_{t+1} is higher than the spot price P_t the asset is bought. For every trade (long) the fictive profit (ΔP) can be calculated by subtracting the spot price P_t from the asset price in P_{t+1} (If sold short the return is $P_t - P_{t+1}$). The fictive profit ΔP divided by the initial investment creates the relative return of this trade. Over the data set the sum of all $\Delta P_t/I$ [3] ($\sum(\Delta P/I) = \Delta P_{t+1}/I, \Delta P_{t+2}/I, \Delta P_{t+3} \ldots \Delta P_{t+n}/I$) determines the overall percentage return. For this paper this is the key indicator for the quality of the forecasts. Mind, with quality only the economical goodness is shown, not the statistical quality. However, a positive return is an indication that the decision support system is reflecting the asset price movement well and since "Investors and market

[3] For the Investment I no index is used, since if the asset is bought the initial investment is in the $(t-1)^{th}$ period and the return is determined in the t^{th}. For a shor sale it would be the other way around.

participants … have trading performance as their ultimate goal and will select a forecasting model on the financial criteria"[4] ,the quality factor this paper chooses should be sufficient.

The third part is motivated by the idea to challenge the decision support system with a trading strategy. This trading strategy combines part one and part two in a one-sided option strategy. So, if the volatility forecast and the asset price forecast are possible, a one-sided option strategy can be applied. Chapter 3 shows the advantages of a one-sided option strategy in this case over the two-sided option strategy mentioned above. Using the direction of the asset price and the mispriced volatility, long call or put options can be used to create profits form the volatility movement and the asset price movement at the same time. The trading strategy is based on searching for points in time where the volatility in the option is mispriced and the asset price forecast shows a pattern of a jump discontinuity. In this case the market could be entered by buying options depending of an over or understatement of the volatility and the forecasted direction of the asset price. The return is used to determine if the strategy is useful in the context of financial market usability i.e. positive return. Again, the quality of the model is measured by observing the return, not by statistical goodness of key factors. However, many papers have already shown that NNR outperforms statistical models. Dunis and Huang (2002) showed that forecasting techniques of NNR and RNN outperformed a combination of ARCH/GARCH-Models. "Schnittenkopf et al. (1998) predict the volatility of the Australian stock market and find neural networks outperform ARCH models."[5] "Schnittenkopf et al. (2000) use daily DAX data and find that volatility predictions from neural networks are superior to GARCH models in that they have higher correlations with implied volatility." [6] Therefore, the conclusion that the model used in the paper is outperforming statistical methods like GARCH /ARCH etc. seems to be valide.

In the end of the paper the question can be answered if ANN's are able to be used as a decision support system for trading decision and strategies by forecasting asset prices or volatility.

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[4] Vgl. Dunis et al., p. 318
[5] Vgl. Iqbal et al., p. 1117
[6] Vgl. Iqbal et al., p. 1117

CHAPTER SIX
CONCLUSION

The introduction divided this thesis in three parts. These are volatility forecast, the asset forecasts and the option trading strategy. Since the biggest part of this thesis is dealing with the possibility of asset forecasting and asset trading strategies these results are concluded at first.

The results from chapter five determine that it is possible to create **asset forecasts** with ANN as a decision support for trading purposes and to create positive double digit returns. This is not revised in case of trading with bid- and ask-spreads, since chapter 5.2.5 shows that bid- and ask-spread can be forecasted and therefore be incorporated in the trading strategies. Trading cost where not considered. However there are good reasons to believe that even with trading cost, positive return can be generated. One of the reasons can for example be found in the result from chapter 5.2.3 where 2,5% return is fictively created with only three trades.

In Chapter 5 it was also shown that **volatility forecasts** are possible in general. However, due to a lack of a sufficient implied volatility database the trading strategy could not be applied and tested in an economic feasibility study. However, the positive results from the forecast ability of asset prices and volatility with this decision support system show the theoretical possibility.

At the end of this paper the question from the introduction can be answered: It is possible to use artificial neural networks as a decision support system for trading decisions and strategies by forecasting asset prices or volatility.