# Medium-Term Forecasts of Energy Resource Prices with Artificial Neural Networks

## Bachelorarbeit

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# 1. Introduction

*'Prediction is very difficult, especially if it's about the future.'*

[Niels Bohr]

Forecasts of asset prices for the next few minutes, hours or days have widely been researched (see below). The results of these short-term forecasts demonstrate the feasibility and potential of financial prediction. Far less attention has been given to forecasts on a horizon of several months.
Due to their economic significance, fundamental assets, such as energy resource prices, might allow to anticipate their future trends for up to a year. However, increasing the prospect of forecast most likely provokes to reduce its accuracy. Therefore, the actual validity of these medium-term forecasts is yet to be examined.

The approach of this research is to create such forecasts using artificial neural networks. Since they have proven to be very effective in pattern recognition, artificial neural networks are capable of determining complex relationships among time series. In fact, artificial neural networks are widely applied in various areas of forecasting (cf. Dunis *et al.*[1][2], von Mettenheim[3] and McNelis[4]). Generation and training of these networks were computed by the neurosimulator FAUN.

Background of the created forecasts are different stock market indices. Since they benchmark regional or sectoral markets, stock market indices contain most relevant political, technical and economic information, as well as expectations. Furthermore, they are

[1] Dunis & Williams, 2002
[2] Dunis & Jalilov, 2002
[3] von Mettenheim, 2009
[4] McNelis, 2005

readily available, quantified and can be applied in various combinations.

Though its scientific relevance is sufficient reasoning for research on medium-term forecasts, anticipation of price trends for several months has its practical applications as well. An accurate prediction of future energy resource prices on medium-term prospect may facilitate proper strategic decisions in the industry and transport sector. Furthermore, dependent on its forecast validity it might provide purchase and trading recommendations.

The structure of this thesis follows the research process. Chapter 2 introduces the reviewed energy resources and describes the model of artificial neural networks. In the following chapter, it is discussed which information provides a solid economic basis for medium-term forecasts. On this background, artificial neural networks are used to generate forecast functions. Chapter 4 details how the required networks were defined and trained. In the next chapter, the created forecasts are depict, evaluated and discussed. Moreover, some suggestions on further research are given. Finally, chapter 6 contains a short report of achieved experiences as well as an outlook on future research in this area.

# 6. Conclusion

Starting with a retrospect on the work with FAUN, a few recommendations are given that may improved the applicability of forecast creation. At last, an outlook on future research is made by suggesting further approaches.

## 6.1. Experience with FAUN

Sometimes finding the right network topology and training parameters is rather more directed trial and error than explicit deduction. Therefore, it may often be a good choice to automate as much as possible of the computing processes.

Work with FAUN can be divided in three parts: pattern creation, training process and finally analysis.
The creation of the needed training and validation files should be automated at any rate. This is best conducted by an individual program or script.
Hardly able to automate is the training process. Fortunately, FAUN comes with a GUI add-on that offers already most possible convenience. Further assistance may only be of use if many networks have to be trained sequentially without attendance.
Most important to consider is automating the final analysis. Transforming the trained weights into actual functions and computing results based on new patterns is likely to be required in every application. Yet, other processes, as in my case the creation of heat maps, may be automated reasonably well, since they have to be processed often and can help evaluating the results.

Although a program for extracting top 10 networks is available for FAUN, I decided to compile my own. Thus, I had the possibility to simply extract more than 10 top networks as well as to apply the function to networks with activated shortcuts. However, networks without shortcuts did turn out to be of little use.

The forecast of sequent periods demands many trained networks. A common approach was to determine a set of good fitting parameters and execute several FAUN runs in a row. As FAUN offers a very easy way to use it without GUI, it can smoothly be included in an individual program. Hence, it was easy to design a tool to sequentially copy the pattern and control files and execute FAUN.

The development of such an environment does of course take time, but within the scope of, e.g., a bachelor thesis, this is absolutely advisable.

An issue that took me some time, while getting used to FAUN, was an error that occurs if the input neurons outnumber the pattern pairs in the training or validation file. If the amount of input neurons is too high or respectively the number of patterns too low FAUN prints various unknown errors and terminates itself. Since a training process containing this disproportion is a priori determined to produce valid results, it is not likely to be chosen as common practice, but it can hinder the process of getting used to the program.

## 6.2. Outlook on further Research

Forecasts of assets on medium-term perspective should a priori not be expected to give a precise picture of future development. They should rather be seen as an indicator of basic trends. These expectations were affirmed by the results throughout this research. While forecasts of concrete price levels provided rather poor results, the analysis of return patterns showed a certain potential of forecasting energy resources.

In section 5.3, it is discussed to what extent heat maps allow more valid assumptions. It can be concluded that forecast trends can be found in actual historic development, though they are overlain by short-term trends. This leads to the suggestion that similar forecasts might be able to anticipate turning points in future price development. A few suggestions on further research in this area are given in section 5.4.

Altogether, it can be assumed that medium-term forecasts with artificial neural networks are capable of providing valid information of general trends for crude oil, coal and

natural gas. Moreover, the results suggest that turning points can be forecast for various assets. Since the validity of the return forecast was independent of the reviewed resource, it seems likely that other assets can be forecast as well.

Although other assets may have slighter economic significance, there exist a general interest in medium-term forecasts. Since the forecast horizon determines the coverage of the pictured trends, a medium-term forecast might also be of use to adjusted short-term forecasts for seasonal trends.

Disclosing chances and limits, this thesis should be seen as a first research on general feasibility and validity of medium-term forecasts applying artificial neural networks.