Day-ahead Electricity Price Forecasts using Artificial Neural Networks

Masterarbeit

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1 Introduction

In our times, the probably most valuable and essential asset is energy. Since it is an indispensable part of almost each activity and a crucial part in various fields, energy has developed to the pulse-beat of human civilization. In general, the need of energy is distinguished according to different sources such as electric energy, and chemical energy like oil, coal or natural gas.

However, the purest form of energy is electric power, or electricity. It is used in a vast number of nearly all human activities, and during the last decades its market in most countries was interfused with a progressive liberalisation (see Conejo et al. [2005]). Along with the significant restructuring changes of these markets in the last time, new structures, questions and opportunities have arisen (see García-Martos et al. [2011]).

In this context, one of the most important question is about the future price of electricity. In today's wholesale electricity markets the accurate prediction of future electricity prices is critical to each market participant. In the short term actors rely on forecasts to maximize their profits by minimising their costs, by optimising their activities with respect to the possibilities on the spot markets, whereas in the mid- and long term horizon the predictions are used to hedge against risks, and for planning the power production, the investments or related issues (see Li et al. [2007]).

With respect to all this, the main issue of the following thesis is to generate adequate, feasible and preferably robust day-ahead neural network based forecasts of the the electricity prices given by the Physical Electricity Index (PHELIX). In combination with this, the focus lies on analyses of available data to identify typical and prediction relevant features, as well as on analysing the resulting models and their predictions in short and long term applications. On this occasion, the purpose is not only motivated by itself, but rather intended as basement for decisions, and potential solution support within the scope of problems that arise by the handling of electricity in recent times.

This thesis is organised as follows: Section 2 introduces the problem-setting and objective related to features of the European Energy Exchange (EEX). In addition to that, section 3 gives an overview about common insights of published literature for the purpose of predicting electricity prices. Section 4 presents the methodological procedure of this work, separated by the used models, data basis and the applied procedures. Based on this, section 5 illustrates in detail the procedures, their results and main parts of their sensitivities in a short term optimisation and a long term application. Finally, section 6 gives a closing discussion of the approach with respect to its limiting aspects, whereas section 7 draws the conclusion.

7 Conclusion

The awareness of the typical behaviour of electricity prices and future electricity price is obviously a crucial and highly valuable information. For decisions on the generation, supply and consumption of electric power market participants rely on their knowledge of these information. Moreover, actors in electricity markets trust in price forecasts to optimise their asset allocation, investments, or bidding strategies, as well as to hedge risks by using bilateral contracts or other products of derivatives markets. By this reason, they are also used by market regulators to monitor and regulate the behaviour of market participants.

The presented work, took part in this topic by describing the current situation of the electricity market in Central Europe and by creating a rolling neural network based framework for predicting electricity prices on a daily basis. To this end it has introduced, discussed and analysed prediction relevant aspects of the market, the available data and common literature, such as the statutory publication requirements, or typical features of electricity prices.

In this context, great emphasis was placed on a careful perfection of work, as well as on comprehensible and justified decisions about the structure, the evolution and the application of the presented model frameworks.

First and foremost, the results demonstrate that an once optimised dynamic, or time varying modelling procedure is able to outperform common forecast methods in short term practice and also within a long term usage. On the other hand, the analysis of the generated neural network based predictions against a reduced regression benchmark has shown, that the resulting forecasts of different forecast methods are very similar, while the main reason for this outcome is certainly the strong interconnection of the used approaches.

However, the variation of involved input reveals a heterogeneous effect on predicting next-days electricity prices. In contrast to conventional results, it was not possible to improve the dynamic forecast by transformations of data, the usage of common technical indicators, or by the inclusion of weather data in the form of real measured temperatures. The incorporation of informations on planned power generation data, however, leads to a significant increase of forecast quality, especially for artificial neural networks.

Further research has to show, if it is useful to extend the presented approach on long term price predictions, and if an ongoing, or automatic optimization of model parameters is able to outperform a single setting. In addition to that, this thesis emphasises that the most important manner is to find a meaningful solution for an adequate integration of additional price relevant informations.