Resemblance measurement of electricity market behavior based on a data distribution model

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ABSTRACT

In this paper, a data modeling method is proposed to assess the similarities of electricity market performance patterns in various times. To put the method into operation, an approximate data distribution (DD) model and a difference measuring technique are proposed to assess the similarities among the data series based on the physical outline or appearance of data distributions. The DD model is utilized to organize price suggestions, load and Share Weighted Average Lerner Index (SWALI) data based on their dependencies. Afterwards, distinction between DD models is measured using the Resemblance Measurement technique for their Minimum Total Cost (MTC) values. Based on the amount of Minimum total cost, the resemblance of electricity market manner in two time horizons is investigated, and the similar electricity market manner will be recognized. Since determining the market manner or the resemblance of market between two time horizons by pure statistical data is not easy, in this paper a method is proposed to characterize the market manner using mathematical formulations. In order to demonstrate the accuracy of this proposed method the real-world data of New York electricity market, New York Independent System Operator (NYISO) for the period 2002–2010 is used.

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Introduction

One of the common strategies used for investment instruction is discovering investment information signal from historical data. On this basis, measuring the resemblance of the market manners from different time horizons is regularly utilized. This resemblance measurement has several applications such as being used to retrieve valuable investment information or generally being used for electricity market manner analysis. Through studying the electricity market historical data, the dependencies amid electricity market quantities, such as price suggestion, some market power indices and so on can be captured. Correspondingly, even investors can choose the best time to participate in the electricity markets.

In addition, similar manner patterns in particular periods of time are broadly searched, for making investment decisions. Many archived data are generally available to be employed as an investment signal; an automatic search mechanism is required to find a meaningful, valuable and applicable market manner pattern among historical data. Several methods have been proposed to assess the existent dependency between past and future data.

But we propose this paper to assess the changes of market manner with higher accuracy than prevailing reported methods. In [1], the relationship between evolution of internet technology and manner of resemblance of market indices has been presented for Istanbul Stock Exchange. In order to discover the correlation, a data mining technique has been used. Five series of stock indices have been selected as sets of variables. Steps of Knowledge Discovery in Databases (KDD) process have been applied. Discrete Fourier Transformation and Fourier coefficients have been employed to present time series. Moreover, to recognize the similar manner of diverse sets of time series, an enhanced Euclidian technique has been employed. But there are documents, archives and a lot of information which is impossible to exploit this information to the fullest without an appropriate manner pattern. Besides, these study cases are done for other kinds of markets than the electricity market.

Electricity markets analysis is typically undertaken through analysis of the market power measurements which is affected by the network constraints. The results, obtained through this analysis are used for electricity market simulation. In [2], various features of the market power that can be employed by generation companies' strategies have been reported and the effects of the grid constraint on preparing additional potentials to exert market power have been taken into account. A series of indices,

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particularly devised for investigating grid effects, have been presented to measure the market power of the generation companies in an electricity market. However none of the researches have compared various markets with each other. In this paper, we have proposed an approach that is able to investigate not only the being of market power but also the other principal aspects of market manner through comparison between various electricity markets behaviors and/or electricity market behavior at various periods of time. In [3], measuring market power in the Iberian wholesale electricity market by application of the residual demand curve elasticity has been proposed. Most of these recent papers have focused on market power or the invention of some indices. In other words, they have limited expression in comparison with our new presented approach that has capability of being use in electricity market studies comprehensively. In [4], a method to estimate the hypothetical differences of the market structure and generation companies has presented. On basis of the estimates of hypothetical differences in a real electricity market, a factual method has been reported to study the dynamic strategic behavior of market power and a real-world electricity market has been employed for the case study. All of the previously presented methods can be used to measure market power but they are limited to only assessing the market in the power aspect and can't asses every aspect of the power market. However the proposed method in this paper can be used not only for the market power analysis, but also for other aspects of electricity market such as price suggestions or offered prices and the players' unfair behaviors detection and so on. Therefore, due to the market structure analysis, our proposed method is extremely applicable for regulators.

Additionally, the existence of lots of data and information which require processing is always one of the main problems in the analysis of electricity market and is a major concern of the regulators. Despite this difficulty, in [5], a large-scale system related to the U.S. Eastern Interconnection using a DC power flow system has been studied. The results have demonstrated that the approach has been able to evaluate potential market power of generation companies with an accurate estimation of the real grid over a large-scale system. Although such methods have been employed to study market scheme alternatives, their wide practical use to regulatory decisions for market power mitigation has been more disputable. In fact, this approach is a model of large-scale wholesale electricity markets. In sum, each of these articles proposed patterns of real markets at a particular and limited duration. However, none of them compare the various markets. In this paper a comparison is made on various markets and on various periods of time for one market. This comparison which is developed by this method not only provides the market regulator with a more comprehensive knowledge of the market than the other methods but also the more practical patterns can be designed. Obviously, it is particularly important to analyze the market manner in detail continuously. The Midwest price spikes in the summers of 1998 and 1999 are considered as an example that emphasizes the importance of detailed analysis of market manner. a number of studies have been carried out to identify the reasons for this price increase to $7000/MW h and $9000/MW h or to assess the conditions of Major Accident Prevention policy (MAPP) in June of 1997 when the system came near to collapse or Western Systems Coordinating Council (WSCC) in July and August of 1996 when the system collapsed [6]. These events depict the crucial importance and substantial impact of rules and decision-making in the electricity market. Reliability of system has always been one of the main concerns of regulation bodies. The reasons for such issues and the impact of the new rules can be obtained by assessing the extracted patterns of the proposed method in this paper.

With respect to other kinds of markets, in the past, a large number of studies such as [7] have presented to evaluate the forceful

behavior of a single financial series. These studies often assessed the achievable dependency among past and future data in a way that agrees with various suppositions and data features, such as linearity and mutual reliance. In other words, researches principally concentrate on application of the time reliance of financial sets in order to model system forceful.

In [8], a systematic review of auto-regression and neural network to predict the time series of financial systems at a national level has proposed. Through learning the manner of financial system by using historical information, the mentioned models have been applied to forecast the changes but not for the long-term investments. For example, [9] has presented a neural network model to forecast the cost of electricity utilizing the direct prediction method on the basis of historical information. In [10], an approach that combines the highest qualities of different classification methods using heuristic-based hybrid technique has been presented, in order to become more effective and to forecast the failure probability.

From another point of view, some reports have been presented to assess the likelihood of a business-cycle. In [11], business examination information has used to find turning points and deciding moments of business cycle. On this basis, they found that multivariate data can be utilized to review important financial relations. In [12], Gregoir's method on four sets of data has employed to obtain a reliable and advanced qualitative probabilistic indicator. However, these methods are proposed to investigate the correlation between the input and output data in detail which are complicated and the obtained results are difficult to analyze. It means that, one can have probabilistic knowledge of named electricity market activities, those activities that are neither famous nor known well, but obtains limited information about what is really happening.

More accurate data is generally preferred, therefore fundamental knowledge and approximate results from financial files can be combined to achieve suitable investment decisions. In this paper a resemblance measurement model is proposed to calculate the resemblances among store information sets in financial collections of records and information. The deformation degree of the physical outline of a data distribution (DD) will be reflected by the measured resemblance values.

Since the physical outline or form of a DD shows the relation between data variables, the approximate resemblances can depict the variation of the relation. Based on resemblance measurement, store information can be investigated, and analyzed to provide knowledge for investment signals and so on.

The presented resemblance measurement includes two major parts: the DD model, and a deformation degree measurement technique. By employing the DD model to demonstrate the physical outline or form of data distributions, the reliance amid electricity market features, such as price and SWALI, are described. SWALI is selected to model market behavior and compare variations in this index in terms of price variations in different periods.

According to the series of deformation operators (that is discussed in section 'Data distribution model'), the resemblance between two data sets from the physical outline of two distributions, the data distributions among market prices and SWALI in 2004 and 2006 are dissimilar.

Fig. 1 depicts the data distribution of the prices versus SWALI during years 2004 and 2006. Based on the different physical outline of the mentioned data distributions, it can be seen that the market patterns for 2004 and 2006 are not the same, and from the position of physical outline changes, the turning points and deciding moments of market activities are notable.

According to the presented approaches, the first sample of system is considered to obtain the subsequent objectives. The presented approach produces query by sample to assist both