Chapter 10
Fuzzy Logic in Portfolio Selection:
Selected Applications

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ABSTRACT

This chapter deals with possibilities of using fuzzy logic in the process of selecting stocks for the portfolio. Often investors observe specific cognitive uncertainty problems within the portfolio selection. This is where fuzzy logic can help with the final decision. After the description of the selected fuzzy logic concepts and comparison with other similar approaches, an empirical section provides detailed insights into the applications of such methodology. The analysis utilizes weekly data for the period January 2018 – April 2019 for 20 selected stocks in order to exhibit the usefulness of the observed approach in the portfolio selection.

INTRODUCTION

Portfolio selection represents one of the greatest problems for investors today. Many different areas of knowledge are needed to be present in order to conduct a successful investment strategy over time. One of the areas which need to be included in the whole process is quantitative finance. This area of research is growing rapidly, due to a greater number of different financial products, computational capabilities and the development of financial markets as a whole (Fabozzi, Focardi and Jonas, 2007). Since many problems within the portfolio selection fall within the optimization problems, which are full of uncertainties, fuzzy set theory (FST) could be an approach which can help with finding the solutions. FST is developing since the 1960s (Zadeh, 1965), and it represents a set of models to find solutions, i.e. answers to questions which fall within ambiguous, subjective and imprecise judgments of the decision-maker (Zadeh, 2005). Using such approach within the portfolio selection enables reduction of information loss

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due to modeling the linguistic constraints by using probabilities of belonging to a set or not. (Fard and Ramezanzadeh, 2017).

The main focus of this chapter is to provide detailed description on how to conduct the selection process via fuzzy logic (FL) when observing the characteristics of stocks which the potential investor is considering for his portfolio. Since the popularity of this approach is getting bigger in the last couple of years (Huang and Jane, 2009; Ma, Luo and Jiang, 2017), such insights would be helpful for those interested in the topics of portfolio selection. There exists a gap in the literature with respect to these topics. Although the number of papers is rapidly growing (see Rubell and Jessy, 2015; Nakano, Takahashi and Takahashi, 2017; Razi, 2014; Lajevardi and Razi, 2014), often there does not exist rationale from the finance theory on which variables should the investor use when comparing the stocks one to another. This is why this chapter will use the approach from the investor's utility theory (Athayde and Flores, 2004; Jurczenko and Maillet, 2005), where the first four moments of the portfolio return distribution have economic interpretation and meaning to the investor. Main contribution of this study includes the analysis of portfolio performance after the investment strategies have been simulated, in a detailed manner which is not found in the existing literature. In that way, (potential) investors could obtain insights in the usefulness of the analysed strategies. The approach utilized in this study falls in the area of artificial intelligence (AI), as both try to imitate life in problem solving (Klement and Slany, 1994). Yager (1997) explains that the FL has the ability to extend many of the knowledge representation structures within the AI, which enables the flexibility of modelling.

Thus, the rest of the chapter is structured as follows. The second section describes the fuzzy logic which will be used in this chapter. The third section compares this approach to methodologies which can be used to answer similar questions. This is so that (potential) investors can compare advantages and disadvantages of those methods so that their future work can fully utilize some of the described approaches when needed. The fourth section is the empirical analysis with interpretations, where the Sugeno (1985) deffuzyfing model will be used so that the investment decisions can be made and trading strategies simulated and commented on. Conclusions are given in the final, fifth section.

FUZZY LOGIC APPROACH DESCRIPTION

For the introduction to fuzzy set theory, please refer to Zimmermann (2001) or Jang et al. (1997). Here, a brief description of the main ideas is presented with the focus on the portfolio selection. In brief, the FST has a basis in partial truths and the uncertainty. This is often present when the information given to the decision maker is imprecise, not full and often non-numerical, expresses in words. The fuzzy set theory is an extension to the crisp set theory (CST). Within the CST, an element either belongs to a set or not, based on the characteristics of that element and the characteristics which need to be fulfilled to belong to a given set. The FST is based on probability functions which give information on the probability of belonging to a set. One of the main problems here is how to define these functions, i.e. how to fuzzify the input values of belonging to a set or not. Next, rules have to be defined in order to calculate fuzzy output functions, execute them and based on the results one needs to defuzzify the output into a crisp output value. This value will be used in the decision making process whether a stock should enter the portfolio or not. In order to fuzzify the input variables, several approaches can be made (Li and Xu, 2013).