

# Chapter 6

## Designing an Early Warning System for Stock Market Crashes by Using ANFIS

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### ABSTRACT

*This chapter focuses on building a financial early warning system (EWS) to predict stock market crashes by using stock market volatility and rising stock prices. The relation of stock market volatility with stock market crashes is analyzed empirically. Also, Istanbul Stock Exchange (ISE) national 100 index data used to achieve better results from the view point of modeling purpose. A risk indicator of stock market crash is computed to predict crashes and to give an early warning signal. Various data mining classifiers are compared to obtain the best practical solution for the financial early warning system. Adaptive neuro fuzzy inference system (ANFIS) model was proposed to forecast stock market crashes efficiently. Also, ANFIS was explained in detail as a training tool for the EWS. The empirical results show that the fuzzy inference system has advantages to gain successful results for financial crashes.*

### INTRODUCTION

Failures in financial systems may cause financial crises and then the latter may develop into economic fundamental crises that might not be always inevitable results. Economic crises are characterized by sharp falls in both asset prices and currency

values. Failures could lead to a stock market crash that is often defined as a sharp dip in share prices of equities listed on the stock exchanges. Rising stock prices and excessive economic optimism may also cause a stock market crash. Although there is no a numerically specific definition of a stock market crash, it can be defined as double-digit percentage losses in a stock market index over a period of several days.

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Stock market crashes can provoke recessions, lead to failures in the financial system or consume years of savings and pensions instantaneously. Testing for the existence of log-periodic behavior and attempting to forecast crashes are thus important for financial regulators, risk and portfolio managers, policy makers and financial institutions (Cajueiro, et al., 2009). Generally, in any given field, crashes are extremely difficult to forecast accurately. Forecasting of crashes is one of the most popular research topics in finance. Many theoretical and empirical studies have been done to forecast crashes and many models have been developed to predict the occurrence of such crashes.

With increasing globalization and financial integration, crises in a country could make other countries highly vulnerable to shocks. The United States (US) subprime mortgage crisis also hit the Turkish economy in 2008. The Istanbul Stock Exchange (ISE) decreased from 54708 to 26864 in 2008 because of the rapid decrease in foreign markets and insufficient fresh money entrance. The ISE is the only securities exchange in Turkey. The ISE is a dynamic and growing emerging market with an increasing number of publicly traded companies, state-of-the-art technology and strong foreign participation. The ISE provides a transparent and fair trading environment not only for domestic participants, but also for foreign issuers and investors (<http://www.ise.org/>). Iseri indicates that the ISE has very high chaotic phenomena. So prediction on chaotic phenomena is very complex (Iseri, et al., 2008). Investors are intensely interested in market directions and possibilities of stock market crashes. Therefore behavior patterns of risky market days should be defined. Relationships among variables derived from the historical financial data should be discovered and a financial early warning system (EWS) should be constructed to forecast stock market crashes. Financial early warning systems have evolved considerably during the last decade thanks to data mining.

Data mining is the automatization of the process of finding interesting patterns in datasets. Methodologies in data mining come from machine learning and statistics. Machine learning is connected to computer science and artificial intelligence and is concerned with finding relations and regularities in data that can be translated into general truths. The aim of machine learning is the reproduction of the data-generating process, allowing analysts to generalize from the observed data to new, unobserved cases (Giudici, 2003).

Early warning systems in finance are vital tools for monitoring and detecting events in financial markets to predict upcoming financial crises. The world financial crisis in 2008 has put an emphasis on the importance of prediction of crises in both academic and industrial senses. It's now more necessary to develop an efficient and predictive model to give early warning signals and to anticipate crises. From a policy perspective, EWS models that help to reliably anticipate financial crises constitute an important tool for policy makers if they are employed carefully and sensibly. Many financial crises over the past few decades had devastating social, economic and political consequences. Developing reliable EWS models therefore can be of substantial value by allowing policy makers to obtain clearer signals about when and how to take pre-emptive action in order to mitigate or even prevent financial turmoil. It should be stressed that EWS models cannot replace the sound judgment of the policy maker to guide policy, but they can play an important complementary role as a neutral and objective measure of vulnerability (Bussiere & Fratzscher, 2006).

Forecasting simply means understanding which variables lead or help to predict other variables, when many variables interact in volatile markets. This means looking at the past to see what variables are significant leading indicators of the behavior of other variables. It also means a better understanding of the timing of lead-lag relations among many variables, understanding the

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