AN EMPIRICAL APPROACH TO FINANCIAL CRISES: THE CASE OF TURKISH FINANCIAL CRISES IN THE EARLY 2000s.

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by

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To My Dear Wife, Zeliha

APPROVAL PAGE

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1. The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than that for which it is now submitted.

2. The program of advanced study of which this thesis is part has consisted of:

i) Research Methods course during the undergraduate study

ii) Examination of several thesis guides of particular universities both in Turkey and abroad as well as a professional book on this subject.

Birol GÖRMEZ

June, 2009

ABSTRACT

Birol GÖRMEZ **June 2009**

AN EMPIRICAL APPROACH TO FINANCIAL CRISES: THE CASE OF TURKISH FINANCIAL CRISES IN THE EARLY 2000s.

Financial crisis, a type of economic crisis, is a big problem suddenly arising in money, foreign debt and banking areas of the financial sector. It hampers the effective functioning of the financial sector and has multi-dimensional and negative effects on real sector.

This thesis is intended to analyze the Turkish financial crisis in the early 2000s. To this effect, the thesis is divided into four chapters. In the first chapter, theoretical background of the concept of financial crisis is laid. In the second chapter, financial crisis models and the reasons of financial crises are elaborated. In addition, the reasons of the financial crises that took place in Turkey in the early 2000's, namely November 2000 and February 2001 financial crises, are also examined descriptively. In the third chapter, the Turkish financial crises in question are investigated empirically by making use of the method of Artificial Neural Network (ANN). In the fourth chapter, the thesis is concluded.

Key words: Financial Crisis, Financial Crisis Models, November 2000 and February 2001 Turkish Financial Crises, Artificial Neural Networks.

KISA ÖZET

Birol GÖRMEZ **Haziran 2009**

FİNANSAL KRİZLERE AMPİRİK BİR YAKLAŞIM: 2000 YILI BAŞLARINDAKİ TÜRKİYE FİNANSAL KRİZLERİ ÖRNEĞİ

Ekonomik krizin bir türü olan finansal kriz, finans sektörünün para, dış borç ve bankacılık alanlarında birdenbire ortaya çıkan büyük problemdir. Finans sektörünün etkin işleyişini engeller ve reel sektör üzerinde çok boyutlu ve olumsuz etkilerde bulunur.

Bu tez, 2000 yılı başlarındaki Türkiye finansal krizlerini analiz etme amacındadır. Tez bu amaçla dört bölüme ayrılmıştır. Birinci bölümde, finansal kriz kavramının teorik arka planı inşa edilmektedir. İkinci bölümde, finansal kriz modellerinin ve finansal krizlerin sebeplerinin üzerinde durulmaktadır. İlave olarak, Türkiye'de 2000 yılı başlarında meydana gelen Kasım 2000 ve Şubat 2001 finansal krizleri betimsel bir şekilde açıklanmaktadır. Üçüncü bölümde, söz konusu Türkiye finansal krizleri Yapay Sinir Ağları yöntemini kullanmak suretiyle ampirik olarak incelenmektedir. Dördüncü bölümde ise tez sonuçlandırılmaktadır.

Anahtar Kelimeler: Finansal Kriz, Finansal Kriz Modelleri, Kasım 2000 ve Şubat 2001 Türkiye Finansal Krizleri, Yapay Sinir Ağları.

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LIST OF ABBREVIATIONS

ANN	Artificial Neural Network
i.e	In other words
Ibid	ibidem-in the same book
S.E.E	State Economic Enterprise
G.D.S	Government debt security
F.E.A	Foreign Exchange Account
M2/CBER	M2 (Money Supply)/Gross Int. Reserves of Central Bank
TPCP	Total Deposits of Commercial Banks
DCA	Domestic Credit Amount
CBI/CBE	Consolidated Budget Income/Consolidated Budget Expenditure
RER	Real Exchange Rate
DR	Deposit Rate
CPI	Consumer Price Index
CAB/GDP	Current Account Balance/Gross Domestic Product
EX/IMP	Export Coverage Import Ratio
SPI	Speculative Pressure Index
FPI	Financial Pressure Index
EMP	Foreign Exchange Market Pressure Index
MSE	Mean Squared Error
RMSE	Root Mean Squared Error

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INTRODUCTION

SUBJECT, AIM AND SCOPE OF THE THESIS

Historical incidents evidence that economic life does not have a stable structure. Statistical data indicate that there have been fluctuations in the volume of world economic activities, and in price and employment levels constantly. The fluctuations that might occur at local, national or international level result in phases of prosperity, crisis or recession inevitably. Open economies are effected by the internationally-drawn fluctuations in various ways and at different intensities, depending on the vulnerability of their economic structure and some other factors. For instance, whereas The States lost about 47 % of its GDP due to the Great Depression in 1929, Japan lost only 2 % of its. Economic fluctuations, which had occured rarely and due to medical or seasonal reasons such as war, epidemic disease or drought before the Industrial Revolution, started to emerge more frequently and also because of economic reasons after the Revolution. Prosperity and crisis periods have followed each other like day and night.

Of the economic fluctuations that are classified as trend, seasonal, stochastic and business cycle in economic literature, business cycle is certainly the most important of all. To define broadly, business cycle refers to the fluctuations in the volume of economic activity. The phase of economic crisis of business cycle that is analyzed under the phases of revival,

prosperity, crisis and recession has been the focus of interest of economists due to the multi-dimensional problems it causes.

Economic crisis is the sudden and unanticipated strong fluctuation that has devastating effects on economic units in an economy. To some studies, economic problems such as unemployment, poverty, hunger, and social problems such as increase in crime rate, toxicomania are a few of the matters economic crisis leads to.

The causes and emergence patterns of crises are constantly in a state of flux due to the changing economic conditions. Economic crises, which would emerge because of real imbalances such as surplus of production and lack of consumption once, started to emerge because of financial imbalances such as the application of fixed exchange rate system and the liberalization of capital movements as well. Therefore, it would be felicitious to research economic crisis under the titles of financial and real crisis to analyze it more accurately. The real crisis refers to the severe contraction in production and/or employment level. Financial crisis means the efficieny loss of financial markets. The sudden and strong changes occuring in price and quantity of financial instruments such as foreign exchanges, stocks, promissory notes, bills of exchange, which are transacted at financial markets, are called financial crisis. Because such changes disrupt the efficieny of financial markets.

Many scientific studies have been conducted to ascertain the real and financial crises so far. Many theories have been developed. Each theory comprises various perspectives about the causes, warning and dissemination mechanisms of and intervention methods in financial crises. That is to say, it is impossible to argue that the theories in question are in agreement on the mentioned issues.

The subject of the thesis is to analyze the Turkish financial crises in the early 2000s. Two theoretical and one empirical analyses are performed for the purpose of achieving the mentioned aim. The thesis is divided into four chapters in accordance with its subject and aim. The first three chapters comprise the scope of the thesis at the same time.

In the first chapter, theoretical background of the concept of financial crisis is constructed.

In the second chapter, financial crisis models and the reasons of financial crises are elaborated. In addition, the reasons of the financial crises that took place in Turkey in the early 2000's, namely November 2000 and February 2001 financial crises, are also examined descriptively.

In the third chapter, the Turkish financial crises in question are investigated empirically by making use of the method of Artificial Neural Networks (ANN).

In the fourth chapter, the thesis is concluded.

CHAPTER ONE

THEORETICAL BACKGROUND OF THE CONCEPT OF FINANCIAL CRISIS

1.1. Introduction

Nearly all people would like to have an uninterrupted prosperous life. This demand can only be met as long as some specific conditions are established. For instance, the efficient utilization of the existing limited resources in the production of goods and services, and fair and uninterrupted distribution of the produced goods and services are two of the specific conditions that have to be established so as to ensure high and sustainable personal welfare. However, it is impossible to state that these conditions can be met any time since sometimes there may be ups and downs in economic activities. November 2000 and February 2001 Turkish crises can be given as examples for such ups and downs. Fluctuations not only in the production of goods but also in prices, employment level of resources and many other real and financial factors are effectual on welfare level. The fluctuation phase called "crisis" may have drastic economic, social and political effects. Economic crisis, which is analyzed under two main titles of real crisis and financial crisis, is an important multi-dimensional concept which has many characteristics and to which people has been exposed at different times for hundreds of years.

In this chapter of the thesis, the theoretical basis of the economic crisis concept is laid. Secondly, the types of financial crisis are explained in detail.

1.2. Basis of the Concepts of Economic Fluctuation and Crisis

This subchapter presents the basic concepts necessary for a better understanding of the economic crisis concept before discussing financial crisis concept. To this end, firstly, economic fluctuation is defined. Secondly, types of economic fluctuation are explained. Thirdly, phases of business cycle -one of the types of economic fluctuation- are clarified. By this way, the basis of the economic crisis concept will be laid.

1.2.1. What is Economic Fluctuation?

Many concepts are used in the literature to explain the ups and downs in the form of expansion and contraction, which are recorded in the macroeconomic figures. Business cycles, cyclical fluctuations, economic fluctuations, commercial cycles and economic cycles are only a few of these concepts. Economic fluctuation concept is preferred in this thesis study to refer to the concerned ups and downs. The trough point of the economic fluctuations is described with the concepts of crisis or depression. Expansion process of the economy is described with the concepts of revival or recovery. While economic revival period is characterized by an increase in the welfare, employment and production levels, economic contraction period is characterized by a decrease in the same figures. Each economic school offers a different explanation for the reasons, leading indicators and expansion

mechanisms of the economic fluctuations. For instance, Keynesian, Post-Keynesian and New Keynesian Economic Schools explain economic fluctuations on the basis of internal factors[1] while Frish and Slutzky explain them on the basis of external factors.[2] Fluctuations recorded in the economy are not of the same type and characteristics. Some of these fluctuations are periodical and some are random. Besides, some fluctuations follow a specific order although they are nonperiodic. These fluctuations have to be differentiated from each other so as to learn their structure and to develop appropriate economic tools necessary for the prevention of such fluctuations.

1.2.2. Types of Economic Fluctuation

Fluctuations in the economic activities are classified into four groups of

(i) seasonal fluctuations

(ii) random fluctuations

(iii) trend and

(iv) "business cycles on the basis of differences in the impacts, direction and severity of various economic, social and psychological factors."[3] Except for these four types of fluctuations, there are some other fluctuations that can be classified under the title of "specific fluctuations".

[1] The factors included in the economic system such as money, investment, total demand, profit and stocks.
[2] Climate conditions, political reasons and psychological factors.
[3] Özer, Mustafa and Taban, Sami (2006), *Modern Konjonktür Teorileri*, Bursa: Ekin Publications, 2nd Edition, p.5.

1.2.2.1. Seasonal Fluctuations

"Seasonal fluctuations refer to the periodical changes (decreases or increases) in the production volume, sales, consumption and price level of a country due to the climate conditions and/or socio-economic reasons."[4]

Climate conditions are among the reasons of the seasonal fluctuations. Climate changes are effectual particularly on the agricultural sector since the total production and total employment in this sector fluctuate on seasonal basis. For instance, production and employment increase in summer and harvest times but decrease in winter. Production and employment fluctuations based on seasonal conditions are naturally effectual on some macroeconomic indicators and some sectors. For instance, the price of a specific product increases when the agricultural supply for that product is low. In this case, production cost of the units using the concerned product as an input increases. Therefore, an increase will be recorded in the general price level due to both cost and the price inflation.[5] In addition to the agricultural sector, climate conditions are effectual on tourism, construction, transportation and energy sectors as well. In the tourism, construction and transportation sectors, goods and services production decreases and energy production increases in winter and vice versa in summer.

The second reason behind the seasonal changes is the social habits and the behavioral patterns changing in due course. Some sectors revive on

[4] Unay, Cafer (1999), *Makro Ekonomi*, Bursa: Vipaş Publications, 7th Edition, pp.48-49.
[5] Assuming that all other conditions remain the same and the product is not stored.

holidays and when the schools start. For instance, an increase is recorded in the sale of school uniforms and stationary equipment when the schools start and a decrease is recorded in the sale of alcohol and tobacco in Ramadan (a holy month in Islam when people feast). Textile and candy sales increase and transportation sector revives during religious and national festivals as well.

Characteristics of the seasonal fluctuations can be summarized as follows:

a) They are foreseeable fluctuations.

b) They have mainly local and sectoral impacts. Thus, they do not pose an important risk for the whole economy

c) They are cyclical and periodical fluctuations. They complete their natural cycle in 12 months.

1.2.2.2. Random Fluctuations

As the case in the seasonal fluctuations, main reason behind random fluctuations is the natural events and social and cultural developments. Although these two types of fluctuations are similar in terms of their reasons, they differ in many ways. The reasons of the seasonal fluctuations are foreseeable and they arise according to a schedule. However, the same reasons of the random fluctuations are unforeseeable and arise as shocks. Earthquakes, droughts, floods, epidemics, wars, terrorist attacks and strikes-lockouts are among the reasons that lead to random fluctuations. For

instance, the earthquake that hit Marmara Region of Turkey in 1999 resulted in some random fluctuations in the economy.

Characteristics of the random fluctuations can be summarized as follows:

a) This type of fluctuations are unforeseeable as it is impossible to foresee their place, time and impacts.

b) It is believed that the sources of the random fluctuations generally create short-term fluctuations. However, sometimes these fluctuations develop into cyclical fluctuations or other types of fluctuations.[6]

1.2.2.3. Trend

"Any fluctuation that occurs within an economy in a long period, such as 20-30 years, is called "trend" or "secular movement"."[7] Compared to the last century, higher level of aggregate economic activities has been recorded in this century. Although some recessions (contractions) and crises have been experienced from time to time, a continuous upward trend is observed in the size of the aggregate economic activities. Ups can follow downs and vice versa in the economic activities. However, despite these short-term ups and downs or expansions and contractions, economic activities show either an increasing or decreasing trend the long term. This can be either a linear or curvilinear trend. Endogenous and exogenous variables which regulate the economic growth determine the direction of the trend. Increases and improvements in the components such as population, amount of production

[6] Özer, Mustafa and Taban, Sami, ibid, p.7.
[7] Unay, Cafer (2001), *Ekonomik Konjonktür*, Bursa: Ekin Publications, Updated 6. Edition, p.51.

factors, technology and organizational structure have an increasing effect on the trend while the decreases and deteriorations in these components have a decreasing effect on the trend. Economic trend movements occur in the long term as a result of the improvements in the internal and external factors (such as increase in capital stock, qualitative and quantitative improvement of the population, technological developments and rationalization of political and social institutions) that ensure development and growth.[8] Some deviations from trend may be observed due to economic shocks from time to time. These deviations can be either temporary or permanent. "The world experienced an upward trend in 1848-1874 period and a downward trend in 1873-1894 period, and then an upward trend again in 1895-1913 period in the economic activities."[9]

1.2.2.4. Business Cycles

As well as seasonal and random fluctuations, an economy can be exposed to cyclical fluctuations as well. The reason of such type of fluctuations is the economic factors. The concept of "cycle" has been defined in many different ways. Focusing on different aspects of the cycle phenomenon, these definitions have made considerable contributions to the theory. In its most general and static meaning, cycle is the present situation of the aggregate economic activities and addresses the status of disequilibrium rather than equilibrium.

[8] Unay, Cafer (II), ibid, p.51.
[9] Özer, Mustafa, Taban, Sami, ibid, p.6.

According to a definition, "short-term fluctuations which affect economic figures such as GNP, industrial production, employment and interest rates and which occur around the long-term growth trend are called business cycles (cyclical fluctuations)."[10]

To another definition; "cyclical fluctuations are economy-wide fluctuations in total national output, income, and employment and are usually lasting for a period of 2 to 10 years, marked by widespread expansion or contraction in most sectors of the economy."[11]

Arthur Burns and Wesley Claire Mitchell make the most comprehensive definition of the cyclical fluctuation as follows:

> Cyclical fluctuations are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; in duration, cyclical fluctuations vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar characteristics with amplitudes approximating their own.[12]

Characteristics of the business cycles (cyclical fluctuations) can be summarized as follows:

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[10] Pamuk, Y. (2002). *Devresel Dalgalanma Teorilerinin Analizi ve Türkiye Ekonomisi Üzerine Bir Uygulama*, Unpublished M.A. Thesis, Erciyes University, p.21.
[11] Samuelson, Paul A., Nordhaus, William D. (2001), *Macroeconomics*, USA: McGraw-Hill Irwin, p.132.
[12] http://en.wikipedia.org/wiki/Business_cycle (11.02.2009).

✓ Cyclical fluctuations have economic reasons. Neither climate conditions nor social, political or natural events has any impact on the cyclical fluctuations.

✓ Universality and generality: Cyclical fluctuations can affect all sectors as well as one or more sectors of a country. In addition, it can be an international fluctuation that is effectual on all industrialized countries. Because the cyclical status of a country that is open to the world affects the cyclical status of other countries with which it has commercial relationships. In other words, national cycle is not autonomous. Rather, it is dependent on external factors.[13] This situation may result from many different factors. Some of these factors are the import and export relationships and capital flows between the countries, a decrease/increase in the general price levels in the outward-looking economies, and depreciation/appreciation of the national currency of a country against convertible currencies, particularly the currencies used in the foreign trade.

✓ Cyclical fluctuations are specific to free market economies. These fluctuations can not be observed in the socialist economies based on central planning.

✓ Cyclical fluctuations are observed not in agricultural societies but in industrial societies. Agricultural societies are mainly exposed to seasonal and random fluctuations. A newly invented product, a new technology developed

[13] Unay, Cafer (II), ibid, p.46.

to produce an existing product at larger amounts, at a higher quality and cheaper price in unit time, and similar developments are specific to industrial societies and result in expansion (i.e. cyclical fluctuations) in the concerned sector.

- ✓ Circularity and Cyclicity: Cyclical fluctuations are repeated -in other words circular- fluctuations. Trough-expansion-peak-contraction structure of the cyclical fluctuations can be observed again and again within the same economy. However, cyclical fluctuations are not periodic. They do not occur at regular and foreseeable intervals. The length of such fluctuations is not clear or fixed.

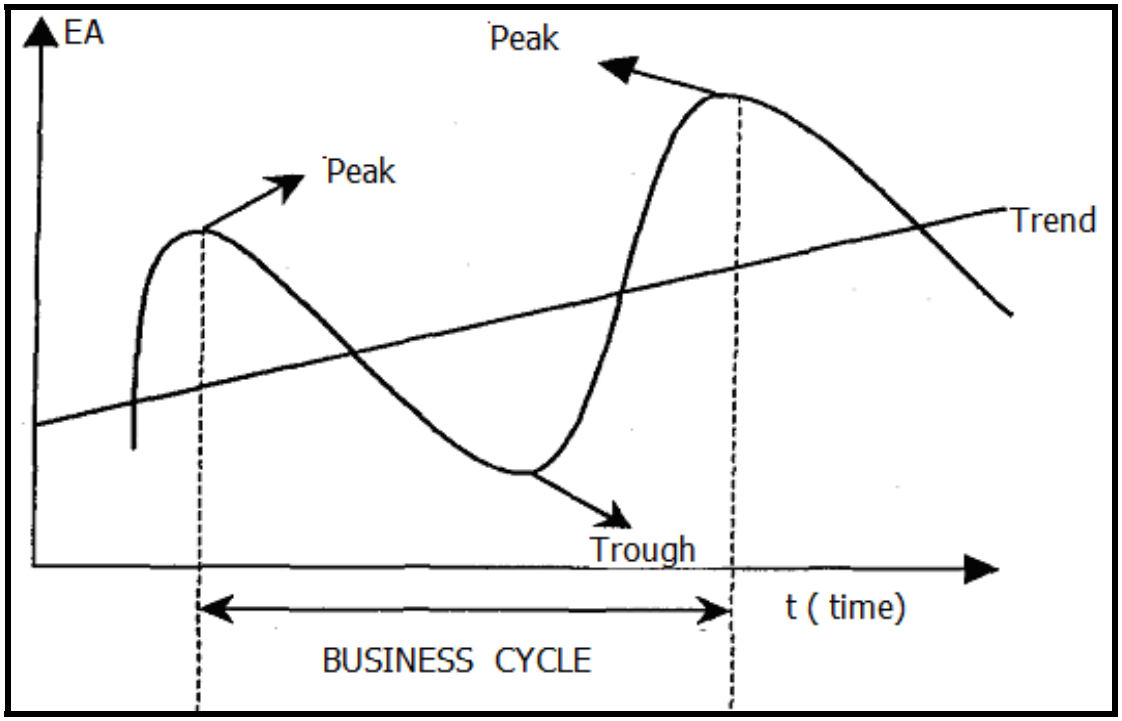
- ✓ Severity Difference: Severity of the cyclical fluctuations observed in the economy repeatedly differs from one fluctuation to another. Moreover, the variables affected by the cyclical fluctuations are recorded to fluctuate at different levels in each cyclical fluctuation.

- ✓ Unpredictability: Cyclical fluctuations are random and irregular. It is impossible to foresee such fluctuations.

1.2.2.4.1. A Business Cycle and Its Phases

In each cyclical fluctuation, there is a maximum and a minimum point: "trough" point and "peak" point respectively. The period between the successive two trough or two peak points of a cyclical fluctuation is called "business cycle". Outline of a business cycle is graphed in FIGURE 1.

FIGURE 1 A BUSINESS CYCLE



Source: Brenfenbrenner, Martin, Sichel, Werner and Gardner, Wayland (1987), *Macroeconomics*, Second Edition, Massachusetts: Houghton Mifflin Company, p.184.

The line extending from the lower left hand side to the upper right hand side is called "trend line". This trend line can be either straight or curved. This line is drawn to show the potential production levels, which refer to the production levels which can be achieved when all production factors are used. Since the potential production capacity of the economy increases in due course, the line shows a trend from the lower left hand side to the upper right hand side rather than a trend parallel to the horizontal axis or a trend extending from the upper left hand side to the right hand side.

Trough and peak points are the transition points between the periods of a business cycle. In the expansion period from the trough point to the peak point, the first phase is revival and the second phase is prosperity. However,

in the contraction period from the peak point to the trough point, the first phase is crisis and the second phase is recession. To summarize, despite the considerable differences between them, all business cycles have a standard structure following the order of "trough →revival →prosperity →peak →crisis →recession.[14] Therefore, the phases of a business cycle can be explained as follows:[15]

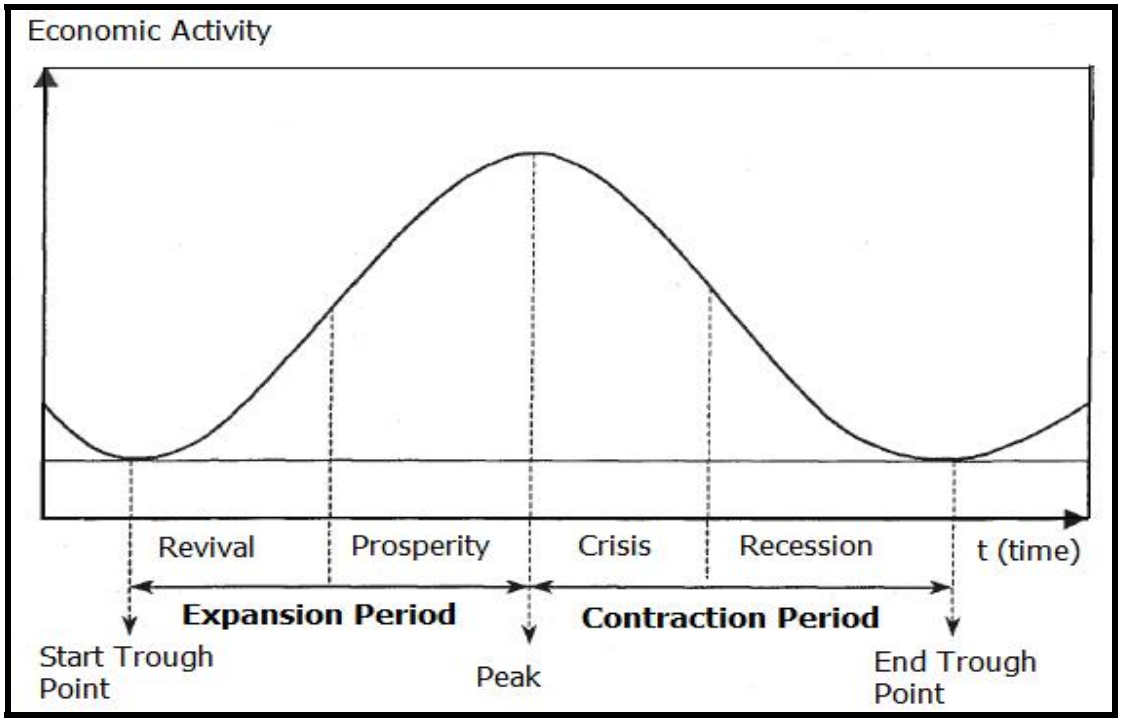
- Expansion Period
    1. Recovery or Revival Phase
    2. Prosperity Phase

- Contraction Period
    1. Crisis Phase
    2. Recession Phase

FIGURE 2 presents a business cycle with its all phases.

[14] Pamuk, ibid, p.20.
[15] Pamuk, ibid, p.26.

FIGURE 2 PHASES OF A BUSINESS CYCLE



Source: Mürütoğlu, Ali (1999), "Devresel Hareketlerin Tahmininde Öncü Göstergeler Yaklaşımı ve Türkiye Ekonomisi İçin Bir Öncü Göstergeler Endeksi Denemesi". *İMKB Dergisi*, 3(9), p.34.

Detailed analytical analysis of these phases is presented below:

Business volume increases continuously in *expansion period.* This period is characterized by the increase in the investment, employment and production levels. Corporate profits as well as consumer income, in turn, welfare levels increase. Expansion period is divided into two phases. Revival is the first phase which starts from the trough point and during which economy grows at an increasing growth rate. Prosperity is the second phase which starts where the revival phase ends, continues till peak point and during which economy grows at a decreasing growth rate. Following is the analysis of these phases on the basis of their characteristics.

In the *revival phase,* the economy -which has hit the bottom after going through contraction period composed of crisis and recession phases- tries to revive. An economy which has minimum real macroeconomic figures is indeed an economy in the first phase of the revival process. Expansion conditions are in fact established in the contraction period. Because at this phase, there are high numbers of production factors that are ready to be canalized into production, funds waiting in the banks, mattress savings as well as millions of people fed up with economic problems and longing for a prosperous life. In addition, production costs are very low since the banks having huge amount of funds in their hands agree to supply funds at low interest rates. Moreover, the people who are unemployed for a long time agree to work with low salaries and the workplace owners who can not rent their workplaces for a long time give in to low rent incomes. The only need is an impetus to carry the economy from contraction period to expansion period.[16] For instance, Keynesian economists suggest that increasing public expenditures (i.e., implementing expansionary fiscal policies) can revive economy. Discovery or invention of a raw material with high economic value may serve for the same function as well. Then, how does revival process start at this point? Economic revival can be explained from Keynesian perspective as follows: Expenditures started to be made in the stimulating sector that triggers economic revival increase the demand for the production factors. Production factors (incomes of which increase by this way) demand

[16] Economic thought disciplines have different views about this issue.

goods and services to meet their needs. Demand increase activates supply as well. This supply-demand interaction is also started to be recorded in other sectors. Thus, the revival in the stimulating sector affects other sectors gradually. As a result, all sectors and economy start to revive. By this way, investment, employment and income production levels and GNP increase, the prices of goods and services that decreased in the contraction period start to rise, and producer profits start to rise thanks to the increase in both prices and the sales volume. Consequently, producer and consumer prosperity increases. The basic distinction between revival phase and prosperity phase is that real macroeconomic figures grow at an increasing growing rate in the former. These economic improvements have positive effects on the public sector as well. Tax revenues increase, transfer expenditures of the public sector -which are recorded high in contraction period- start to decrease, positive difference between the public revenues and expenditures is canalized to the current and investment expenditures. Thus, public sector revives. Allocation of the increasing budget revenues of the public sector to the public investments results in an increase in demand and then in supply. To summarize, demand increase recorded in this phase leads to production increase and the production increase leads to a rise in employment and in turn, fall in unemployment. Capacity utilization rate increases. Demand increase brings about an increase in the general price level as well. Price increase stimulates production. Both producers and consumers are optimistic at this phase.

Revival phase includes some factors that bring its end. Reduction in the amount of the production factors used heavily, price increases and downturn in the marginal propensity to consume of the units whose income increased are some of the factors that end the revival phase. The economy which completes revival phase merges into *prosperity phase* by continuing its expansion.

Business volume is considerably high in the *prosperity phase.* Economic developments taking place in this phase can be explained as follows. Real figures such as investment, employment and production as well as nominal figures such as pay, profit and price have significantly increased as of the merge of the economy in the prosperity phase. Many firms have already reached the limits of their production capacity at the start of the prosperity phase. Therefore, economy functions at a level close to the maximum employment level. High level corporate and consumer welfare is recorded. Despite the high investment and production volumes, a relative decrease is recorded in the economic growth rate and investment rate at this phase when compared to the revival phase. Because economic activities are carried out at a level close to the full employment level so idle capacity level is quite low and it is not easy to increase this capacity in the short term. This phase also includes some economic developments that bring its end. The developments that prevent a long-lasting prosperity phase are explained in the crisis phase. Two factors unique to this phase should be explained here. First factor is "peak" which is the highest point of the business cycle, where

aggregate economic activity rises to the maximum level. At this point, production and employment levels go beyond the potential trend. Economy operates at full capacity. All production tools are canalized to production. 100 percent workforce is employed and a part of the workforce even overworks. Since preservation of full employment level is quite difficult, it is impossible to stay at peak point for ever. Second factor unique to this phase is the exceeding of the peak point by the aggregate business. Production boom occurs at this point.

Business volume decreases in the *contraction period*. In this period, investment and production volumes as well as employment level are subject to a sudden decrease, firms go bankrupt, unemployment increases, and some deteriorations are recorded in the social life. Contraction period is divided into two phases. Crisis is the phase which starts at peak point and during which business volume decreases suddenly and sharply. Recession is the phase which starts with the end of the crisis phase and during which business volume continues to decrease at a slowing pace.

High level of underemployment is recorded at the *crisis phase*. It is possible to explain how a crisis erupts as follows: The drop in sales profits and total demand as well as the increase in costs towards the end of the prosperity phase decrease total supply. The processes before and after the total supply drop occur as follows: Production and investment costs increase towards the end of the prosperity phase as the increasing production volume

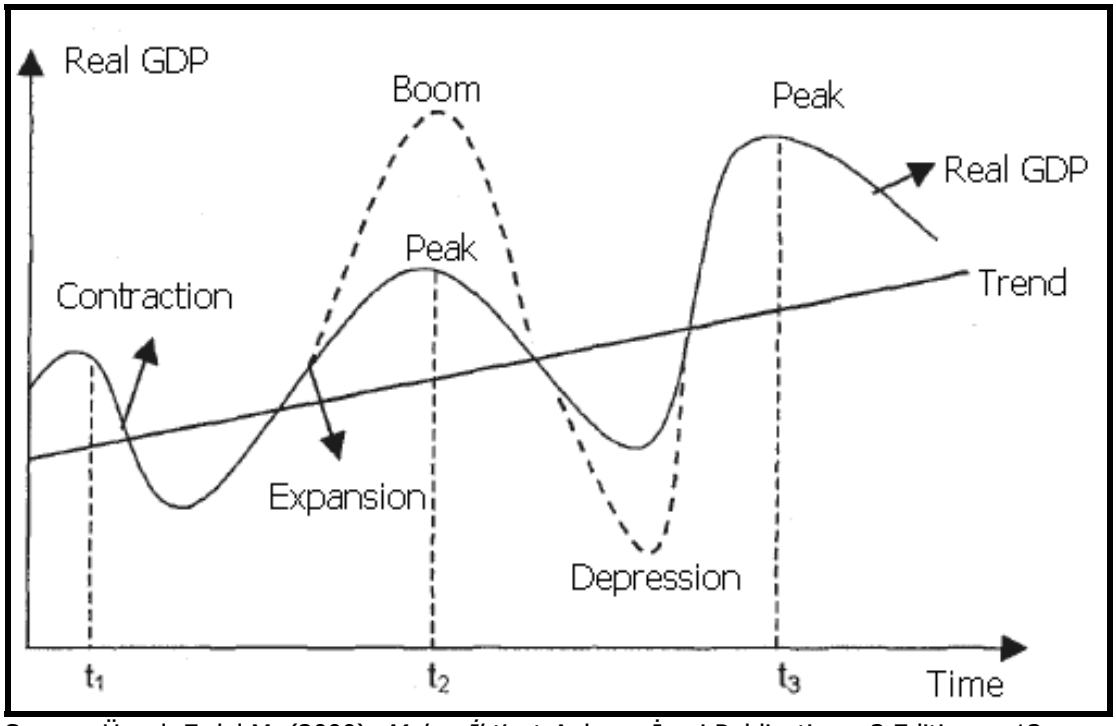
increases loan and labor demand. Since the amount of loanable funds of the credit institutions has drastically decreased, loan interest rates increase. On the other hand, pays increase as the labor demand exceeds labor supply. In addition, personnel costs increase as the labor efficiency decreases. As a result, the increase in the interest rates and pays and the decrease in the labor efficiency bring about an increase in the production and investment costs. On the other hand, since the total demand significantly increases towards the end of the prosperity phase, inflation rate raises as well. Governments start to implement contractive policies to reduce inflation. Demand level, in turn, consumption level decreases. As the household income increases towards the end of the prosperity phase, marginal propensity to save of the household exceeds the marginal propensity consume of the same. Therefore, consumption gradually decreases and sales increase rate rapidly falls. Increase in loan and labor costs on one hand and slowdown in growth rate of the prices and sales on the other hand lead to a decrease in the corporate profits. In this case, firms reduce their supply. Thus, economy enters into crisis phase. In the crisis phase, firms sharply reduce their production and discharge their employees, employment level declines, factor incomes drop as the factor demand decreases, and factor demand even drops to zero level. In this case, total demand decreases considerably. Economy continues to contract. Firms have difficulty in paying high interest rates and pays. They even go bankrupt. Public sector is negatively affected by the crisis phase as well: tax revenues fall, transfer

expenditures increase, and current and investment expenditures decrease. By this way, as the case in the private sector, the public sector is exposed to contraction. Since the crisis phase is the main subject of this thesis study, economic crisis issue is also briefly discussed in the following pages.

The second phase of the contraction period is *recession phase.* Business volume contraction that started in the crisis phase continues at this phase as well. Reduction in the demand has a decreasing effect on production and investment as well. GNP rapidly falls down to zero level. Income of all economic units drops. Decrease in the income level decreases demand as well. Higher unemployment and poverty levels are recorded. Public revenues decline. Government, which has decreased current and investment expenditures at the crisis phase, has to limit also the transfer expenditures at the recession phase. There are two important situations that occur in the recession phase. The first is the "trough" point, which is the end of the contraction period and begging of the revival and prosperity phases. It is the point where business volume is at the lowest and underemployment level is at the highest level. Unemployment is at the maximum level. Investment and production volume is at the lowest level. In case the recession phase lasts longer (i.e. in case negative development continues for more than a few quarters), economy faces a more long-lasting contraction problem. This long-lasting contraction is called "depression". Depression is the second important situation to occur in the recession period. In case of depression, the contraction in the business volume is surprisingly long and severe.

Contraction, expansion, peak, boom and depression situations are presented in Figure 3 in detail.

FIGURE 3 PHASES OF A BUSINESS CYCLE (IN DETAIL)



Source: Ünsal, Erdal M. (2000), *Makro İktisat*, Ankara: İmaj Publications, 3.Edition, p.13.

1.2.2.5. Specific Fluctuations

Specific fluctuations derive from the theories classifying fluctuations on the basis of their length. Each specific fluctuation is generally named after its theoretician. The duration/length of a business cycle refers to the duration during which it affected the economy.

1.2.2.5.1. Kitchin Waves

This wave is suggested by Joseph Kitchin, a South African statistician. In 1923, Joseph Kitchin published an article entitled "Review of Economic Statistics". It was about his discovery of a 40-month cycle resulting from a

study of U.S. and UK statistics from 1890 to 1922 and his first article to analyze business cycles. Kitchin waves are the economic fluctuations with 2-4 years between two subsequent peak points. "Kitchin cycles (duration: 2-4 years) are associated with inventory movements but also with bank clearings and wholesale prices."[17] Related to the decreases/increases in the business stocks, these waves are also named as "inventory waves".

1.2.2.5.2. Juglar Waves

"The first authority to explore economic cycles as periodically recurring phenomena was the French physician and statistician Clément Juglar, who in 1860 identified cycles based on a periodicity of roughly 8 to 11 years."[18] Subsequently, Juglar developed his approach further. He found out three phases, or periods, of a typical cycle: prosperity, crisis, and liquidation.

1.2.2.5.3. Kuznets Waves

This type of economic fluctuations occurs in construction sector as well as some economic sectors and has a periodicity of 15-25 years. This wave is developed by Simon Smith Kuznets, a Russian-born US economist. Since the statistics show that a building should be renewed in 15-25 years, length of a Kuznets wave is stated to be 15-25 years. "Kuznets waves" is also called infrastructural investment cycle.

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[17] Burda, Michael and Wyplosz, Charles (1997), *Macroeconomics A European Text*, USA: Oxford University Press, Second Edition, p.358.

[18] http://www.britannica.com/EBchecked/topic/86233/business-cycle/259081/The-Juglar-cycle (24 February 2009).

1.2.2.5.4. Kondratieff Waves

Nikolai D.Kondratieff introduced the concept of Kondratiev waves, which is also called supercycles, surges or K-waves. He was a Russian economist, who was a proponent of the New Economic Policy (NEP) in the Soviet Union.

Kondratiev waves (hereinafter called the cycle) are regular and sinusoidal cycles, which arise as the results of discoveries, inventions and technical innovations. The length of these waves is approximately 50 years on average with variation between 40 and 60 years. Thus, they are longer than the heretofore mentioned fluctuation types. Kondratieff identified three phases in the cycle: expansion, stagnation, recession. Why capitalist economies have these long waves has been analyzed by many economic schools so far. The ideas about the reasons of the waves in question have revolved around capital investment, innovations, war and capitalist crisis. In other words, there is a lack of agreement over the causes of this phenomenon. To Schumpeter, the causes of the Kitchin, Juglar and Kondratieff waves are the same. They are discoveries and technological innovations. The only difference between these waves is their length.

1.3. Economic Crisis

Economic crisis concept refers to the process of transition from expansion or continuous improvement period to the long or short-term depression or contraction period within a cyclical fluctuation. Economic crisis has some characteristics which can be listed as follows:

Unpredictability: Crisis can be defined as the negative development that occurs suddenly[19]. Due to this characteristic, "economic crisis can also be defined as the creation (by the suddenly-occurring economic developments) of the important results that affect the national economy at macro level and corporations at micro level"[20]. For instance, inflation is not a crisis while hyperinflation is a kind of crisis. Because, unlike inflation, hyperinflation causes a rapid and sudden increase in the general price level. Similarly, deflation -which is defined as the decreasing tendency of the general price level- is not a crisis. However, depression, which is defined as the cyclical phase when prices drop suddenly and unexpectedly, is a crisis.[21]

Challenges and Opportunities: While economic crisis means some challenges and threats for some units, it means new opportunities for the others. There are some actors who try to overcome a difficult situation that comes up at any unexpected time due to any reason on one hand and there

[19] Fırat, E. (2006). *Ekonomik Krizler ve İstikrar Paketleri, Türkiye Uygulaması*, Unpublished Doctoral Dissertation, Selçuk University,p.13.
[20] Coşkun, C. A., and Şen, H. (2001), "Ekonomik Kriz: Nedenler ve Çözüm Önerileri" http://www.canaktan.net/canaktan_personal/canaktan-arastirmalari/toplam-kalite/aktan-sen-ekonomik-kriz.pdf (11 March 2009).
[21] Kök, Recep (2001), "İktisadi Krizlerin Konjonktürel Analizi ve Türkiye Özeline İlişkin Bir Deneme". *Yeni Türkiye Dergisi*, No 42, p.1199.

are some other actors or circles who regard this situation as an opportunity for restructuring on the other hand.[22] For instance, developments in the communication technologies mean opportunities for some organizations and crisis for some others.

Variability of the Duration: The duration/length of the crises can be short or long. Depending on the duration of taking and implementing measures, the crises can have either short or long-term effects.

Spillover Effect: A crisis that erupts in one sector of an economy can have sectoral, inter-sectoral and even international impacts. In other words, economic crises are contagious.

The reasons, eruption way and spillover mechanisms of the economic crises have changed throughout the history. In the beginning, economic crises mainly resulted from real factors. Today, however, financial reasons play an important role in the eruption of the economic crises as well. Studies conducted on this issue to date have underlined the necessity to make a differentiation between the economic crises on the basis of these two groups of factors. Therefore, it is suggested that "real crises-financial crises" differentiation should be made when considering the "economic crisis" in general terms.[23]

[22] Yılmaz, Levent (2001), "Umberto Eco ile Kriz Üzerine". *Cogito*, No:27, p.23.
[23] Demirci, Nedret (2005), *Finansal Krizlerin Anatomisi. Modern Kriz Teorileri Işığında Gelişmekte Olan Ülkeler ve Türkiye*, Ankara: Sermaye Piyasası Kurulu Publications, p.9.

1.3.1. Real Crisis

"Real crises erupt as drastic contractions (recession and/or unemployment crisis) in the "amounts" (i.e. in production and/or employment) in goods-services and labor markets."[24] In other words, real crises erupt as recession and inflation in goods-services markets and as unemployment crisis in the labor market. Real crises are the important problems suddenly arising in the markets of non-cash flows. Each real crisis theory points out a different factor as the main reason of such crises. Crisis Theories based on underconsumption and developed by Sismondi, Malthus and Keynes are only a few of the theories aimed at explaining real crisis. Real crises are explained in detail in the Recession Subpart of the Cyclical Fluctuations Part of this thesis study.

1.3.2. Financial Crisis

The financial system has a crucial function in the economy. It enables fund-owners to lend those who are in need. Unless the financial system operates effectively, the economy does not function efficiently and economic growth is severely hampered. Financial crisis is an important problem that hampers effective functioning of the financial sector and that has multi-dimensional and negative effects on real sector. Financial crises erupt when banks and other financial institutions have difficulties in repayment, a drastic drop is recorded in the stock market prices, and uncertainty of economic

[24] Kibritçioğlu, Aykut (2001), "Türkiye'de Ekonomik Krizler ve Hükümetler, 1969-2001". *Yeni Türkiye Dergisi*, 41, p.174.

activities increase. These crises have negative impacts on production, employment and the value of the national currency.[25] Theoreticians define financial crisis from their own perspective in different ways. In its broadest meaning, financial crises are the big problems suddenly arising in money, foreign debt and banking areas of the financial sector. In the light of this definition, it is possible to classify financial crises into "banking crisis", "monetary crisis" and "foreign debt crisis" groups.[26] Following part gives brief information on the concerned financial crisis types.

1.4. Types of Financial Crisis

1.4.1. Banking Crisis

Banks are the most important institutions of any financial system. Banks ensure transfer of capital, which is the most important input of the economic growth. Any crisis that erupts in the banking sector may have catastrophic impacts on the real sector. Banking crisis can be defined in many ways. Two of these definitions are as follows:

"A banking crisis refers to a situation in which actual or potential bank runs or failures induce banks to suspend the internal convertibility of their liabilities or which compels the government to intervene to prevent this by extending assistance on a large scale."[27]

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[25] Bastı, Eyüp (2006), *Kriz Teorileri Çerçevesinde 2001 Türkiye Finansal Krizi*, Ankara: Sermaye Piyasası Kurulu Publications, p.7.
[26] Bastı, ibid, p.1.
[27] http://www.imf.org/external/pubs/ft/weo/weo0598/pdf/0598ch4.pdf (15 March 2009).

"A banking crisis is the situation in which depositors rush to the banks to draw their deposits due to loss of confidence in the financial system."[28] "In a systemic banking crisis, a country's corporate and financial sectors experience a large number of defaults and financial institutions and corporations face great difficulties repaying contracts on time."[29] As a result of the sharp increase in the amount of non-performing loans, almost all of the banking system capital is exhausted. Depressed asset prices, sharp increases in real interest rates, and a slowdown in capital flows may accompany this situation.

Main reasons behind the banking crises can be listed as follows: deterioration of the quality of the asset items included in the banks' balance sheets, increase in the share of the unproductive funds in the portfolio of the banks, sudden fluctuations in the asset prices, increase in the number of the firms going bankrupt, and high number of depositors who rush to the banks to draw their huge amount of deposits due to the changes in the political and economic situations.[30]

1.4.2. Monetary Crisis (Currency Crisis) and Twin Crisis

"If an economy suffers from balance of payment problems and if the Central Bank does not have a certain reserve utilization policy to pursue fixed

[28] Seyidoğlu, Halil (2001), *Uluslararası İktisat Teori Politika ve Uygulama*, İstanbul: Güzem Press, p.583.
[29] Laeven, L. and Valencia, F. (2008), "Systemic Banking Crises: A New Database", *IMF Working Paper* http://www.imf.org/external/pubs/ft/wp/2008/wp08224.pdf (16 March 2009)
[30] Çeviş, İsmail (2005), *Para Krizlerine Ampirik Bir Yaklaşım*, Ankara: Sermaye Piyasası Kurulu Publications, p.11.

exchange rate policy, this economy has to undergo three phases: in the first phase, the reserves reduce slowly; in the second phase, sudden speculative attacks are made, and in the third phase, the value of the national currency decreases as the fixed exchange rate policy will no longer be applicable. Monetary crisis erupts at the end of these three phases."[31] A monetary crisis or a currency crisis erupts if the attacks on the national currency of a country end up with devaluation or a sharp depreciation or if the Central Bank is forced to protect the value of the currency by selling huge amount of reserves or increasing interest rates sharply.[32]

"A currency crisis may be said to occur when a speculative attack on the exchange value of a currency results in a devaluation (or sharp depreciation) of the currency, or forces the authorities to defend the currency by expending large volumes of international reserves or by sharply raising interest rates."[33]

Monetary crises may lead to banking crises and vice versa. In other words, monetary crises may result in banking crises and banking crises may result in monetary crises. "For instance, many international financial crises of the 1980s and 1990s included both a massive devaluation and a collapse of the banking system -a phenomenon labeled 'twin crises'. These crises are called

[31] Yavaş, H. (2007). *1980 Sonrası Gelişmekte Olan Ülkelerde Yaşanan Finansal Krizler, Finansal Kriz Modelleri ve Çözüm Önerileri*, Unpublished M.A Thesis, Kadir Has University, p.47.
[32] Delice, Güven (2003), "Finansal Krizler: Teorik ve Tarihsel Bir Perspektif". *Erciyes Üniversitesi İİBF Dergisi*, 20, p.59.
[33] http://www.imf.org/external/pubs/ft/weo/weo0598/pdf/0598ch4.pdf, (15 March 2009).

"twin crises" due to the interaction between the monetary crises and banking crises. The mechanism relies on two features that characterize emerging markets which have experienced twin crises: First, governments held fixed exchange rate regimes or narrow exchange rate bands, which were vulnerable to speculative attacks. Second, domestic banks had a mismatch between foreign liabilities and domestic assets and were thus exposed to exchange rate risks."[34]

Eruption process of the twin crises in the developing markets having these two characteristics can be explained as follows: A monetary attack big enough to deteriorate foreign currency will result in a relatively bigger depreciation in the investments of the banks than in their liabilities. Foreign investors and credit institutions will foresee that banks will have fewer reserves to pay their liabilities. Therefore, they will believe that immediately drawing their deposits from the banks will be more profitable. Government reserves exhaust when the foreign investors draw their deposits from the banks, in turn, from the country's economy. In this case, the government has to undertake a larger cost so as to protect the national currency and most probably it will abandon fixed exchange rate system. This vicious circle reveals two facts. First is that banking crisis erupts because of the monetary crisis expectations of the creditors. Monetary crisis, on the other hand, result from the banking crisis expectations of the speculators. In other words, both

[34] http://www.res.org.uk/society/mediabriefings/pdfs/2005/march05/goldstein.pdf (16 March 2009).

types of crisis result in the eruption of the other and create a vicious circle. Therefore, these two types of crisis are called "twin crises". Second fact is that these crises may/may not erupt simultaneously due to the above mentioned vicious circle.

1.4.3. Foreign Debt Crisis

Public or private sector of a country can borrow from foreign institutions. Such foreign debts have to be paid back as capital and interest. "Foreign debt crisis is the declaration by a country of the fact that it can not pay "capital+interest" of the public or private foreign debt (that it can not pay debt service) due to the foreign payment problems it encounters."[35] Allocation of foreign debt to the unproductive long-term investments with high return risk is one of the reasons leading to foreign debt crisis. Foreign debt of a country is a burden on its GNP, export and foreign currency reserves. This burden increases undoubtedly as the higher amount of foreign money is borrowed and negative term and interest condition develop.[36] Since the increase in the interest rates means increase in the foreign debt, this situation may lead to default, in other words, foreign debt crisis. Various ratios are taken into consideration in relation with the sustainability of the interest and capital debt amount. Foreign Debt Service/ Export, foreign Debt Service/ GDP, Interest Service/ Export are only a few of these ratios. "12-

[35] Seyidoğlu, ibid., p.583.
[36] Dinçer, M.E. (2003). *Finansal Krizlerin Karşılaştırmalı Bir İncelemesi: Meksika – Brezilya ve Arjantin*, Unpublished M.A Thesis, Yıldız Teknik University, pp.22-23.

20% Interest Service/ Export ratio points out a mid-level foreign indebtedness and above 20% ratio points out high-level indebtedness."[37]

[37] Özer, Gül (2006), *Finansal Liberalizasyon Politikaları ve Kriz İlişkisi (1990 Sonrası Asya ve Türkiye Örneği)*, Ankara: Sermaye Piyasası Kurulu Publications, p.97.

CHAPTER TWO

THEORETICAL ANALYSIS OF FINANCIAL CRISIS

2.1. Introduction

Many financial crises have erupted particularly since the last decade of the 20th century. Foreseeing the financial crises and taking measures to minimize the length and impacts of the erupted ones are of great importance. Many financial crisis models have been developed to guide the institutions that try to achieve these goals. Theoreticians have made different comments on the reasons and eruption processes of the crises. Thus, they have suggested different solutions to this problem.

In this chapter of the thesis, the concept of financial crisis is theoretically analyzed. To this effect, firstly, the financial crisis models are explained in detail. Secondly, the reasons of financial crises, which are dealt with in the literature most commonly, are elaborated. Thirdly, November 2000 and February 2001 financial crises that took place in Turkey are theoretically investigated. In this way, a theoretical basis for the empirical analysis carried out in the third chapter is hoped to be constructed.

2.2. Financial Crisis Models

Some models and theories have been developed to explain the nature of the financial crises. Each model or theory clarifies one or more aspects of the nature of interest. "Classification of financial crisis models as First Generation Financial Crisis Models and Second Generation Financial Crisis Models has been widely accepted."[38] Some models have also been introduced into the literature, which aim at explaining the financial crises named as "Asian Financial Crisis" and erupted on 2 July 1997 with the devaluation of Thailand's national currency. These last group models are called Third Generation Financial Crisis Models or the Models Explaining Asian Crisis. This chapter is aimed to lay the theoretical basis of the indicators/independent variables used in the empirical analysis made in chapter 3, to give information on financial crisis models.

2.2.1. First Generation Financial Crisis Models

First Generation Financial Crisis Models are named as Traditional Crisis Models, Canonical Crisis Models or Speculative Attack Models as well. Main starting point of these models is the fact that foreign currency can exhaust and its supply can not be increased easily. First financial crisis modeling developed by Paul Krugman in 1979 has been considerably improved, and today it is named as "First Generation Financial Crisis Models".

[38] Bastı, ibid, p.1.

According to the first generation models which try to model monetary crises, main reasons behind monetary crises are macroeconomic structural imbalances and unsustainable policies. "High and increasing budget deficits, high inflation, high domestic interest rates, high rates of money supply increase, huge current deficits, extremely valuable exchange rate, and decreases in international reserves can be given as examples of macroeconomic structural imbalances."[39] Issuing money to finance budget deficits in a country where fixed exchange rate system is implemented can be given as an example for unsustainable and unstable policy. According to these models, covering of financial deficits while implementing a fixed exchange rate policy or increasing money supply drastically to balance a weak banking system causes financial crises. In other words, incompliance of economy policies, which are divided into two groups of monetary policy and fiscal policy, with foreign currency target result in financial crises.[40]

According to First Generation Models, financial crises (monetary crises) erupt as follows: Assume that fixed exchange rate policy is implemented in an economy, that the budget of the economy has a deficit, and that the units implementing macroeconomic policies prefer issuing money to finance the budget deficit and the only tool they have to fix the deficit is to intervene in the foreign exchange market. In such case, interest rates fall on one hand

[39] Kuran, İ. (2006). *Türkiye'de Ekonomik Krizler ve İstikrar Programları (1980-2005)*, Unpublished M.A Thesis, Harran University, p.9.
[40] For more detailed information: See; Krugman, Paul (1979), "A Model of Balance of Payment Crises". *Journal of Money, Credit, Banking*, 11: 311-325.

and inflation rises on the other hand due to increase in money supply. The fall in interest rates and the rise in inflation cause reduction of economic reserves and, thus, result in crises. First of all, foreign investors demand foreign currency (as the interest rates fall) and then export foreign currency. In addition, shadow price[41] of the foreign currency exceeds the official foreign exchange rate due to increasing foreign currency demand. Secondly, national currency is valued due to fixed exchange rate policy. This has a decreasing effect on export and increasing effect on import. Rise of inflation has negative impacts on export as well. As a result, foreign trade deficit gradually increases. The increase in the foreign trade deficit means a reduction in economic reserves. Moreover, these two developments bring along another development that reduces reserves more: in an economy where foreign trade deficit increases (i.e., where balance of payment is deteriorating), speculators foresee that fixed exchange rate policy will be abandoned and, thus, foreign currency rate will increase. Therefore, speculators who want to maximize their profits sell their reserves in national currency and buy foreign currency. Together with the above-mentioned factors, this situation plays a role in the depletion of the reserves as well. Speculative attack plays an important role in the First Generation Models. The most important characteristic of Speculative attack is that investors decrease the relative share of the national currency and increase the share

[41] Shadow price is the price determined by the supply-demand status of any good when the price is not fixed by the authorized institutions. Shadow price of any foreign currency is the price that is determined when the exchange rate is not fixed.

of the foreign currencies and foreign assets in their portfolios. Speculators sell their reserves in national currency as the value of the foreign currency starts to increase and then buy foreign currency. Central Bank, which tries to maintain fixed exchange rate, puts its foreign currency reserves on the foreign currency market. Central Bank, the reserves of which decreases to a critical level, has to abandon fixed exchange rate regime. As a consequence of this process, a financial crisis (monetary crisis) erupts. To summarize according to Krugman's approach, variables such as financial and monetary expansion result in reserve losses when there is no parity to prevent the loss of foreign currency reserves. This situation creates an increasing pressure on the foreign exchange rate.[42]

To explain briefly, First Generation Models point out public sector as the source of the crises and suggest that crises erupt due to the inconsistency between excessive public sector deficits and foreign exchange rate system. These models suggest that the increase in money supply decreases interest rates and increases inflation and that these two developments trigger the crisis by reducing the reserves in many ways. In addition, they also claim that high interest rates turn into a structural problem and create a suitable environment for the financial crises.

[42] Kaminsky, G.L., Lizondo, S. and Reinhart, Carmen M. (1998), "Leading Indicators of Currency Crises", *International Monetary Fund Staff Papers*, 45(1). http://www.imf.org/external/pubs/ft/staffp/1998/03-98/pdf/kaminsky.pdf (17 February 2009).

2.2.2. Second Generation Financial Crisis Models

Common characteristic of the Second Generation Financial Crisis Models is that these models suggest financial crises can erupt even when there is no deterioration in the economic indicators. "These models explain how speculative attacks targeting national currency can result in crises even when the monetary and fiscal policies are consistent."[43]

Second Generation Models emphasize that when there are inconsistencies between fixed exchange rate and some important economic figures, politicians may prefer to float the exchange rate and not respond to the speculative attacks even when there is sufficient amount of foreign currency reserve.[44] According to the Second Generation Models pioneered by Maurice Obtsfel, governments have grounds both to continue and to abandon the fixed exchange rate policy. Governments make benefit-cost analysis when deciding on whether to continue or abandon the fixed exchange rate policy. The benefit of the fixed exchange rate system is that it decreases the inflation pressure and creates an economic environment that promotes trade and investment. On the other hand, the cost of the fixed exchange rate system is that it causes an increase in the real interest rates. In case downward inertia is observed together with the high interest rates, unemployment rate increases and growth rate decreases. As can be

[43] Özer, Mustafa (1996), *Finansal Krizler, Piyasa Başarısızlıkları ve Finansal İstikrarı Sağlamaya Yönelik Politikalar*, Eskişehir: Anadolu University Publications, No:1096, p.67.
[44] Bilgin, M.Hüseyin, Karabulut, Gökhan and Ongan, Hakan (2002), *Finansal Krizlerin İşletmelerin Finansal Yapıları Üzerindeki Etkileri*, İstanbul: İstanbul Ticaret Odası Publications, Publication No:2002-41, p.14.

understood from the context, increasing real interest rates may lead to failure to sustain the fixed exchange rate system and, in turn, to eruption of crises. Since it will not be rational to keep the exchange rate at its current level in case costs exceed benefits, the exchange rate is floated. To reduce unemployment and current transaction deficits and to promote growth, governments prefer to switch to the floating exchange rate system although foreign currency reserves are sufficient to protect the exchange rate.

In another model established by Özkan and Sutherland,[45] the cost of keeping the exchange rate at a fixed level is determined as deviation from production target and the benefit is determined as strengthened credibility. It is suggested that, in a fixed exchange rate system, an increase in foreign interest rates may decrease the production level, that this cost has to be born unless the foreign interest rates rise to a specific level, and that the parity should be abandoned after the foreign interest rates exceed a specific threshold. In a study made by Velasco[46], it is suggested that high interest rate has the possibility of weakening the banking system and that monetary authorities prefer devaluation to possible bankruptcies to be caused by deposit guarantee.

[45] Özkan, F.G, Sutherland, A. (1995), "Policy Measures to Avoid a Currency Crises", *Economic Journal*, 105(March): 510-519.
[46] Velasco, Andres (1987), "Financial and Balance of Payment Crises: A Simple Model of the Southern Cone Experience". *Journal of Development Economics*, 27:263-283.

Second Generation Models has two main characteristics: "Self-fulfillment of the expectations and multiple equilibria."[47]

Self-fulfillment or self-legitimization of the expectations can be explained with the following example: Assume that there is an economy where fixed exchange rate policy is implemented. This implementation will have costs as well as its benefits. In case these costs exceed the benefits, private sector foresees that the government would abandon the fixed exchange rate policy. When this foresight grasps the whole market, speculators start to expect devaluation and make speculative attacks. As a result, devaluation occurs. This process is called self-fulfillment of the expectations. In other words, interest rates (interest rates will increase since the government will try to increase foreign exchange flow from abroad to protect the value of its national currency) and prices will increase in this process due to devaluation expectations. As a result of these negative developments to be observed in the macroeconomic structure, the cost of pursuing the fixed exchange rate policy will increase. In turn, cost increase will increase the devaluation expectations. Self-fulfillment process to occur between expectations and the cost of sustaining fixed exchange rate regime will end up with devaluation. Studies made by various economists specialized in financial crises can be given as examples for self-fulfillment process. For instance, according to Guillermo A. Calvo, the basic variable that results in multiple equilibria and

[47] Bastı, ibid, p.12.

self-fulfillment is the crises risk the banking system is exposed to.[48] Calvo suggests that any government which sets and implements its economic policies in an independent manner causes a term mismatch between the liabilities and assets of a bank in due course. Term mismatch brings about self-fulfillment expectations and, in turn, financial crises. Calvo explains crises and self-fulfillment process as follows: it is not known for sure whether the government, which is authorized to plan and implement its economy policies independently, will strictly pursue these policies or not. There is an issue of uncertainty. This uncertainty turns this country into a risky area for the investors who want to make investment and foreign capital transfers. It is the government's duty to minimize or completely eliminate this risk. For instance, particularly in the countries where the central bank is not autonomous, the latter can guarantee fund provision to the problematic banks as the government policy requires so. In other words, it can act like the final loan authority. In this case, depositors (particularly institutional and professional investors) do not take into consideration the match/mismatch between their deposits in the banks and the terms of the loans granted by the banks. Term mismatch finally results in financial crisis.

Multiple equilibria can be explained as follows: There may be a single equilibrium point for any good in its related market, however, there may be many equilibrium points for the same good in its related market as well. This is true for the foreign currency market as well. However, expectations

[48] Bastı, ibid, p.15.

determine at which point the foreign currency will be equilibrated. In addition, multiple-equilibria develop on the basis of the macroeconomic figures. "In general terms, in case of mid-level macroeconomic figures, foreign currency rates may be equilibrated at high levels due to negative expectations or at low levels due to positive expectations. Therefore, it is possible to conclude that multiple-equilibria can be observed in case of mid-level macroeconomic figures."[49]

2.2.3. Third Generation Financial Crisis Models

These models are also called "The Models Explaining Asian Crisis". Financial crises were widely believed to be caused by the public sector before the eruption of Asian Crisis. Reasonable inflation levels, low budget deficits and even budget surpluses recorded in the Southeast Asian countries eliminated the risk of financial crises. However, as time passed, private sector started to suffer from some economic problems. Valuation of the foreign currencies both decreased the export and increased the foreign trade deficit and current deficit as well as private sector foreign borrowing. But, since these were not public-oriented but private-oriented problems, no financial crisis expectation raised. However, "Asian Crisis" erupted when the national currency of Thailand was devaluated.

Two main suggestions have been made to explain the reasons of Asian Crisis. First suggestion is that Asian Crisis can be explained on the basis of

[49] Bastı, ibid., p.13.

the Second Generation Crisis Models. According to this suggestion, concerned countries were exposed to a self-fulfilling pessimism by the international investors. The pessimism of the creditors and investors created a pessimist atmosphere for the other investors as well. The resulting cycle caused the Asian Crisis. According to the researchers who made the second suggestion, the weak economic structure produced by the wrong policies and structural problems resulted in the Asian Crisis. These structural problems can be summarized as follows:

The first problem was the presence of microeconomic problematic implementations such as implicit deposit insurances and confidential public guarantees. These implementations have been suggested to pave the way for the crisis due to moral hazard and excessive borrowing. Governments could provide direct or indirect guarantee for the foreign borrowing of the banks or big businesses.

The second problem was the insufficient auditing of the financial sector and particularly the banks. When the system is not properly audited, banks can enable use of funds by their affiliated companies at such huge amounts to increase financial fragility. In addition, in weak systems, huge amount of funds inflowing to the country result in not only high amount of domestic fund transfers via poorly-managed banks but also domestic demand boom. The loans granted without any risk analysis can not be paid back in economic shrinkage times and result in crises.

The third problem was the unreliable balance sheets of the banks and non-bank financial institutions. The problems in the balance sheets of the banks mainly result from mismatch. When the banks borrow money in foreign currency and lend in national currency and when they make short-term borrowing and make lending for long-term investments, it means that they encounter both monetary and term mismatch problems.[50] Wrongly-valued foreign currencies and unpaid debts are the other balance sheet problems. In other words, if the foreign exchange rate of a country is not equilibrated, if the financial institutions have term and monetary problems, and if the debts are not paid back, it means that the banks have structural problems. Such situations create the appropriate environment for the financial crisis.

As can be understood from the given information Third Generation Crisis Models emphasize that mainly structural problems and wrong policies result in financial crises. In the First and Second Generation Crisis Models, on the other hand, it is suggested that the interest plays role on the financial crises.

[50] Yay, Turan, Yay, G.Gürkan and Yılmaz, Ensar (2001), *Küreselleşme Sürecinde Finansal Krizler ve Finansal Düzenlemeler*, İstanbul: İstanbul Ticaret Odası Publications, Publication No:2001-47, p.26.

2.3. Reasons of Financial Crises

This subchapter explains the reasons that lead to financial crises. Raising interest rates and uncertainty, deterioration of balance sheets, structural problems, adverse selection, deterioration of moral structure and herd behavior are the main reasons that lead to eruption, spread and deepening of financial crises. It is possible to list some other factors as well. This section aims at explaining the reasons of financial crises and to point out the role of interest factor as a reason.

2.3.1. Raising Interest Rates

Lessons learned from the experiences of the developing countries to date show that increase in the interest rates results in financial crises through different mechanisms. The reasons why the raising interest rates result in financial crises can be explained as follows:

Firstly, raising interest rates has negative impacts on the balance sheet of the corporations since they decrease cash flows. It is a high possibility that the corporations with deteriorating balance sheets head towards more risky projects to increase their market value. Because most of the loss has to be undertaken by the credits institution in case these corporations make loss after using the credits granted by the former. Such preference of the borrower is called moral hazard. Moral hazard that arises due to asymmetric information means that one of the parties behaves dishonestly after signing of the contract. What lies behind the moral risk is the concept of "hidden

action". "Hidden action refers to the situation in which one party cannot completely observe the actions taken by the other party within the scope of an economic relationship."[51]

Secondly, raising interest rates force credit institutions to grant more limited amount of credits. In other words, it leads to credit crunch. This situation results from the adverse selection problem raising in the financial system and caused by the asymmetric information. Rational, bona fide real or legal entities should not apply for credit under money market conditions in which interest rates increase rapidly. However, it is still possible to encounter some real or legal entities applying for credit under such conditions. These economic units generally ask for credits for their most risky investments. In other words, those which apply for credit under the high interest rate conditions exhibit a risky consumer profile. Such units do not have any concern about repayment. Grant of credits by the creditors to this type of consumers is known as adverse selection. Briefly explaining, adverse selection problem is the asymmetric information problem which arises before the contract and in which the most willing credit customer is the potential "bad" borrower (discredited credit borrowers who can not pay their debt and all related liabilities on time).[52] This problem points out the possibility of making a costumer selection that can create undesirable effects for the

[51] Tuna, K. (2008), "Basel II Çerçevesinde Bankalarda Kurumsal Yönetim ve Türk Bankacılık Sektörünün Analizi", http://www.iubam.org/bky.pdf (2 January 2009).
[52] Aras, G. and Müslümov, A. "Kredi Piyasalarında Asimetrik Bilgi ve Bankacılık Sistemi Üzerindeki Etkileri", http://www3.dogus.edu.tr/amuslumov/research/Article/Muslumov%20-%20Asimmetry%20-%20IF%20-%202004.pdf (2 January 2009).

financial markets. Adverse selection situation occurs when a bank client, who knows that he has quite low repayment possibility, agrees to pay considerably high interest rates to take credit from the bank. The reason behind adverse selection is the *asymmetric information* problem experienced in the financial market. Asymmetric information means that one economic unit has more information that the other economic unit. The part that has higher amount of information gets an unjust advantage over the other party. This situation hampers efficient functioning of the market. "Important market difficulties are experienced due to the asymmetric information situation that occurs between the economic units as a result of the failure to ensure complete information flow."[53]

Thirdly, raising interest rates may have negative effects on the balance sheets of the banks. Credits, which constitute the assets of the banks, generally have a long-term structure while the deposits, which constitute the liabilities of the banks, generally have a short-term structure. Increase in the interest rates decreases current value of the assets but increases current value of the liabilities. And this leads to deterioration of the financial instability.[54]

[53] Karahan, Özcan (2006), " Asimetrik Bilgi ve Para Politikasının Etkinliği". *Yönetim ve Ekonomi* , 12, p.157.
[54] Mishkin, Frederic S. (2001), "Financial Policies and the Prevention of Financial Crises in Emerging Market Countries". *NBER Working Paper*, Series: 8087:1-43.

2.3.2. Raising Uncertainty

In case that uncertainty in financial markets increases, creditors have higher possibility of making adverse selection. In addition, they have difficulty in solving moral hazard problems. Therefore, they are less disposed to grant credits when compared to the financial certainty periods. They reduce their credit volume. As a result of lower amount of the credits granted by the creditors, a decrease is recorded in investment, employment and income levels.

2.3.3. Deterioration of Balance Sheets

The effects of the deterioration in the balance sheets of both real market corporations and the financial market corporations (particularly the banks) on financial crises can be explained as follows:

Banks are the most important actors of the financial markets. Reduction of the credit amounts by the banks may have negative effects on the economic life. Banks with deteriorating balance sheets reduce the amount of the credits they grant. Poor supervision of the banking sector, increase in the interest rates, depreciation of the national currency and drop of asset prices are the main reasons behind the deterioration of the banks' balance sheets. In addition, banks may encounter balance sheet deterioration problems when the revenues they generate from their activities fall behind the payments they make for their liabilities.[55] As it results in reduction of the

[55] Alp, Ali (2001), *Finansın Uluslararasılaşması*, İstanbul: Yapı Kredi Publications, p.47.

credit amounts, deterioration of the banks' balance sheets plays an important role in the eruption of financial crises. For instance, balance sheet deterioration may result in bankruptcy of a bank. Increase in the number of the banks going bankrupt may result in the situation named "bank panic". As a result, the depositors who lose their confidence in the banks may withdraw their deposits. Thus, a decrease is recorded in the amount of the deposits to be granted as credit. This situation deepens the financial crisis.

Some deterioration in the balance sheets of the real sector corporations may deepen financial instability. This relationship can be clarified as follows:

Deterioration in the borrowers' balance sheets leads to an increase in the adverse selection and moral hazard problems. For instance, a drop in the prices of the movables and immovables of the borrower due to any macroeconomic reason (drop in asset prices) decreases the value of the guarantees given by the borrower to the bank in return for the credit the former has taken from the latter. In other words, banks' balance sheets deteriorate. Therefore, banks prefer to limit the amount of the credits they grant. At the end of this process, financial instability occurs. On the other hand, borrower's market value decreases (i.e. its balance sheet deteriorates) as the prices of its shares drop. Collapse in the share market will increase the moral hazards taken by the borrower on one hand and will expose creditors to bigger adverse selection problems. Therefore, credit volume will decrease, in other words, financial instability will occur.

2.3.4. Asymmetric Information, Adverse Selection and Moral Hazard

Asymmetric information refers to the situation in which the buyers and sellers of the same product do not have the same amount of information about the product. For instance, a borrower taking out a loan usually has better and more information about the risks and returns of an investment for which the loan is used than the lender has. This problem is known as asymmetric information. Asymmetric information causes three problems: Adverse Selection, Moral Hazard and Herd Behavior.

The problem of adverse selection arises due to asymmetric information and before the transaction occurs. "Adverse selection in financial markets occurs when the potential borrowers who are the most likely to produce an undesirable (adverse) outcome -the bad credit risks- are the ones who most actively seek out a loan and are thus most likely to be selected."[56] In case the risky projects with low financial return are financed, credit default may occur. Banking crisis may possibly erupt when high numbers of adverse selections are made in credit transactions.

The problem of moral hazard also arises due to asymmetric information but after the transaction occurs. "Moral hazard in financial markets is the risk (hazard) that the borrower might engage in activities that are undesirable (immoral) from the lender's point of view because they make it less likely

[56] Mishkin, Frederic S. (1998), *The Economics of Money, Banking and Financial Markets,* USA: Addison Wesley Longman, Inc., p.35.

that the loan will be paid back."[57] Moral hazard refers to the low probability of the funds to be paid back. Consequently, the lenders would rather not make a loan to anyone. Moral hazard problem arises when the granted credits are used in the risky areas with low return or long-term return. In case no return is ensured from the borrowed funds, creditor can not collect the capital and the interest; i.e. it faces moral hazard problem.

2.3.5. Herd Behavior

One of the factors that prevent efficient functioning of the financial markets is the herd behavior. This situation occurs when the investors have their position not on the basis of the analysis on existing market information or macroeconomic indicators but on the basis of the market speculations or the preferences of the investors in whose information sources they trust. Herd behavior has deepening effects on the financial crises. For instance; when the value of a foreign currency starts to increase, investors buy the concerned foreign currency thinking that its value will continue to increase. Some investors may demand foreign currency after observing the actions of the other investors. In case such herd behavior reaches a considerably high foreign currency demand, currency crises may erupt. Or, a currency crisis to have erupted due to another reason may deepen as a result of the herd behavior.

[57] Mishkin, ibid, p.36.

2.3.6. Structural Problems and Wrong Policies

Structural problems that result in financial crises can be explained as follows:

Poor regulation and supervision of the banking sector is one of these reasons. Insufficient financial sector supervision, lack of the early warning mechanisms to evaluate the financial risks, and a non-transparent financial system are some of the factors that facilitate the eruption and spreading of financial crises.

Existence of financial sector managers who lack sufficient knowledge constitutes another structural problem. Eruption of a financial crisis is not a surprise in a poorly-managed financial sector.

Existence of the banks with low capital stock levels is also among the factors that lead to financial crises. Indeed, this situation is a result of the poor regulation and supervision of the banking sector. Capital adequacy refers to the minimum capital amount the banks must reserve against risks. In case capital adequacy is not stipulated as a precondition for the start of the operation of a bank, banks with capital inadequacy may enter into the system, damage the whole system and make the system more vulnerable to crisis.

Another structural problem is the *existence of public banks in the banking sectors.* Since the public banks are not autonomous, the decisions related with the credits to be granted by these banks can be made by the political

will. These decisions may be made in such way to enable use of the credits in the unproductive and risky areas or grant of credits to the customers with low repayment capacity. This situation may make the banks more vulnerable to financial crises.

Deposit insurance implementation also constitutes another structural problem. This is not an unnecessary implementation. However, it is an insurance type the timing and coverage of which has to be decided in detail and cautiously. When a very high or unlimited insurance coverage is provided, creditors become more vulnerable to the adverse selection and moral hazard problems. They may offer very high interests for the deposits and may even grant credits to be used in the risky areas. On the other hand, depositors sometimes do not pay required attention in the selection of the banks to which they deposit their money. These problems may pave the way for the financial crises. Complete abandonment of the deposit insurance implementation may result in the loss of the confidence in the financial system. It is suggested that unlimited deposit insurance be applied in the crisis periods for a specific period of time and timing be cautiously made when it is decided to abandon this guarantee implementation.[58]

[58] Karacan, Ali İhsan (1999), *Yükselen Ekonomilerde Bankacılık Krizleri, Kökenler ve Politika Seçenekleri*, İstanbul: Dünya Publications, p.82.

2.4. Theoretical Analysis of Turkish Financial Crises in the Early 2000s.

IMF signed a three-year "Inflation Reduction Program" agreement with Turkey in 1999. "This agreement was based on four columns: fixed exchange rate system, public reform, privatization and structural reform in social security system and agricultural sector."[59] As well as its main purpose to reduce the inflation, the program also aimed at reducing real interest rates, increasing the potential of economic growth and ensuring more efficient and fair distribution of the economic resources.[60]

Reduction of real interest rates was planned to increase investments, in turn, employment and production on one hand and to alleviate the interest burden on the public debt stock. The program was hampered twice; first one on 22 November 2000 and the second one on 19 February 2001. Finally, the program was replaced by a new program labeled "Transition to Strong Economy".

This subchapter discusses the reasons and eruption process of and interest effect on the financial crises that erupted in Turkey on November 2000 and February 2001. It mainly aims at clarifying the relationship between the interest factor and financial crises within the scope of November 2000 and February 2001 financial crises. Second aim is to present information about these two crises. And the third aim is to lay the

[59] Turan, Z. (2005), "Türkiye Ekonomisinde Kasım 2000-Şubat 2001 Krizleri", http://www.tuhis.org.tr/dergi/agustos2005/makalezturan.pdf (18 April 2009).
[60] Parasız, İlker (2002), *Enflasyon, Kriz, Ayarlamalar*, Bursa: Ezgi Publications, p.455.

foundations of the variables, used in the empirical analysis made in Chapter 3, within the framework of the above-mentioned crises.

The main reasons behind November 2000 and February 2001 financial crises and the role of interest factor as a reason are as follows:

2.4.1. Public Sector Problems

Regarding the eruption of the crises, the most important problem created by the public sector is public deficit. Public deficit mainly results from the consolidated budget deficits, State Economic Enterprises' (SEEs) deficits, social security institutions' deficits, local administrations' deficits, funds' deficits, public banks' deficits and inefficient agricultural subsidies. "Rapidly increasing public deficits increase public domestic debt load. This situation results in the sharp increase of the interests in the domestic market, in turn, creates vicious circle of domestic debt-interest."[61]

Public deficits can be explained as follows:

Consolidated Budget Deficit is one of the public deficit types. Consolidated budget aims at including all public revenues and expenditures in a single budget and consolidates budgets of all public units to ensure budget unity. In 2000, consolidated budget revenues of Turkey were recorded to be below the consolidated budget expenditures. In other words, consolidated budget had a deficit in 2000.

[61] Kandemir, O. (2005). *Türkiye'nin 2000/2001 Ekonomik Krizinin Nedenleri ve Alınan Önlemler*, Unpublished M.A Thesis, Abant İzzet Baysal University, p.41.

Agricultural Subsidy is also one of the factors that result in public deficit. Subsidy refers to the free assistance (in the form of money or tools having monetary value) provided by the government to protect and promote producers. Agricultural subsidies were granted in Turkey in different ways. Buying products from the farmers by providing product guarantee, offering reduced prices for the agricultural inputs to be purchased by the farmers, and granting by public banks of low-interest credits to the agriculture sector and SEEs purchasing products from the agriculture sector were some of these methods. While such subsidies mainly aimed at ensuring sustainable income for the agricultural sector, this goal could not be achieved. The price of some agricultural products exceeded the average world price. This led to production surplus and stocks increased. Farmers could not repay the whole credits. Therefore, public banks which granted credits to this end made considerable loss. Deficits of the SEEs which mediated purchase of agricultural products from farmers increased as well. Inefficient subsidies resulted in an increase in the budget deficit.

Another factor that results in public deficit is the *deficits of SEEs (State Economic Enterprises)*. Enterprise gap that was detected after the foundation of the Republic was tried to be filled via public economic enterprises. However, SEEs made losses due to overemployment, failure to keep up with the technological developments, unqualified management, etc reasons. Transfer payments were made to SEEs to compensate these losses and these transfers increased budget deficit.

Deficits of the social security system are among the reasons of public deficit. Turkish Social Security System had USD 470 million deficit for the first time in 1990. Financing deficits were tried to be compensated via transfer expenditures. 345 quadrillion transfer expenditure was made in 1994-2003 period to cover these deficits. This figure corresponds to 2003 national income and to 1.24 times of 2003 total consolidated debt stock. Borrowing requirements increased in parallel with the increase in these deficits.

Briefly explained public deficit types naturally had some effects on the economic life.

Since tax revenues were not at a sufficient level, the Treasury had to issue government debt securities (GDSs) to cover these deficits. As a result of the risk premium increase caused by GDSs and high and varying inflation rate, considerable increases were recorded in the real interest rates. According to the "Inflation Reduction Program" signed with IMF in 1999, fixed exchange rate policy was pursued and real interests were kept at high levels to promote capital inflow. In this environment, rather than transferring funds to the real sector, banks turned into the biggest GDSs buyers. The more interests increased, the more borrowing increased and the more borrowing increased, the more interest rates increased. While 90.5% of the tax revenues were allocated to "capital+ interest payments" of the debts in 1992, tax revenues could no longer compensate "capital+ interest payments" of the debts as of 1993. Even the share of only the interest expenditures in

the tax revenues rose nearly to 72% of the tax revenues in 1999, and this share was recorded to be 103% in 2001, the highest figure recorded ever. Even only this figure is enough to see how the environment was unsustainable and suitable for the crisis.[62] As a result, deficits resulted in borrowing, borrowing led to interest rate increases, and interest rate increases rose debts to a much higher level. Vicious circle of "domestic borrowing-interest" turned domestic borrowings problem into an unsustainable situation.

2.4.2. Banking Sector Problems

Some structural problems experienced by the banking sector before November 2000 crisis: wrong financing policies implemented by the banks, poor analysis of the inflation reduction program as well as macroeconomic and political structure by the banks, and excessive risks taken in the scope of the credit policies were the factors effective on the eruption and deepening of November 2000 and February 2001 crises. These problems and policies can be clarified as follows:

✓ *Public banks and inefficient regulation and supervision of the banking sector:*

Effects of the public banks on the financial crises erupted in early 2000s can be listed as follows:

[62] Kandemir, ibid, p.59.

Firstly, as discussed under the title of Public Sector Problems, public banks granted low-interest and long-term credits to some sectors. This implementation resulted in an increase in the duty loss of public banks. These duty losses imposed a burden on the budget and served as a reason for public borrowing.

Secondly, public banks were used for political interests. Some politicians regarded public banks as an employment area. This resulted in overemployment and hampered efficient functioning of the banks. In addition, political preferences resulted in poorly-managed banks. These problems were also effective on the losses of the public banks.

✓ *Problems raised by wrong borrowing policies aimed at financing public deficits:*

Main function of the commercial banks is to finance the real sector investments. However, banks in Turkey preferred to finance public deficits before November 2000 crisis. Government issued GDSs to cover public deficits and the share of the GDSs in the asset items of the banks increased. Such that USD 4-5 billion GDSs were recorded in the portfolio of Demirbank, which had USD 300 million capital stock before transferred to Saving Deposit Insurance Fund (TMSF).[63] GDSs procurement by the banks, i.e. the method they adopted to cover public deficits, and the disadvantages of this method are detailed below:

[63] Keyder, Nur (2001), "Türkiye'de 2000-2001 Krizleri ve İstikrar Programları". *İktisat İşletme ve Finans*, 16(183), p.39.

They chose short-term borrowing option to cover domestic borrowing requirement of the government. They used short-term domestic Foreign Exchange Accounts (FEAs) and foreign syndication loans to this end.[64] They took loans in foreign currency and converted these currencies into TL to buy GDSs. This situation increased the short position of the banks. As long as the difference between the interest rates and exchange rates was in favor of the interest rates, banks went on borrowing. In other words, their short positions increased more and more since that condition provided them with the opportunity of making high profit. This situation created a fragile financial system. The policy pursued in 1990-2000 period reduced interest and currency fluctuations, limited currency increase to inflation rate, enabled overnight funding for the markets and ensured easy borrowing by the Treasury. However, this policy kept banks away from taking required measures against interest and exchange rate risks.[65] Banks made short-term borrowings. However, the term of their receivable GDSs was expanded up to 15 months in 2000. This situation presented banks with mismatch problems and interest risk. In other words, banks were exposed to term mismatches and interest risk due to the long-term structure of their active items and short-term structure of their debit items. Indeed, borrowing requirement of the Treasury was an advantage for the banks. Since high inflation rate,

[64] For more detailed information; See: İnan, E. Alp (2000), "Türk Bankacılık Sektöründe Etkinlik ve Verimlilik". *TBB Dergisi*,34.
[65] Binay, Şükrü and Kunder, Kürşat (1998), *Mali Liberalleşmede Merkez Bankasının Rolü*, Ankara:TCMB Publications, p.54.

political uncertainties, high GDSs interest rates and many factors made it irrational and risky to grant credits to the real sector, banks preferred GDSs because of their repayment guarantee and high return. But, the advantageous situation of the commercial banks (financing public institutions even at high interest rates) resulted in the deepening of the crisis.[66] The process followed these steps: The small and medium size banks that survived by financing the public sector made short-term borrowings as the interests of the securities increased (security prices decreased). This was the starting point of the crisis. As of the middle of November, interest rates started to increase. Since raising security interests meant drop of security prices and since these securities were financed via short-term debts, banks started to surfer from liquidity problems. Moreover, some foreign creditors rejected to renew syndication loans of Turkish banks because of the macroeconomic conditions of Turkey and the risks these banks were exposed to.[67] Illiquidity problem became more serious under these circumstances. Banks started to sell (even at low prices) GDSs in their hands to overcome this illiquidity problem. This situation increased security interest rates again. Illiquidity resulted in an increase in overnight interests. Overnight repo interest (O/N) reached 210% and rose to 1700% in Interbank Money Market due to TL shortage in the markets. Overnight interests exceeded 6000%

[66] Eren, A. and Süslü, B. (2001), "Finansal Kriz Teorileri Işığında Türkiye'de Yaşanan Krizlerin Genel Bir Değerlendirmesi", *Yeni Türkiye*, 41: 662-674. http://www.econturk.org/Turkiyeekonomisi/krz.rtf (5 March 2009).
[67] Bastı, ibid, p.126.

level in Interbank Money Market on 21 February. As a result, the interest risk posed by the term mismatches resulted in the bankruptcy of Demirbank.[68] As can be understood from the process, security interests played an important role in the deepening of November 2000 and February 2001 crises.

Poor regulation and supervision of the banking sector was another problem experienced by the banking sector in pre-crisis period. As it was quite easy to establish a bank in 1990s, the number of banks increased rapidly. However, these banks were small enterprises which had insufficient amount of capital and which were established to finance public deficits and production of group companies rather than performing the main duties of an ordinary commercial bank. Boards and institutions which had to ensure efficient regulation and supervision of the banks could not meet the need. Banks affiliated to the Undersecretariat of Treasury were used to be supervised by the certified comptrollers of the Treasury before November 2000 and February 2001 financial crises. So, there was no single supervision board similar to the one that operates today.

2.4.3. Balance of Payments Problems

"Balance of Payments" is a statistical statement which records (systematically and in line with the accounting records) the differences in the assets related with the economic flows between the domestic and foreign actors of an economy, in transfer payments and in reserves. It shows the

[68] Bastı, ibid, p.126.

direction of the change in the economic flows of one country with the other countries. There are three main accounts included in the balance of payments of a country: current account, capital account and official reserves account. This subchapter focuses on the problems created by these three accounts and proved to be effective on 2000 and 2001 crises.

2.4.3.1. Current Account Problems

Current account is a sub-item of balance of payments. All foreign currency revenues and expenditures generated by the current transfers composed of goods and services trade, direct investments and portfolio investments, workers' remittances, and official transfers are kept in the current account. In the light of these information, the developments that took place in the current account of Turkey before the crises can be summarized as follows:

The main purpose of the agreement made with IMF in 1999 was to reduce the inflation. The increase to be recorded in the empirical exchange rate was foreseen to be equal to the increase expected in Wholesale Price Index (WPI) (20%). Exchange rates were planned to be declared in advance and in line with the inflation target. However, targeted inflation reduction could not be achieved. At the end of 2000, WPI was recorded as 32.7% and CPI as 39%. Increase in energy prices, unexpectedly high rises in the prices of the public products (2%), poor planning of the revenue policy in the program, failure of Rent Increase Adjustment Law enacted to minimize the effects of rent increases on inflation and unexpectedly high wage increases both in

public and private sector[69] were some of the reasons behind the problems encountered by disinflation program and the failure to achieve the inflation target. As can be understood from the information given, revival of domestic demand played a role in the unexpectedly high inflation rates. One of the most important reasons of the sudden increase in the domestic demand was the sharp interest decrease. GDSs compound interest and deposit real interests fell below both the realized and the estimated inflation levels, which triggered domestic demand. Moreover, relatively high inflation when compared to exchange rate increase (real valuation of TL) brought about both price (substitution) and revenue effect. These effects created a rapid increase in the import demand.[70] Import increase, in turn, exchange rate demand was realized well beyond the expected levels. On the other hand, export, in turn, foreign currency inflow decreased as a result of the domestic demand increase and real valuation of TL. Current account was negatively affected by the increase in the import level and decrease in the export level. Current deficit sharply increased. Current deficit which was estimated to be realized around USD 4 billion was recorded as USD 10 billion. Current deficit is one of the basic indicators which point out an approaching crisis. In addition, "if the current account of a country making foreign debt repayment does not have sufficient amount of surplus, it means that devaluation, i.e.

[69] Wage increases were estimated to remain under 25% ceiling for the public sector. Private sector was planned to comply with this target. However, this plan was not abided by. Wage increase in public and private sector was recorded to be nearly 60-70%.
[70] Uygur, E. (2001), "Krizden Krize Türkiye: 2000 Kasım ve Şubat 2001 Krizleri", *Türkiye Ekonomi Kurumu Discussion Paper 2001/1*, p.13. http://www.tek.org.tr/dosyalar/KRIZ-2000-20013.pdf (10 March 2009).

crisis, is too soon."[71] As a result of the 7% growth recorded in 2000, import increased by 23% and export by 2.2% in Turkey. Current account deficit increased to USD 9.819 million in 2000 -nearly 5% of GNP (USD 201.3 billion)- and exceeded the critical threshold.[72]

2.4.3.2. Capital Account Problems

"International capital transactions refer to the physical investments made by the institutions or persons in a country other than the country they are located in and the financial sources transferred to other countries (foreign securities, shares, opening bank accounts, etc)."[73] Direct investments, portfolio investments, long-term and short-term capital movements are recorded and monitored in the capital account of the balance of payments. International capital flows with terms longer than one year are long-term and those with terms shorter than one year are short-term capital transactions.[74] Long-term capital movements have some advantages such as making positive effects on economic growth and ensuring foreign currency and new technology inflow. Thanks to their long-term structure, these movements do not result in crises provided that they are utilized in an efficient manner. Short-term capital movements, on the other hand, serve as speculative hot money. "Hot money is a capital movement seeking arbitrage. Therefore,

[71] Fischer, Stanley (1988), "Real Balances, the Exchange Rate, and Indexation: Real Variables in Disinflation". *Quarterly Journal of Economics*, 103 (1), p.39.
[72] Keyder, ibid, pp.38-39.
[73] Seyidoğlu, ibid, p.141.
[74] Direct capital investments, portfolio investments (such as foreign securities and shares) and term deposit accounts opened in foreign banks.

portfolio investments targeted at shares and short-term securities (Treasury or private sector securities), short-term credits granted to the banks and other private actors (except for commercial credits), bank deposit changes and the changes in the other non-bank institutions are named as Hot Money."[75] "When compared to the long-term investments, they are more vulnerable to the financial indicators such as interest rate and share indices.[76] "Hot money mechanism is founded on three pillars: Interest rate, inflation rate and increase in exchange rate."[77] In case inflation increases more than exchange rate, overvaluation is recoded in the national currency. Although exchange rate increases are observed to be either under or above the inflation rate in Turkey, GDSs interest rates have always been three-digit figures since January 1994.[78] Hot money inflows make positive contributions to the economy of a country and do not lead to a crisis as long as the budget does not have a deficit and capital markets are well-structured. Failure to meet these conditions in 80s and 90s turned short-term capital inflows, i.e. hot money, into a risk factor for Turkish economy. In November 2000 and February 2001 crises in Turkey, hot money left the country due to the deterioration in macroeconomic indicators and expectations and economy was exposed to financial crises. For instance, nearly USD 7 billion hot money

[75] Boratav, Korkut (2001), "2000/2001 Krizinde Sermeye Hareketleri". *İktisat, İşletme ve Finans*, 16(186), p.9.
[76] Güven, Semih (2001), "Sermaye Hareketlerinin Nedenleri, Etkileri ve Türkiye Örneği". *İktisat, İşletme ve Finans*, 16(185), p.82.
[77] Eren, Süslü, ibid, p.15.
[78] Eren, Aslan (2000), *Türkiye'nin Ekonomik Yapısı ve Güncel Sorunlar*, Muğla: Muğla University Press, p.109.

left the country just in two weeks during November 2000 crisis.[79] "This figure is approximately two folds of the net USD 3.6 billion hot money inflow that was recorded in 6 years in 1992-1997 period."[80] On the basis of the statements made by Korkut Boratav[81], it is possible to summarize the effects of capital movements on November 2000 and February 2001 crises in figures: net foreign capital inflow in the first ten months of 2000 rose to USD +15.2 billion. Net capital outflow in November 2000-June 2001 period accounted for USD -10.4 billion. Therefore, the difference between these two figures is drastically high: USD 25.6 billion. When the domestic actors are included in this figure, pre-crisis net capital inflow is found to be USD +9.9 billion while the during-the-crisis net capital outflow is USD -13.5 billion. Thus, the change in the direction of the capital movements of domestic and foreign actors resulted in a negative shock accounting to USD 23.4 billion in the economy. This figure corresponds to 12% of 2000 GNP (2000 GNP was USD 201.3 billion), which is an important share in terms of the impacts (on financial system, monetary figures and interest rates) of the shocks created by such directional change in the capital flows.

2.4.3.3. Problems Related With Official Reserves Account

Official reserves account is composed of the foreign currencies reserved by the Central Bank to intervene in the exchange rate fluctuations. Fluctuations were recorded in the official reserves account before and after

[79] Karluk, Rıdvan (2002), *Türkiye Ekonomisi*, İstanbul: Beta, p.478.
[80] Kandemir, a.g.e.,p.89.
[81] Boratav, a.g.e., p.13.

November 2000 crisis. Foreign confidence in the inflation reduction program was lost before 2001 crisis due to the failure to cover current account deficit and to achieve privatization at the planned level, delay in structural reforms, extreme risks taken by the banks and many other reasons. Therefore, both short-term capital inflows decreased and borrowing door was closed. These developments reduced the liquidity in the market and raised short-term interest rates. Raising interest rates deteriorated the balance sheet of the banks which had GDSs funded via short-term funds. As a result of these negative developments, speculative attacks were started to be made and November 2000 crisis erupted. Foreign currency reserves of the Central Bank declined sharply due to the crisis. Central Bank reserves declined by USD 3 billion in the first day of the crisis and USD 2.5 billion in the successive week. Therefore, crisis resulted in USD 5.5 billion exhaustion in the Central Bank reserves. In addition, the Central Bank used the credit granted by IMF, which accounted for USD 7.5. billion, to minimize the effects of the crisis. Moreover, interest rates were increased to prevent foreign currency outflow and to ensure new foreign currency inflow to the market. Nearly 3 months after November 2000 crisis, a political crisis erupted in February 19, 2001. This political crisis brought about speculative attacks and the Central Bank foreign currency reserve dropped from USD 27.94 billion to USD 22.58 billion. The reserve lost by the Central Bank just in one week amounted to USD 5.36 billion. Foreign Exchange rate was allowed to fluctuate in the night of 21 February.

2.4.3.4. Problems Related With Fixed Exchange Rate Policy

As per the stability program signed at the end of 1999, fixed exchange rate policy was put into effect. Fixed exchange rate policy aimed at eliminating the effects of exchange rate on the interest rates, ensuring hot money inflow, reducing public deficits and inflation rate, and increasing the Central Bank reserves. Expectations from the fixed exchange rate were as follows: foreign capital inflow would not be effective on the exchange rate, interest rates would drop down and economic development would be achieved, foreign capital inflow would be canalized to public deficits and current deficit, and fixed exchange rate would eliminate the risk related with the exchange rate increase and would promote foreign borrowing by the banks and corporations. However, some factors were not taken into consideration when making such planning. Negative aspects of the fixed exchange rate policy: (i) Import would increase and export would decrease, in turn, current deficit would increase in case real exchange rate increased (valuation of the national currency) (ii). The Central Bank was indirectly prevented from intervening in the foreign exchange market in case of speculative foreign exchange attacks. An overvaluation was recorded in the real exchange rate and, in turn, TL was valued before November 2000 crisis. While the real exchange rate index was 128.5 in January 2000, this figure rose to 142.45 in October 2002, with an approximately 11% increase.[82] The increase recorded in export was 2.8% and import was 32.7%. When

[82] http://evds.tcmb.gov.tr/ (04 May 2009).

compared to the previous year, "foreign trade deficit increased by 92.4%."[83] On the other hand, current account and balance of payments had deficit in 2000. All of these developments reduced the confidence in the program and increased crisis expectation.

2.4.3.5. Political Instability

Turkey has been governed by the coalition governments for long years. Turkey was governed by a three-party coalition before both November 2000 and February 2001 crisis. Every time a dispute arose among the coalition parties, the investors got the idea that the program could not be continued. Harmony and unity problems were experienced due to the three-party structure of the Cabinet of Ministers and these problems prevented smooth implementation of the program signed with IMF. For instance, although privatization was one of the main objectives of the program, Türk Telekom and THY could not be privatized.

[83] Eren, Süslü, ibid, p.10.

CHAPTER 3

EMPIRICAL ANALYSIS OF TURKISH FINANCIAL CRISIS IN THE EARLY 2000s.

3.1. Introduction

To date, many empirical and theoretical studies have been conducted to reveal the reasons behind November 2000 and February 2001 crisis that erupted in Turkey. Various analysis methods have been used. Before the analysis of the thesis study, brief information will be given about some studies which have made empirical or theoretical analysis of Turkish financial crises. After literature review, the crises that erupted in Turkey in November 2000 and February 2001 are analyzed via Artificial Neural Networks method.

3.2. Literature Review

One of the above-mentioned studies is the doctorate thesis of Ali Şen, *"Predictability of Financial Crisis: Turkish Case"*[84]. Totally 14 variables were used in the concerned study. Separate models were developed for the monetary and banking crises that erupted in Turkey after 1980. The models covering the period starting with January 1980 and ending with December 2003 were composed of totally 260-month data and were separately estimated via probit method. Real interests, foreign exchange liabilities of the banks, the Central Bank credits granted to the public, budget deficit and

[84] Şen, A. (2003). *Finansal Krizlerin Tahmin Edilebilirliği: Türkiye Uygulaması,* Unpublished Doctoral Dissertation, İstanbul University.

share indices were listed to be the significant variables of the model that produced the best results for the monetary crises. M2/Reserves, domestic credit changes, commercial bank deposits, real interests and inflation were found to be significant in the scope of the model that produced the best results for the banking crises. The only common significant variable of the models that produced the best results for both monetary crises and banking crises was found to be the "real interests" variable. In other words, "real interests" factor was detected to be the common variable explaining both banking crises and monetary crises.

Another study to be underlined in this scope is the article written by Cevat Gerni, Ö. Selçuk Emsen and M.Kemal Değer, titled "*Analysis of Turkish Crises via Early Warning System*"[85]. In the study concerned, economic crises that erupted in Turkey in 1994-2001 period were analyzed on the basis of the monthly data pertaining to 1990-2004 period. Regression analysis was made via LPM and Logit methods. In addition, signal acquisition method was used as well. All of these three studies produced similar estimations. Valuation of the national currency, decline in reserves, increase in the interest rate differences, fall in the rate of compensation of the public expenditures by the public revenues, drop in the industrial production index and increase in the inflation difference have been recorded to be the signals of an approaching crisis.

[85] Gerni, C., Emsen, Ö.S., Değer, M.K. (2005), "Erken Uyarı Sistemleri Yoluyla Türkiye'deki Ekonomik Krizlerin Analizi", *Ekonometri ve İstatistik*, 2:11-29.

The article titled "*Türkiye Ekonomisinde Finansal Krizler: Bir Faktör Analizi Uygulaması*"[86] by Sayım Işık, Koray Duman and Adil Korkmaz is another study that should be analyzed. In this study, the financial crises experienced in April 1994 and February 2001 in Turkey were analyzed through the method of factor analysis. 23 independent variables were utilized. The independent variables were classified under seven factors. F1 and F2 independent variables, along with four different independent variables, were classified under the demand boom factor emerging with the rising conjuncture. As a result of the factor analysis, the demand boom emerging with the rising conjuncture, the increasing vulnerability of the banking sector and the currency substitution accelerating as a result of the unreliability felt by the household towards the policies implemented were determined as the basic reasons of the aforementioned crises.

In their article titled "*Turkish and Argentine Financial Crisis*: *A Univariate Event Study Analysis*"[87], Mete Feridun and Orhan Korhan analyzed the financial crises that had erupted in Argentina and Turkey after 1990. Monthly data between the periods of February 1991 and February 2001 were used. Six independent variables were included in the study. Stock Market Index, Exchange Rate, Exports/Imports, Money Supply (M1), Domestic Credit, Consumer Price Index are the independent variables used in the analysis. It

[86] Işık, S., Duman, K., Korkmaz, A. (2004), "Türkiye Ekonomisinde Finansal Krizler:Bir Faktör Analizi Uygulaması", *Dokuz Eylül Üniv. İİBF Dergisi*, 19(1):45-69.
[87] Feridun, M., Korhan, O. (2005), "Turkish and Argentine Financial Crises: A Univariate Event Study Analysis", *Journal of Applied Sciences*, 5(4): 768-772.

was emphasized that the increase in consumer price index and the decrease in foreign exchange rate had been effectual on the financial crises in Turkey after 1990. Furthermore, it was stated that the increase in domestic credit volume had been effectual on the crises of 1994 and 2001. It was referred that the decrease in market index and export/import ratio had affected the 1994 financial crisis.

Zeynep Karaçor and Volkan Alptekin have analyzed November 2000 and February 2001 crises via the leading indicators approach in their article titled *"Finansal Krizlerin Önceden Tahmin Yoluyla Değerlendirilmesi: Türkiye Örneği."*[88] 10 independent variables were used. It was concluded that though the net international reserves, export, real foreign exchange rate, M1 money supply, M2 money supply/reserve money, domestic credits/GDP, real deposit interest rate, M2/Gross International Reserves and Index of Industrial Production were the crisis indicators, the variable of the terms of foreign trade was not.

Üzeyir Aydın's master's thesis titled *"Türkiye'de 1980 Sonrası Dönemde Yaşanan Ekonomik Krizlerin Analizi"*[89] is another study on Turkish financial crises. In the study, the independent variables were gathered under five different titles: current accounts balance, budget balance, foreign exchange rates, financial pressure index and foreign capital movements. These basic

[88] Karaçor, Z., Alptekin, V. (2006), "Finansal Krizlerin Önceden Tahmin Yoluyla Değerlendirilmesi:Türkiye Örneği", *Yönetim ve Ekonomi*, 13(2):237-256.
[89] Aydın, Ü. (2003). *Türkiye'de 1980 Sonrası Dönemde Yaşanan Ekonomik Krizlerin Analizi*, Unpublished M.A Thesis, Dokuz Eylül University.

variables were used in order to gather various sub- variables under a common name. Furthermore, GNP growth rates, Wholesale Price Index and unemployment rates were utilized in order to set up a crisis index, which was used as a dependent variable. The results of this analysis covering the period of 1981-2002 are as follows: the current accounts deficit, budget deficit, foreign exchange movements, foreign capital movements, interest rates and the changes in central bank foreign exchange reserves were found influential on the crises after 1980. To the study, the Financial Pressure Index that consists of the public domestic borrowing interest, exchange rate and the central bank foreign exchange reserves is the most influential variable on the crises, followed by the public investment spendings and current accounts deficit.

In his article titled *"The Lessons from the 1994 Crisis in Turkey: Public Debt (Mis) Management and Confidence Crisis"*[90], Fatih Özatay analyzed the 1994 financial crisis. In the study, he argued that the fact that the domestic interest rates were kept under the equilibrium interest rates in order to finance budget deficits in a cost-effective way was the fundamental factor that affected the 1994 crisis. Furthermore, he also concluded that unsustainable level of current and budget deficits in the pre-crisis period was also influential in the crisis to break out.

[90] Özatay, Fatih (1996), "The Lessons from the 1994 Crisis in Turkey: Public Debt (Mis) Management and Confidence Crisis". *Yapı Kredi Economic Review*, 7(1):21-37.

In his theoretical discussion paper titled *"Krizden Krize Türkiye: 2000 Kasım ve 2001 Şubat Krizleri"*[91], Ercan Uygur designated 11 leading indicators, which are short-term foreign debt/foreign exchange reserve, current deficit/foreign exchange reserve, current deficit/GDP, total or short-term foreign debt/export, banking sector open position/foreign exchange reserve, bank credit/foreign exchange reserve, M2/foreign exchange reserve, appreciation of the domestic currency, fluctuation in the capital movement, fluctuation in the short-term domestic interest, rise and fluctuation in foreign debt interest and risk premium. It is referred that the fluctuation in the short-term domestic interest is an important indicator of crisis.

In their proceeding titled *"Finansal Kriz Öncü Göstergeleri ve Türkiye Finansal Kırılganlık İndeksi"*[92], Bedriye Saraçoğlu, Arslan Yiğidim, Ahmet Demir, Sibel Duman and Şenay Açıköz analyzed the financial crisis that had emerged in Turkey in the years of 1994, 2000 and 2001 by using signal acquisition, logit and probit models separately. Speculative Pressure Index (SPI) was constituted through the monthly percentage changes in the foreign exchange rate, interest rate and international reserves. This index was used as a dependent variable. The data between the years of 1992 and 2004 were used. Current deficit/net international reserves, export/import coverage ratio on annual basis, hot money/international reserves and expansion of the real

[91] Uygur, E. (2001), "Krizden Krize Türkiye: 2000 Kasım ve Şubat 2001 Krizleri", *Türk Ekonomi Kurumu Discussion Paper 2001/1*, http://www.tek.org.tr/dosyalar/KRIZ-2000-20013.pdf (10 March 2009).

[92] Saraçoğlu, B., Yiğidim, A., Demir, A., Duman, S. and Açıkgöz,Ş. (2005). "Finansal Kriz Öncü Göstergeleri ve Türkiye Finansal Kriz İndeksi", *The latest advances in Monetary Theory and Policy II*, Symposium conducted at Muğla University, pp. 427-460.

credit volume on annual basis again were considered as the final leading indicators.

In his article titled *"Finansal Krizler ve Kırılganlık: Türkiye İçin Bir Erken Uyarı Sistemi Denemesi"*[93], Ayhan Tosuner analyzed the financial crises in Turkey during the years between 1990 and 2004 by utilizing the signal acquisition method. Domestic credits, M2 money supply, foreign exchange reserves, real foreign exchange rate, international capital movements and international interest rate differences were determined as the crisis indicators.

3.3. About Artificial Neural Network (ANN)

This part covers basic information on Artificial Neural Network.

3.3.1. What is ANN?

The background of the 'Artificial Intelligence' studies that can be referred as teaching the intellectual abilities of human beings, such as learning, memorizing, analyzing, establishing correlation between the events, forecasting, to the computers so that these abilities can be imitated by the computer programs goes back to the 1950s.

"Artificial Intelligence may be defined as the implementation of the high intellectual processes like reasoning, inferring, generalizing and learning from past experiences-that are assumed to be human specific features- by a

[93] Tosuner, Ayhan (2005), "Finansal Krizler ve Kırılganlık: Türkiye İçin Bir Erken Uyarı Sistemi Denemesi". *İktisat İşletme ve Finans,* 20(235):42-61.

computer or computer-supervised machine."[94] The artificial neural network is a sub-branch of the area of Artificial Intelligence, like Genetic Algorithm. It can be stated that "the ANNs that imitate neuron, which is the basic operation element of the human brain, modally and functionally in a simple manner are the programs constituted for a simple simulation of the biological neural system in this way."[95] In the view of such information, it is possible to define the artificial neural network technology as follows.

"An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information."[96] That is to say, the inspiration of producing artificial systems that are capable of performing sophisticated processings similar to those that human brain performs came from the biological neural networks, which are naturally more complicated.

3.3.2. The Structure of ANN

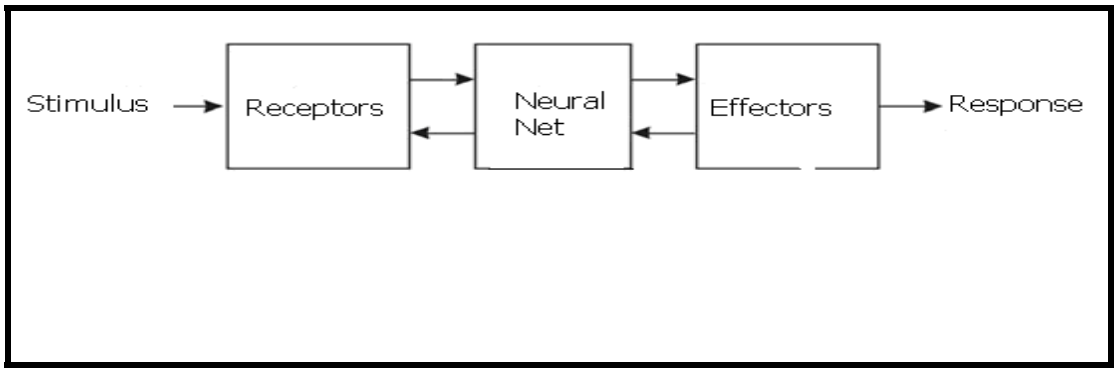
The artificial neural network is designed through the inspiration of the working manner of the human neural system. However it has the ability of carrying out operations in a much simpler way, compared to the human neural system. In order to understand the structure of artificial neural

[94] Halıcı, Uğur and Üçoluk, Göktürk (1993), *Toplumsal, Felsefi ve Hukusal Boyutları ile Yapay Zeka*, Ankara: ODTÜ Publications.
[95] Yurtoğlu, H. (2005). "Yapay Sinir Ağları Metodolojisi ile Öngörü Modellemesi: Bazı Makroekonomik Değişkenler için Türkiye Örneği", *Specialization Thesis*, DPT, p.3.
[96] Stergiou, C. and Siganos, D., "Neural Networks". http://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol4/cs11/report.html#What%20is%20a%20Neural%20Network (06 May 2009).

network, it would be appropriate to provide brief information about biological neural network.

The center of the biological neural system is brain. The neural system has a very complex structure. Nevertheless, it is possible to demonstrate it with a simple figure as follows.

FIGURE 4 THE FUNCTIONING OF THE BIOLOGICAL NEURAL SYSTEM



Source: Yurtoğlu, ibid., p.11.

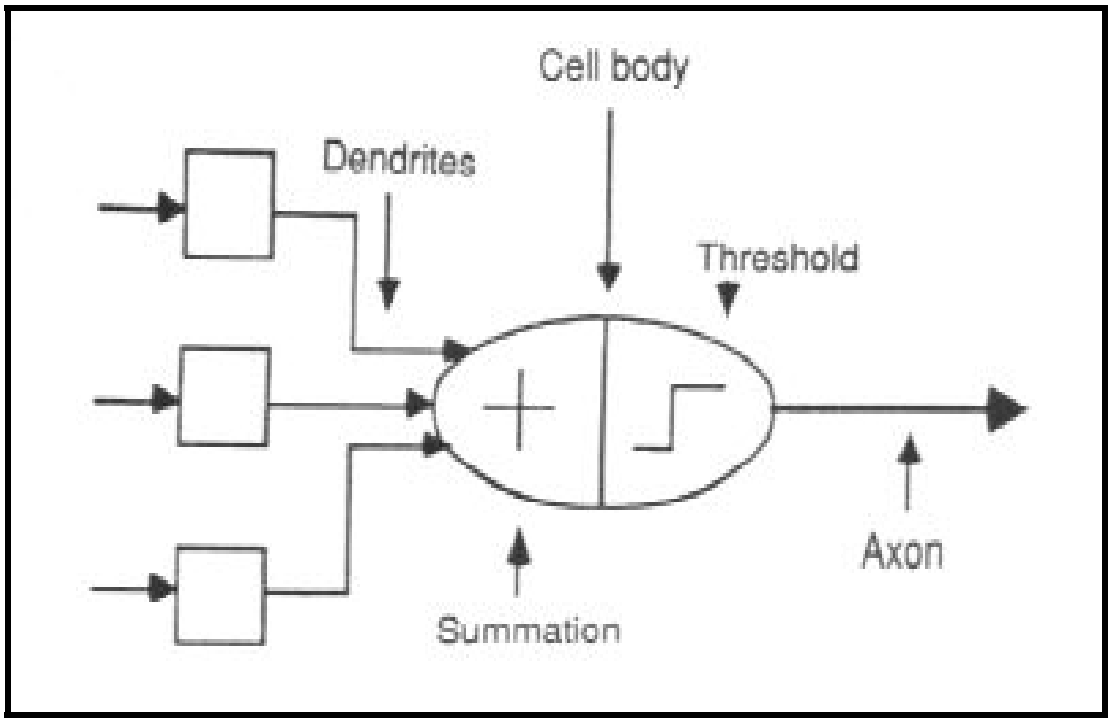
As can be seen in the figure, the signal (warning) received from an outer environment or another organ is transmitted to the Neural Net by receptors. Here, the signal is subjected to an operation and then, transformed into an output signal and sent to the effectors. Afterwards, the output signal is conveyed to the outer environment or other organs via the effectors. The neural network layer includes brain which is the command center of the biological neural system. The most fundamental operation elements of the brain are the nerve cells, that is, the neurons. There are synapses between the neurons. These connections ensure the interaction between the neurons. The intense connections between the neurons provide brain with the ability

of regeneration. As a consequence of this feature, new synapses can be achieved between the neurons and the current synapses can be re-adjusted. The feature of regeneration of the brain is necessary for learning. During the learning process, new synapses are established between the nerve cells, that is, the neurons, and the current synapses are cancelled or the powers of the synapses are changed. Neurons have 4 basic components: Dentrite, soma, axon and connection or synapse.[97] The interaction and distribution of work among these four components of the neuron are as follows: In the human brain, a neuron collects signals (inputs) from the other neurons through *dendrites*. Then, the neuron sends spikes of electrical activity through an *axon*. An axon splits into thousands of branches. At the end of its each branch, a *synapse* converts the activity from the axon into electrical effects that inhibit activity from the axon into electrical effects that inhibit activity in the connected neurons. After a neuron receives excitatory input that is sufficiently large, it sends a spike of electrical activity to its axon. To put it differently, "a brain is composed of networks of neurons. A typical neuron receives input in the form of either excitation or inhibition from many other neurons. When its net excitation reaches a certain level, the neuron fires. The firing is propagated through a branching axon to many other neurons, where it inturn acts as input to those neurons."[98] It is possible to see the

[97] Doğan, V. (2002). *Forecasting Stock Market Return Using Artificial Neural Networks*, Unpublished M.A Thesis, Boğaziçi University, p.31.
[98] Al-Sobiei, O. S. (2001). *Assessment of Risk Allocation in Construction Projects*, Unpublished Doctoral Dissertation, Illinois Institute of Technology, p.46.

four basic components that compose the neural network in the following figure.

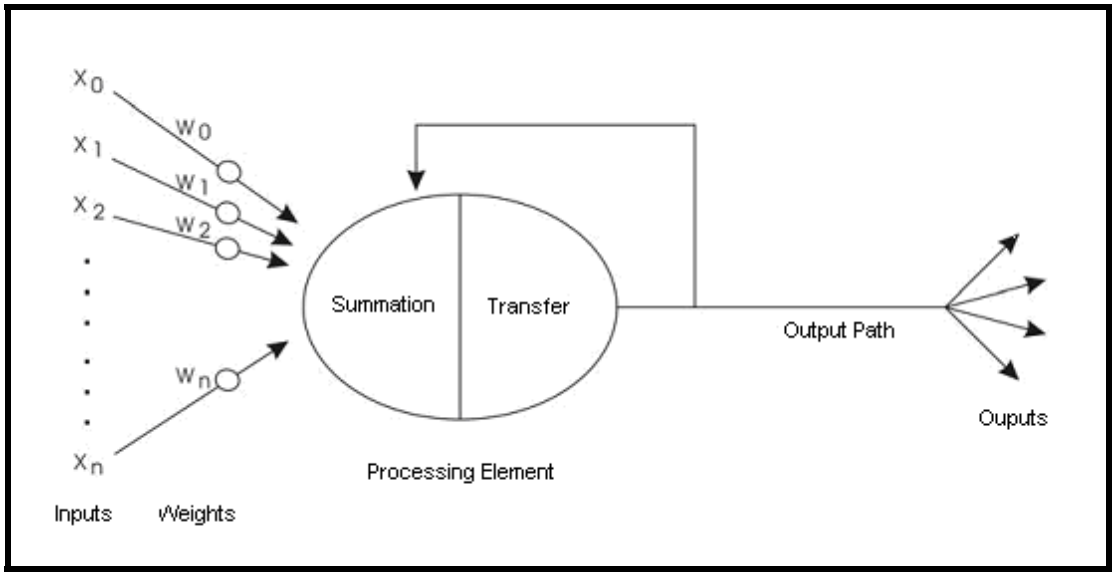
FIGURE 5 FOUR BASIC COMPONENTS OF A NATURAL NEURON



Source:http://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol4/cs11/report.html#How%20the%20Human%20Brain%20Learns (16 May 2009).

The artificial neural network has a structure similar to brain. However, it is the copied version of the brain in a very simply way. It doesn't have a structure as complex as the human brain. The basic elements of ANN are the artificial neurons. It is possible to demonstrate the basic structure of an artificial neuron as follows.

FIGURE 6 STRUCTURE OF AN ARTIFICIAL NEURON



Source: Yurtoğlu, ibid., p.14.

The initial stage of designing the artificial neural network is the designation of the artificial neuron structure as stated above. It is possible to explain the process of designing this element as follows.

X (i) represents the inputs. The figure describes that there are inputs amounting to X (n). Each of these inputs is multiplied with a synapse weight, which is demonstrated with w (i). These multiplications are summed and an output is produced via transfer function. Several functions are utilized during summation and transfer stages. The type of the function to be used varies according to the subject analyzed. The conversion of the input into the output in the artificial neuron is realized as follows. First of all, each of the incoming input values is weighted with w (i) values. Each of the incoming input has a specific relative weight. Weights are the ones that determine the strength of the input. 'The weights demonstrate the impact and significance

of the information received to the cell on the cell. It does not mean whether it is important or not, regardless of its size.[99] In the second stage, the weighted inputs are sent to the summation function. In the summation function, while it is possible to carry out operations like minimum, maximum, mod, multiplication or various normalization operations, summation operation is generally carried out. Following this stage, the output of the summation function is conveyed to the transfer function. The transfer function converts the incoming input into the output via an algorithm. Generally, non-linear transfer functions are used. Sigmoid, step, threshold and tangent functions can be given as examples of the transfer functions used.[100] The output obtained following the operation in the transfer function is sent to the outer environment or to another neuron as an input. It is possible to add an error term in the net prior to the operations in the transfer function. The reason is that the output obtained as a result of the transfer function may deviate from the actual output. In fact, the outputs produced by the brain may be different from the actual outputs as well.

As explained till now, the artificial neural network is comprised of the neurons interlinking with each other. The expression of operation elements is also used for the artificial neurons. A neuron, that is, an operation element, receives signal, which is an input, from other neurons. The received input is

[99] Adıyaman, F. (2007). *Talep Tahmininde Yapay Sinir Ağlarının Kullanılması*, Unpublished M.A Thesis, İstanbul Tehnical University,p.86.
[100] For detailed information about transfer functions, please refer to: Aras, S. (2008). *Yapay Sinir Ağlarında Duyarlılık Analizleri*, Unpublished M.A Thesis, Dokuz Eylül Univ. pp.45-47.

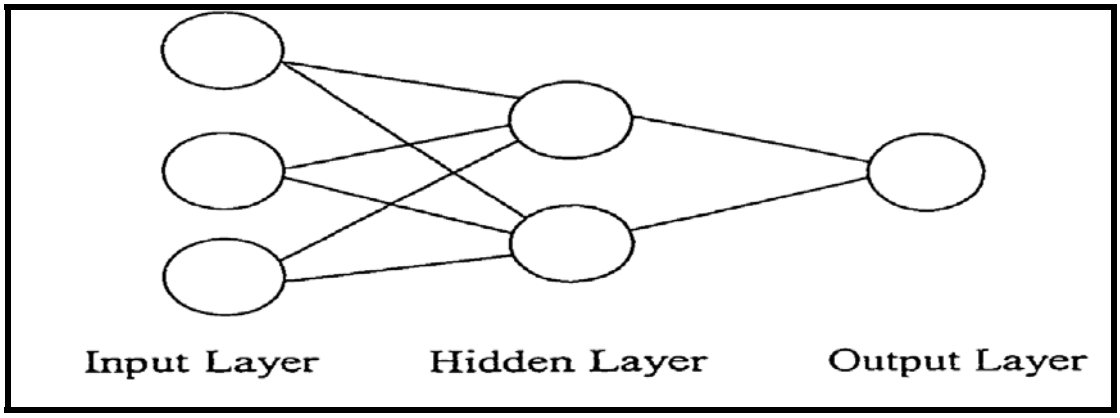
weighted with a weight cluster, passes through many channels by being transformed in a non-linear way, and the output is resulted. The neurons receiving data and producing output exist in almost every network. How the ANN transforms the input data into the output is affected by the weights of these synapses and the transfer functions of the neurons. As can be understood from the explanations provided till now, the ANN is comprised of three basic elements: neuron, synapse ensuring the input-output way and the synapse weight demonstrating the durability of these synapses.[101]

While determining the architecture of the ANN, one of the many mathematical algorithms is used. In this manner, the weight values of the synapses are ascertained in order to maximize the accuracy percentage of the produced outputs. The ANN determines the weights by means of utilizing the data in the learning set and reveals the correlation between the input and the output. Following this stage, the ANN has the ability to produce forecasts by working with new data. The performance of the modeled network is measured according to the value of the difference between the predicted output value of the network and the actual output value. The higher the difference, the lower the performance of the network is. The stage of designing the neuron (designating the weights, determining the summation and transfer functions), as provided till this part, constitutes the first stage of comprising the artificial neural network.

[101] Yurtoğlu, ibid., p.6.

The second stage of designing the ANN covers clustering the neurons and setting up synapses between the clusters. Clustering the neurons refers to the layering operation. After that, these layers are connected to each other. Some of the neurons exist at input layer, some at the hidden layer while the rest at the output layer. The neurons at the input layer receive input, thus, they are connected to the outer part of the network. The neurons at the output layer communicate the outputs to the outer environment. Thus, they are also connected to the outer part of the network. However, the neurons at the hidden layer do not have any connection to the outer environment. The whole connection is enabled with the other neurons in the network. The following figure demonstrates the general structure of the ANN.

FIGURE 7 GENERAL STRUCTURE OF ANN



Source: Al-Sobiei, ibid, p.50.

The input layer, hidden layer and the output layer exist in many of the created networks. The network type that covers these three layers is also referred as 'multi-layer perceptron (MLP)'. "The basic structure of an MLP is comprised of the operation elements that establish connections between the

inputs, of the learning algorithms that ensure the designation of the connection weights and of the transfer function that enable non-linearing, which is one of the fundamental features of the MLP."[102] Each operation element is linked to other operation elements. Thanks to these connections, information passes through the operation elements and the layers and then, reaches the output layer. The neurons at the input layer receive only the arriving inputs, and communicate them to the subsequent layer by not carrying out any operation on these inputs. The output layers are comprised of the neurons that communicate the outputs to the outer environment. The input and the output layer are comprised of a single layer. There is a hidden layer between the input and output layers. There may be more than one hidden layer. Many neurons exist inside the hidden layer. In many of the designed network types, the neurons at the hidden layer generally receive signal (input) from the neurons at the previous layer. They send their own outputs to all neurons of the subsequent layer.

3.3.3. The Phases of ANN Modelling

The artificial neural network is generally modelled in three stages: model building, training and testing.[103]

[102] Akel, V., Bayramoğlu, M.F. (2008). "Kriz Dönemlerinde Yapay Sinir Ağları ile Finansal Öngörüde Bulunma: IMKB 100 Endeksi Örneği", *International Capial Flow and Emerging Markets,* International Symposium conducted at Balıkesir University.
[103] Lee, K. (2001). *Pattern Classification and Clustering Algorithms with Supervised and Unsupervised Neural Networks in Financial Applications*, Unpublished Doctoral Dissertation, Kent State University, pp.25-26.

3.3.3.1. Model Building Phase

The architecture of the artificial neural network is determined at this phase. "The basic tasks in this stage cover the number of the input and output nodes, the number of the hidden layers and hidden nodes and the connections between the nodes. Other parameters like the activation function, learning ratio and momentum should be determined at this stage."[104]

3.3.3.2. Learning/Training Phase

The learning procedure is carried out by the adjustment of the synaptic connections between the cells, that is, the neurons that make up the biological neural network. "It is claimed that there are approximately 10 billion nerve cells in the human brain and that these cells have more than 600 trillion connections with each other."[105] As persons learn and gain experience, the synaptic connections between the neurons in the neural system are re-adjusted. Furthermore, new connections between the neurons are achieved. In this case, learning ability is also constantly developed. The ANN has a learning process similar to the biological neural network. "The learning of the ANN is carried out through the change of the weights of the operation elements with the selected training algorithms."[106]

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[104] Torun, T. (2007). *Finansal Başarısızlık Tahmininde Geleneksel İstatistiki Yöntemlerle Yapay Sinir Ağlarının Karşılaştırılması ve Sanayi İşletmeleri Üzerinde Uygulama*, Unpublished M.A Thesis, Erciyes University, p.74.
[105] Vural, B. B. (2007), *Yapay Sinir Ağları ile Finansal Tahmin*, Unpublished M.A Thesis, Ankara University, p.10.
[106] Şen, Zekai (2004), *Yapay Sinir Ağları İlkeleri*, İstanbul: Su Foundation Publications, p.10.

In this stage, data set is initially divided into two parts, training/learning and validation. The training set is used for the training of the network. The objective in this stage is to minimize the value of the error function. In order to decrease the value of the error function, the values of the weights between the neurons and the layers are changed. As the number of trainings increase, the change in the value of the error function decreases. "If the change in the error function is smaller than the determined threshold value, convergence occurs."[107] The validation set is used in order to ascertain that how well the training set is learned. The fact that the training set is learned well can be accepted as evidence that the model is constructed accurately.

The first of the important elements in the learning process is the learning function. "The objective of this function is to adjust the changeable connection weights that belong to the inputs of each operation element."[108] The learning function can also be referred as the adaptation function because this function enables the change of the connection weights of the inputs in a way that the desired output is obtained.

The second important element of the learning process is the error function or the performance function. It is necessary for the learning function to know the error margin in order to adjust the connection weights again and again. The error function calculates the error between the actual output and the predicted output and implements transformation.

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[107] Coakley,J. R., Carol E. B. (2000), "Artificial Neural Networks in Accounting and Finance: Modeling Issues",*Intelligent Systems in Accounting, Finance & Management*, Vol.9, p.137.
[108] Yurtoğlu, ibid., p.26.

The third important element is the learning rate. "Learning rate and coefficient are important in terms of the speed and function of the learning process."[109] There is a reverse-way correlation between the learning power and learning speed of the ANN. As the learning speed increases, learning power decreases. As the learning speed decreases, learning power increases. To what extent this network will be trained depends on this rate. The complexity level, size and architecture of the network play an important role in determining the learning rate. The learning coefficient gets a value between 0 and 1. The fact that this rate is small means that the learning is slow.

In classifying the ANN, the learning method is used as a criterion. The ANN is classified according to three criteria: learning method, data used by the network and the network structure. "According to the network structure classification, there are two types of ANN: Feed-forward networks and Feedback networks."[110] As the software program used in our study has a specific algorithm, these network types will not be referred.[111] Here is the classification according to the learning method.

"The learning methods used in the training of the artificial neural network are divided into three types: supervised, unsupervised and reinforcement."[112]

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[109] Bayır, F. (2006). *Yapay Sinir Ağları ve Tahmin Modellemesi Üzerine Bir Uygulama*, Unpublished M.A Thesis, İstanbul University, p.46.
[110] Bayır, ibid, p.29.
[111] For detailed information about ANN types according to the net structure, please see "Haykin, Simon (1999), *Neural Networks: A Comprehensive Foundation*, USA: Prentice Hall."
[112] Bayır, ibid., p.29.

Supervised learning: Supervised learning is also known as associative learning. In this type of learning, the network is provided with input and matching outputs. The input values are processed by the network and output values are created. The network compares the created output values to the actual output values. Error term is created via the performance function. In order to minimize this error term, the calculated value is given to the system again. The weights between the neurons are changed and this process continues until this error term is minimized.

Unsupervised learning: Unsupervised learning is also known as Self-organisation. "An (output) unit is trained to respond to clusters of pattern within the input. In this paradigm the system is supposed to discover statistically salient features of the input population. Unlike the supervised learning paradigm, there is no a priori set of categories into which the patterns are to be classified; rather the system must develop its own representation of the input stimuli."[113]

Reinforcement learning: In this type of learning, the learning machine does some action on the environment and gets a feedback from the environment. The learning system grades its action as good or bad based on the environmental response. Accordingly it adjusts its parameters. Generally, this adjustment process continues until an equilibrium state is attained. As soon as the equilibrium is set, the adjustment process is finished.

[113] http://www.learnartificialneuralnetworks.com/ (15 May 2009).

It is possible to explain how the network produces result based on the statements given by Öztemel: "The results produced by the network are obtained from the output layer after the net input, which is acquired as a result of summing the multiplications of the information that enters into the network with their own weights, is processed via a transfer function."[114]

3.3.3.3. Testing Phase

In this stage, the performance of the trained network is measured. Thus, the data set never seen by the network is given to the network and the ability of the network to generalize is tested. That is, how well the network has learned the model is searched. The test whether the network has learned the model well is checked by looking whether the difference between the actual and the predicted values of the outputs is minimized- just like in the learning process.

3.3.4. Advantages and Disadvantages of ANN

Compared to other conventional methods, the Artificial Neural methodology has many advantages and disadvantages.

- ✓ *Non-Linearity feature:* The most significant feature of ANN is that it can learn non-linear structures in real life. Thus, it has the ability to analyze non-linear economic data. Provided that non-linear data are analyzed via linear methods, the behaviours of the variables that are not included in the analysis (e.g. they are indicated with an error term) cannot be explained and

[114] Öztemel, Ercan (2003), *Yapay Sinir Ağları*, İstanbul: Papatya Press, p.50.

the performance of the built model may be low. These may be even many cultural, social and political variables that are not considered in conventional methods. As a conclusion, it is possible to obtain wrong results. Thanks to the use of this method in our analysis, the disadvantages expressed are removed. The ANN does not have a linear structure as it is comprised of the non-linear cells.

- ✓ *Learning:* It depends on the development of a problem-specific algorithm related to the solution of any problem via conventional methods. This situation is constrained by many factors, especially the ability of the programmer. ANN is able to learn the features of the sample by itself and generalize abut the problem that needs to be resolved by using the sample. Thus, it is possible to solve problems that are very comlex to be solved by using the conventional techniques.
- ✓ *Keeping information:* In the ANNs, the information is kept in the connections between the neurons. That is, the information is delivered to the whole network.
- ✓ *Flexibility:* The ANN has a flexible structure. The ability to adjust the weights of the connections between the neurons that comprise the networks attributes the ANN this feature. "Thanks to this flexible structure, any damage in some part of the network only causes decrease in performance,

does not lead to any significant setback in the solution of the problem, and the model does not lose its functionality completely."[115]

- ✓ *Ability to generalize:* "As they have the ability to generalize in deciding upon the unencountered or incomplete data, the ANNs are good pattern recognition engines and robust classifiers." [116] Thanks to their ability to learn by themselves, they are able to generalize based on the pre-learned data.
- ✓ *Adaptability:* ANNs are adaptive. As the weights between the neurons are flexible, ANNs are able to learn the changes in the data set learned and change the weights between the neurons.
- ✓ *Ability to work with incomplete data:* Once the ANNs are trained, they are able to produce results even if there exist incomplete data in new sample. Whether the network performance will decrease depends on the importance of the information. If it is important, the network performance will decrease, if not, it will not.
- ✓ *Ability to work with infinite variables and parameters:* ANNs are able to produce perfect results by working with infinite parameters and variables.
- ✓ *Equipment and speed:* ANNs are able to process information in a fast way.
- ✓ *Wide data set requirement:* A wide data set is needed for both the training of the ANN and to test whether it has learned or not.

[115] Bayır, ibid., p.9.
[116] Yurtoglu,ibid., p.36.

✓ *Uncertainty:* A rule to be implemented in determining the ANN network structure that is compatible with the problem has not been developed yet. In order to determine a suitable network structure, that is, to carry out correct modelling, trial and error method is resorted. Furthermore, in also determining parameters like learning coefficient, number of neurons and layers, a rule has not been developed yet. However, in our analysis, we will select the model comprised of the parameters that give the highest R-square value.

✓ *Deficiencies in Training Process:* In instructing the data set to the network, it is possible to get into some problems. ANN can only work with quantitative data. It cannot work with qualitative data. It is necessary to transform the qualitative data into the quantitative data. However, a method concerning how to carry out this transformation has not been developed yet.

✓ *Failure in Explaining the Network Behaviors:* It is not possible to find any information on why and how the solution is produced when a solution is produced. This situation decreases confidence in ANN.

3.4. Empirical Analysis with ANN

3.4.1. About the Variables and Dataset

In statistics, the variables are divided into two groups: quantitative and qualitative variables.[117] Quantitative variables are measurable, like inflation rate, interest rate, growth rate and foreign exchange rate. Qualitative

[117] Kip, Ergun (1997), *Ekonometrik Yöntemler: Teori ve Uygulama*, Ankara: Gazi University Press, p.59.

variables are immeasurable. Marital status, gender, educational level can be given as examples of these types of variables. The dependent variable used in our analysis is quantitative because it is comprised of foreign exchange market pressure index values. However, the independent variables are qualitative.

It is possible to provide following information on the variables used in the analysis.

Selection of the Variables: In the process of determining the independent variables, the studies that cover the empirical analysis of the financial crises in the years of 1994, 2000 and 2001 in Turkey have been dealt. The leading indicators that produce meaningful results in these studies have been included as independent variables. Furthermore, some independent variables determined by the financial crisis models have been included in our study as well.

Dataset: In our study, a total of 96-monthly data covering the period between January 1996 and December 2003 is used. The reasons why we cannot determine the analysis period for a longer period of time and have taken it for the period between 1996 and 2003 are as follows.

Firstly, the computer program used in our analysis failed at the learning process in case it was kept for a wide interval. It was not able to learn the learning set efficiently. After the dataset interval had been diminished, the program produced better results.

Secondly, monthly data in any period, and that belong to all variables do not exist.

Thirdly, the thesis subject deals with the analysis of the impact of the interest rates on the financial crises in the early 2000s in Turkey. If the analysis period was widened so as to cover the 1994 financial crisis, it would be difficult to make sound comments on the impact of the interest on November 2000 and February 2001 financial crises. Thus, it was not included in the analysis.

Fourthly, the process of determining the threshold value, which will be referred in the dependent variables part, is affected by the width of the sampling. During the process of determining the threshold value, taking into account standard deviation and average of foreign exchange pressure index may lead to the result of 'existence of crisis' despite the fact that there is not a crisis in some months and vice versa. Thus, the time interval during which the crises occurred in Turkey has been taken into account as crisis periods.

Monthly percentage changes of each data were used in the analysis. The data were collected from the Electronic Data Delivery System of the Central Bank of the Republic of Turkey and the web site of the Turkish Statistical Institute.

The dependent and independent variables are as follows:

3.4.1.1. Independent Variables or Inputs

The independent variables used in the analysis are as follows.

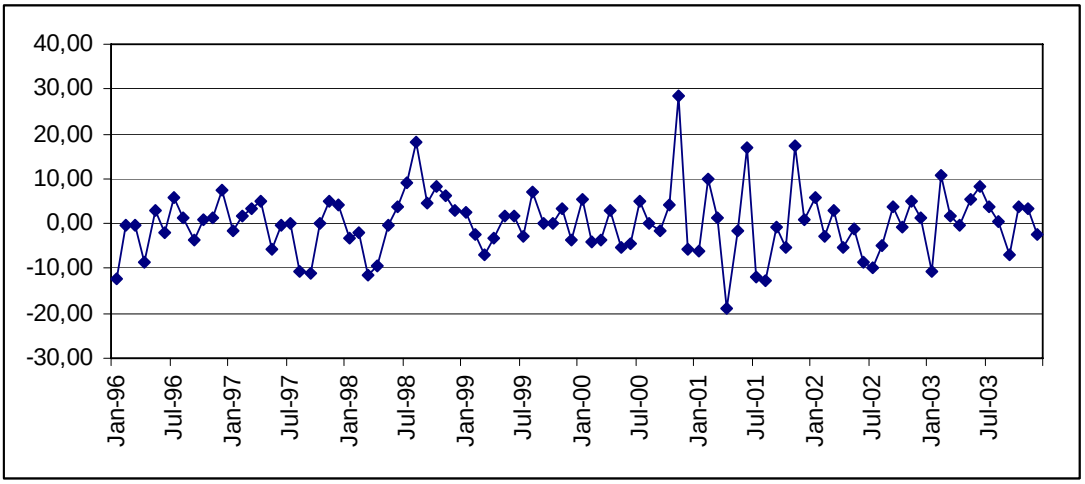
- ✓ *M2 (Money Supply) / Gross Int. Reserves of Central Bank (M2/CBER):*

Money supply is the total amount of money in an economy. "M2 money supply is the sum of the money in circulation, demand deposit and time deposit."[118] Foreign currency reserves refer to the sum of foreign currency kept in a country in order to undertake foreign exchange liabilities. In case of a panic, depositors may want to convert their deposits to foreign currency. As the rise in foreign exchange demand may increase foreign exchange rate, money crisis may occur. The institution to intervene in the foreign currency market is the Central Bank. The Central Bank tries to diminish the value of the rate by introducing its international foreign currency reserves into the market. This indicator provides information on to what extent the Central Bank can meet the liquidity liabilities of the foreign currency reserves. The rise of this rate shows the vulnerability of the financial system against the shocks. According to the third generation crisis models, the rise in this rate enhances crisis possibility. In our analysis, the amount of money supply is referred in 1000 TL, the amount of foreign currency reserve in USD and Million $. However, foreign currency reserves are multiplied with TL/USD buying rate of each month and converted into TL. After M2/CBER rate of each month is calculated in terms of level, monthly percentage changes are

[118] http://www.tcmb.gov.tr/ucaylik/ua3/a67.pdf (18 April 2009).

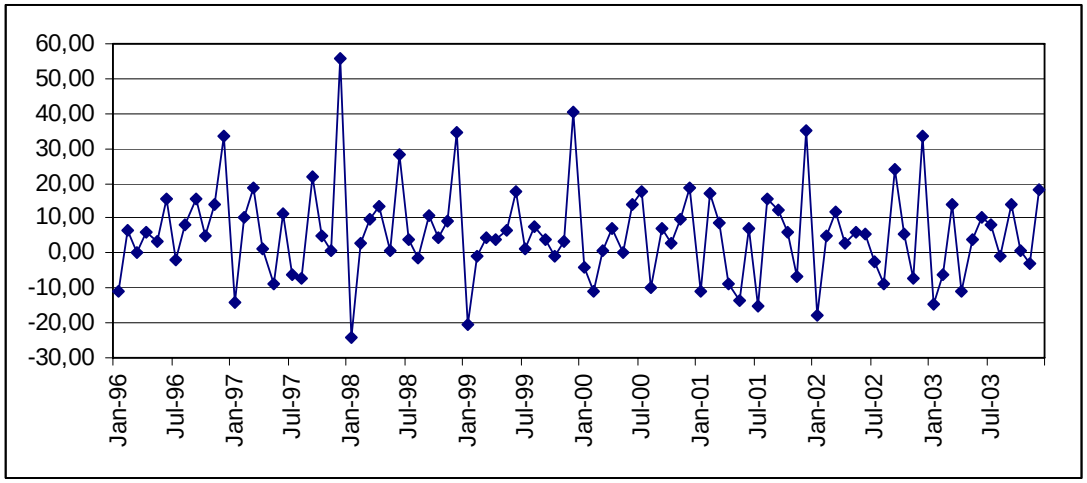
calculated. The percentage changes are used in the analysis. The monthly percentage change of the variable can be seen in the following figure.

FIGURE 8 CHANGE OF M2/CBER VARIABLE OVER TIME



✓ *Total Deposits of Commercial Banks (TDCP):* Deposit of commercial banks is the sum of the deposits in time and demand deposit accounts in which domestic and foreign currency are deposited. It is expected that there is an inverse relationship between the deposit amount and the possibility of financial crises to occur. It has been seen that the bank deposits decrease before the crisis to occur. Decrease in the deposits of the commercial banks refers to a decrease in trust in banks due to deterioration of their balance sheets. It is the indicator of financial crisis envisaged by the third generation crisis models. In our study, the total deposits of commercial banks are taken in 1000 TL. The monthly percentage change of the deposit amount is used in the analysis. The monthly percentage change of the variable over time can be seen in the following figure.

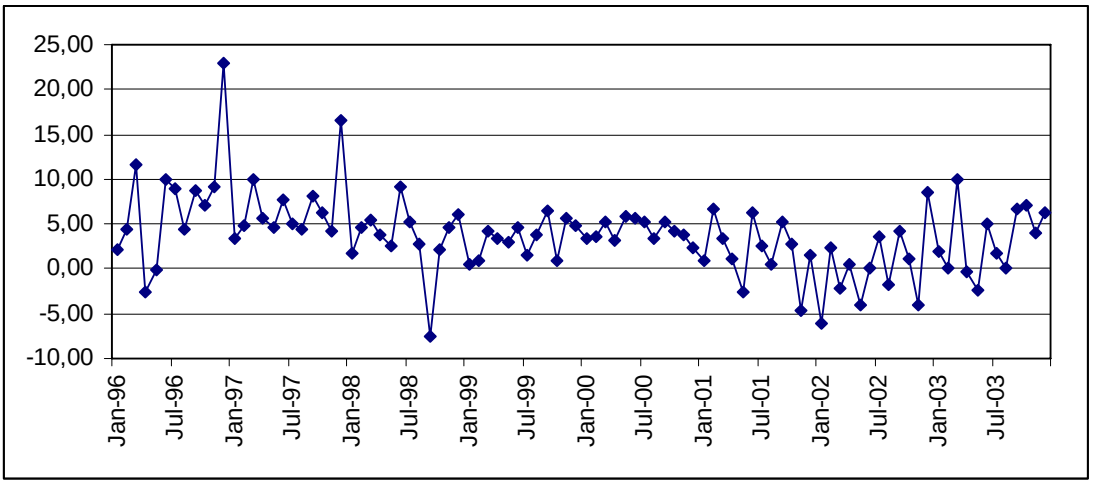
FIGURE 9 CHANGE OF TDCP VARIABLE OVER TIME



✓ *Domestic Credit Amount (DCA):* It represents domestic credit amount given by the commercial banks over the domestic or foreign currency. The empirical findings introduce an increase in the credits amount in pre-crisis period. Prior to the November 2000 crisis in Turkey, an increase in credits, especially in consumer credits, was seen. "In an approach concerning currency crises, it is claimed that the investors will sell their assets to the Central Bank in case of a speculative attack against the domestic credits, and thus, a crisis will break out due to the increase in the national assets of the Central Bank."[119] In our study, the domestic credit amount is referred in 1000 TL. The monthly percentage change of the deposit amounts is used in our analysis. The monthly percentage change of the variable over time can be seen in the following figure.

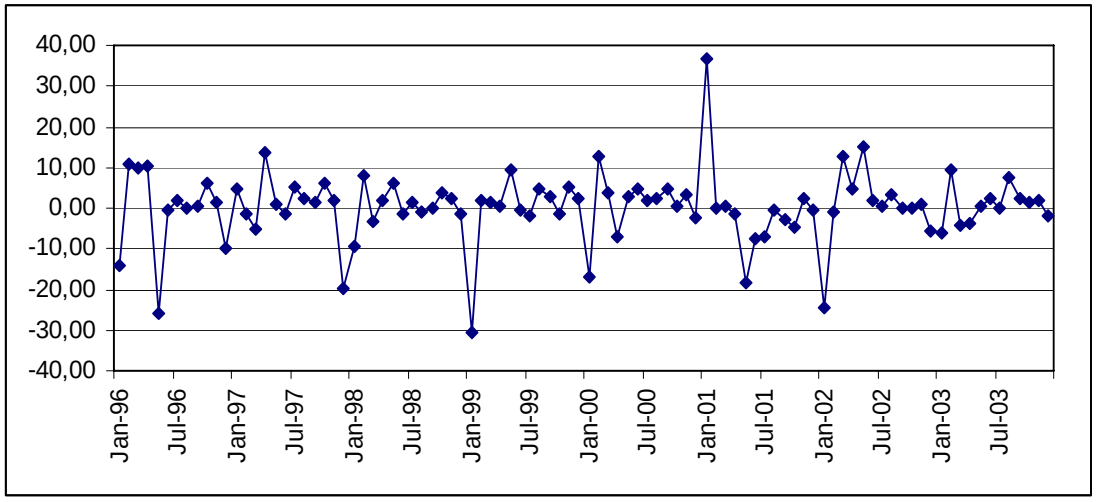
[119] Kumhof, Michael (2000), "A Quantitative Exploration of the Role of Short-term Domestic Debt in Balance of Payment Crises". *Journal of International Economics*, 51(1), pp.196-197.

FIGURE 10 CHANGE OF DCA VARIABLE OVER TIME



✓ *Consolidated Budget Income/Consolidated Budget Expenditure (CBI/CBE):* According to the first generation crisis models, increase in budget deficit enhances the financial crisis risk. That is, it is claimed that there is a positive relationship between the budget deficit and the possibility of financial crisis to occur. Thus, it is expected that the possibility of breaking out of a crisis will increase as the value of this variable decreases. In our study, the consolidated budget incomes and expenditures are referred in 1000 TL. First of all, income and expenditure amounts are proportioned to each other for each month, and afterwards, the monthly percentage change of these rates is calculated. The monthly percentage changes are used in our analysis. The monthly percentage change of the variable over time can be seen in the following figure.

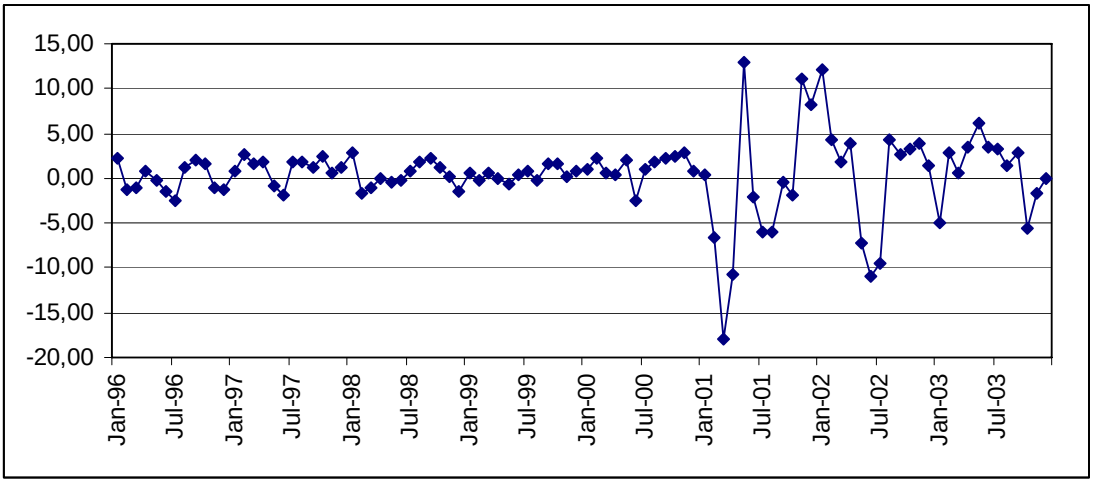
FIGURE 11 CHANGE OF CBI/CBE VARIABLE OVER TIME



✓ *Real Exchange Rate (RER):* Over appreciation of domestic currency, that is, change of the foreign exchange rate in favor of domestic currency, is considered as the financial crisis indicator. "For the speculators, at least % 10 appreciation of the domestic currency within a year indicates that the economy is over warmed up."[120] It is expected that there is an inverse relationship between this variable and dependent variable. In our study, consumer price index based real exchange rate index is used to represent the real exchange rate index. According to IMF's definition, this index is calculated considering nineteen countries. The year of 1995 is taken as a basis year. As price index, consumer price index is used. The monthly percentage changes of the index are used in the analysis. The monthly percentage change of the variable over time can be seen in the following figure.

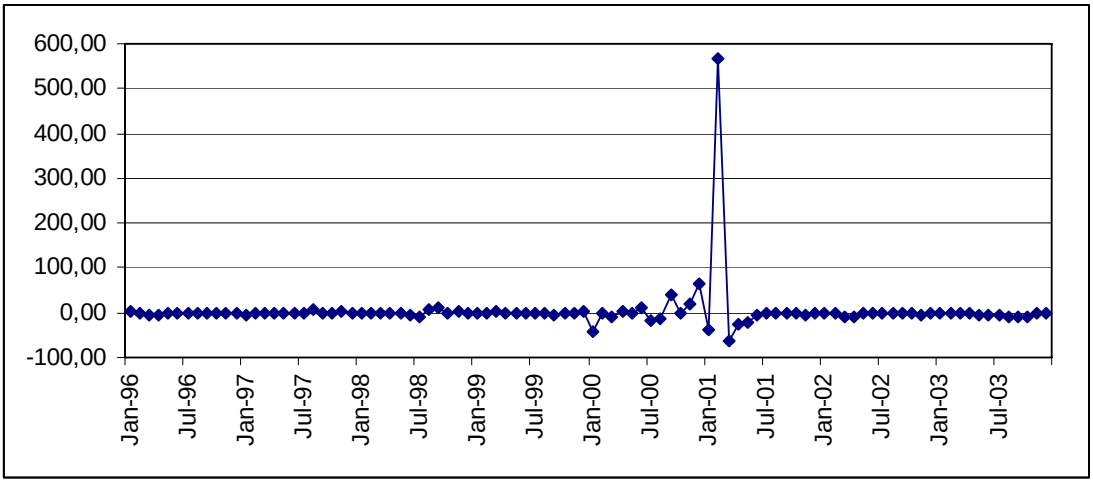
[120] Eren, A., Süslü, B. (2001), "Finansal Kriz Teorileri Işığında Türkiye'de Yaşanan Krizlerin Genel Bir Değerlendirmesi". *Yeni Türkiye*, 7(41), p.666.

FIGURE 12 CHANGE OF RER VARIABLE OVER TIME



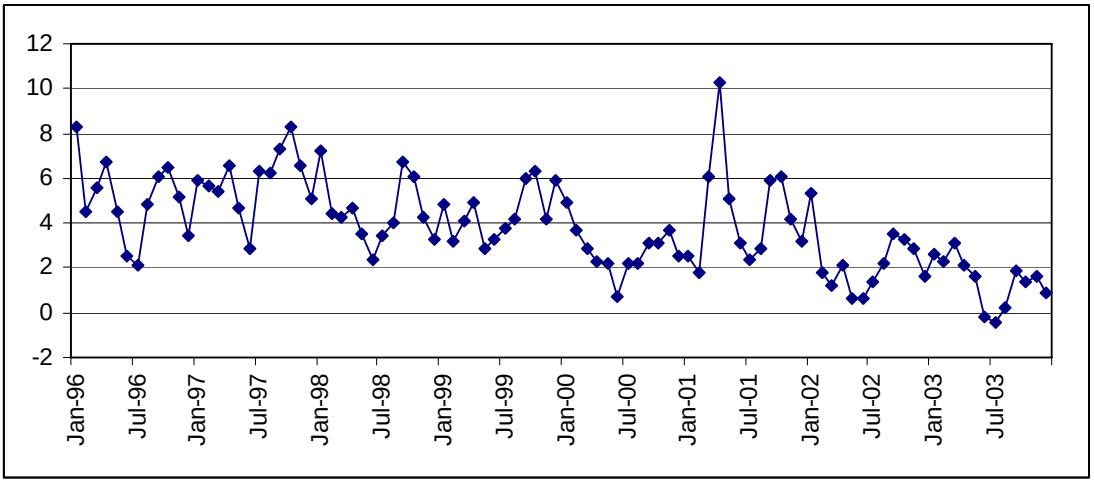
✓ *Deposit Rate (DR):* A positive relationship between deposit interest rate and the financial crisis risk is expected. In our study, the interest rates implemented on 1-month timed TL deposit accounts are taken as a basis. The monthly percentage changes of the rates are used in the analysis. The monthly percentage change of the variable over time can be seen in the following figure.

FIGURE 13 CHANGE OF DR VARIABLE OVER TIME



✓ *Consumer Price Index (CPI):* CPI is included in the analysis to represent the inflation rates. It is expected that a positive relationship occurs between the increase in inflation rate and the possibility of financial crisis to occur. It is known that the inflation rates rise in the periods of pre and post crisis. In calculating the index, 1994 is taken as the basic year. In our study, the monthly percentage changes of the CPI are used. The monthly percentage change of the variable over time can be seen in the following figure.

FIGURE 14 CHANGE OF CPI VARIABLE OVER TIME

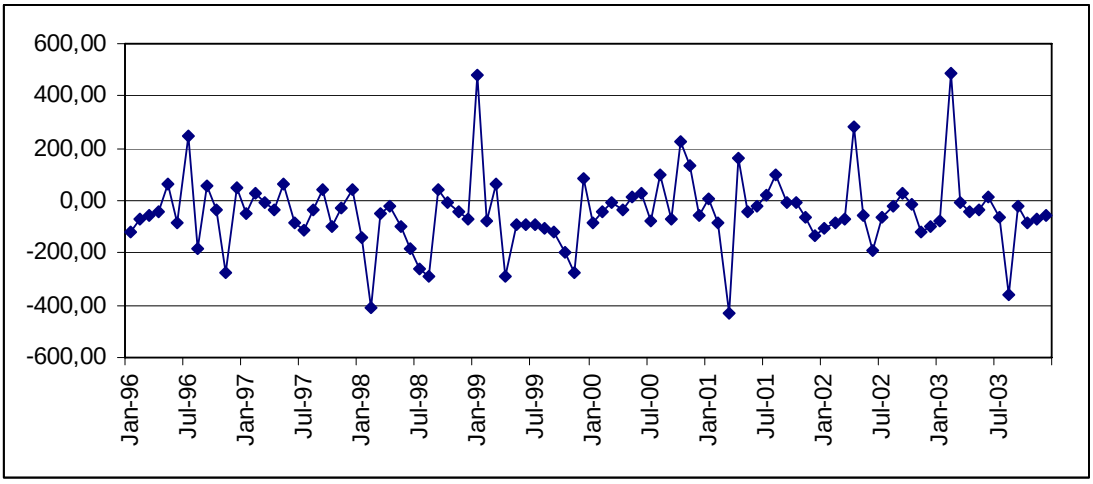


✓ *Current Account Balance/Gross Domestic Product (CAB/GDP):* Increase in this rate is accepted as a financial crisis indicator. Decrease in GDP rate or increase in CAB rate enhances the value of the aforementioned indicator and thus, financial crisis risk. According to the second generation crisis models, slowdown in economic growth can point to the financial crisis. In other words, it is claimed that there is an inverse relationship between the financial growth speed and financial crisis possibility. According to Stanley Fischer, former head of the IMF, the November crisis in Turkey was resulted by the banking sector along with the high current deficit.[121] Some of the international finance institutions claimed that Current Deficit/GDP rate in Turkey was in an unsustainable level as from the autumn period of 2000. The current account balance is referred in million dollars, GDP in 1000 TL. However, the current account balance is multiplied with TL/USD buying rate

[121] Fischer, S. (2001), "Exchange Rate Regimes: Is the Bipolar View Correct", International Symposium conducted at the meeting of American Economic Association, p.18.

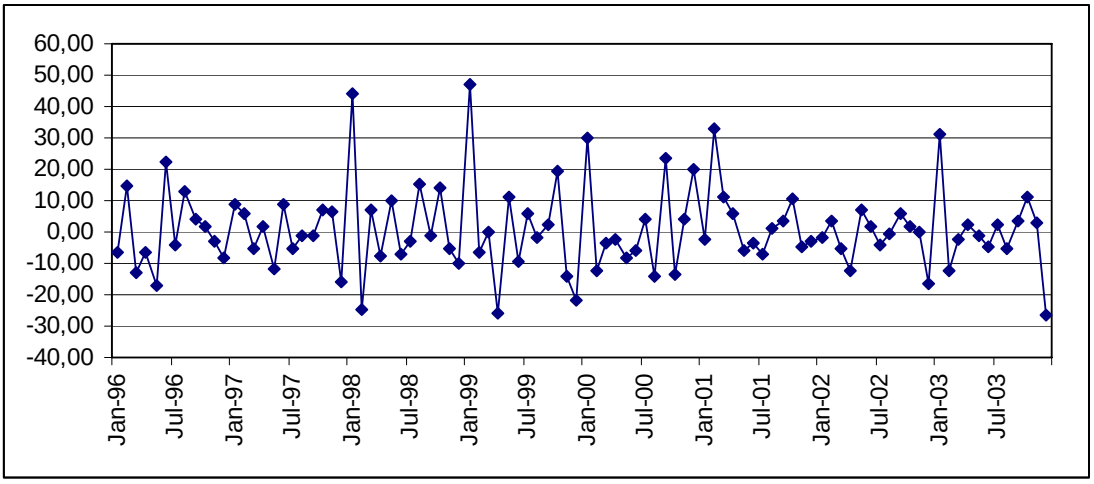
of each month and converted to TL. After the CAB/GDP rate of each month is calculated in terms of level, monthly percentage changes are received. The percentage changes are used in the analysis. The monthly percentage change of the variable over time can be seen in the following figure.

FIGURE 15 CHANGE OF CAB/GDP VARIABLE OVER TIME



✓ *Export Coverage Import Ratio (EX/IMP):* In an economy wherein fixed exchange rate system is implemented, export decreases and import increases refer to the fact that foreign trade and thus, current account balance are adversely affected. That the balance of payments has a deficit increases the pressure on the foreign exchange rate and leads to speculative expectations. A positive relationship between the decrease in this ratio and the financial crisis possibility is expected. In our study, after the ratio of each month is calculated, monthly percentage changes of the ratio are used. The monthly percentage change of the variable over time can be seen in the following figure.

FIGURE 16 CHANGE OF EX/IMP VARIABLE OVER TIME



3.4.1.2. Dependent Variable or Output

In various empirical studies carried out, a pressure index is created in order to determine the dependent variable. These indexes are named as, for instance, Speculative Pressure Index (SPI), Financial Pressure Index (FPI) and Foreign Exchange Market Pressure Index (EMP). In creating index, different formulations are resorted. For instance, in a study[122], the value of FPI is defined as the weighted average of foreign exchange changes, foreign reserves and interest rate changes. In another study[123], financial pressure index is created by using public domestic borrowing interest, foreign exchange rate and the Central Bank foreign exchange reserves. If the values of FPI, SPI or EMP exceed the determined threshold value, it is concluded that there is a financial crisis, if not; there is not a financial crisis experienced.

[122] Kaminsky, G.L., Reinhart, C.M. (1999), "The Twin Crises: The Causes of Banking and Balance of Payments Problems", *The American Economic Review*, 89(3), p.476.
[123] Aydın, ibid., p.238.

Under the situations with financial crisis, the dependent variable receives the value of 1 and without financial crisis, it receives the value of 0. Qualitative variables that can get discrete values like 0, 1, 2 are named as dummy variables. "Alternative names are indicator variables, binary variables, categorical variables, qualitative variables, and dichotomous variables."[124]

In our study, a different method is followed to determine the dependent variable.

In the analysis carried out via Artificial Neural Network method, the values that belong to the foreign exchange market pressure index, instead of the values '0' and '1', are used as dependent variables. As the number of months in which the pressure index value is higher than the threshold value is limited (Five of them got the value of '1' and ninety-one of them got the value of '0'), the software program displayed very low performance. For this reason, the value of the pressure index, instead of the dependent variable consisted of '0' and '1', was taken as the dependent variable. In the months in which the actual value of the pressure index is estimated successfully and exceeds the estimated threshold value, it is expressed that the financial crisis is estimated successfully. The term 'Foreign Exchange Pressure Index' used as a dependent variable in our analysis and the term 'Threshold Value' used in the determination of the months with crisis can be explained as follows.

[124] Gujarati, Damodar N. (1995), *Basic Econometrics*, The States: McGraw-Hill Inc., p.500.

"Foreign Exchange Pressure Index is calculated as a weighted average of the monthly percentage change in gross foreign exchange reserves of the Central Bank of Turkey and of the monthly percentage change in the nominal devaluation of Turkish Lira against USD."[125]

$$EMP_T = \%\Delta e_t - \alpha_1 \%\Delta r_t \qquad (3.1)$$

This equation gives the foreign exchange pressure index.

Where

e_t refers to nominal foreign exchange buying rate of TL/USD at time t.

r_t refers to gross foreign exchange reserves of Central Bank of Turkey

$\%\Delta e_t$ refers to the percentage change of nominal foreign exchange buying rate of TL/USD at time t with respect to time (t-1) (With respect to the previous month).

$\%\Delta r_t$ refers to the percentage change of the amount of CB gross foreign exchange reserves at time t with respect to time (t-1) (With respect to the previous month).

α_1 refers to the ratio of the standard deviation of the serial that is comprised of the monthly change of the foreign exchange rate to the standard deviation of the serial that is comprised of the monthly change of the CB gross foreign exchange reserves (σ_e / σ_r).

[125] Şen, ibid, p.135.

According to this equation, the increase in the nominal foreign exchange rate affects the pressure index positively whereas the increase in the reserves affects negatively. In other words, devaluation of TL vs. USD and decrease in the CB gross foreign exchange reserves increase the pressure on the foreign exchange market, and thus, financial crisis risk.

The threshold value is calculated as follows:

Threshold Value: $\beta\sigma_{emp} + \mu_{emp}$ (3.2)

Where

β refers to the coefficient of standard deviation of EMP.

σ refers to standard deviation of EMP serial.

μ refers to average of EMP serial.

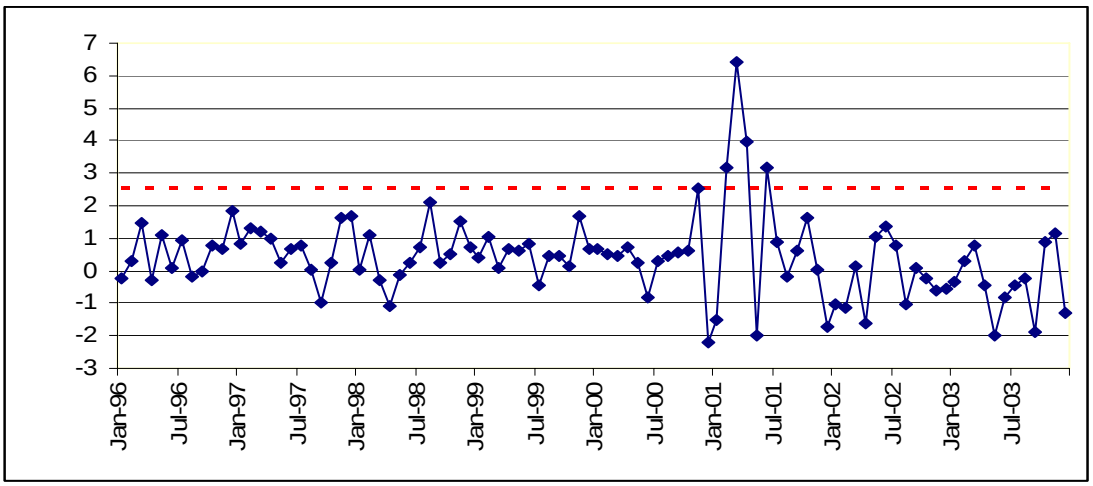
If $EMP_{it} > \beta\sigma_{EMPit} + \mu_{EMPit}$, there is a financial crisis. Thus the dependent variable takes the value of 1.

If $EMP_{it} \leq \beta\sigma_{EMP_{IT}} + \mu_{EMP_{IT}}$, there is not a financial crisis and the dependent variable takes the value of 0.

In our study, the threshold value has been calculated as 2.514596, the standard deviation of the pressure index as 1.6010, the average as 0.4491, the value of (σ_e / σ_r) as 0.1172. "β" coefficient has been assigned the value of 1.29. Naturally, the value of the pressure index has received different values each month. In the light of this information, in November 2000, February, March, April and June 2001, the pressure index receives higher

values than the threshold value. That is, given this information, it is concluded that there was a financial crisis in these months. The fact that a financial crisis existed in November 2000, February, March and April 2001 fit with the facts and the results of other empirical studies. The emergence of the financial crisis in June 2001 can be considered as the follow-up impact of the February 2001 crisis. The foreign exchange market pressure index and the threshold value are demonstrated in the following figure.

FIGURE 17 CHANGE OF THRESHOLD VALUE AND INDEX VALUES



The red-dashed line represents the threshold value whereas the blue line shows pressure index values. As can be seen in the figure, the value of the pressure index in November 2000 exceeds the threshold value slightly. In February, March, April and June 2001, the value of the pressure index exceeds the threshold value. Thus, it is concluded that financial crisis emerged in these five months.

In the process of determining the threshold value, it is important to designate the value of "β", which is the coefficient of the standard deviation

of the foreign exchange market pressure index serial. In fact, according to this value, it is determined whether a financial crisis occurred or not. In determining the threshold value, the values of "σ" and "μ" are calculated through the data. The value of "β" is determined by us. We have determined the value of "β" as 1.29. The emerging financial crisis dates fit into the Turkish economy facts better when "β" is 1.29. Because only this situation leads to the fact that there was a financial crisis in November 2000, February, March, April and June 2001. It is possible to attribute various values to "β" coefficient. For instance, in a study carried out[126], it has been given 1.5, in one study[127] 2.5, and in another study[128] 3, and in another one[129] 2.54.

3.4.2. Modeling the ANN

In the explanations given till this part, it is explained that we go through three stages while modeling the artificial neural network. It is stated that the model is built in the first stage, trained in the second stage and tested in the third stage. By the virtue of the software program used, all parameters that need to be designated in the stage of model building will not be determined, only some parameters will be determined. Following the model-building stage, the learning stage will be realized. Subsequently, the network's

[126] Aziz, J., Caramazza, F., Salgado, R. (2000), "Currency Crises: In Search of Common Elements", *IMF Working Paper*, No.WP/00/67.
[127] Edison, Hali J. (2000), "Do Indicators of Financial Crises Work? An Evaluation of an Early Warning System". *Board of Governors of the Federal Reserve System, International Finance Discussion Paper*, No. 675.
[128] Kaminsky, Graciela, Lizondo, Saul, Carmen, M.Reinhart (1998), ibid.
[129] Esquivel, G., Larrin F. (1998), 'Explaining Currency Crises', *HIID*, No.666.

success of learning the training set will be measured in the validation stage. The testing stage will not be realized because the aim of building the ANN model is not to do forecasting, but rather to search for the reasons of the November 2000 and February 2001 crises and the role of the interest rates among these reasons. The software used will produce a number of statistical information at the end of the training and validation stage, which will determine the characteristics of our model. The name of the software program used for the analysis is 'The NeuroShell® Predictor'. It is a software program designed to simplify the creation of a neural network application to solve forecasting and pattern recognition problems. This software program uses a specific algorithm called "TurboProp2" as a learning algorithm.

In this section, firstly, we will carry out the model building stage and secondly the training stage and refer to the results of this stage. Thirdly, we will search whether the model has been learned well by using the same data utilized during the training stage. In order to realize these operations, the whole data set was used for training and validation purposes.

3.4.2.1. Model Building Phase

The software we used in our analysis is "The NeuroShell® Predictor". This software does not require the determination of the parameters such as transfer function, activation function, learning rate, and momentum manually. In other words, the analyst using this software does not have to designate the parameters in question at the model building phase. Because

the software designates these parameters by itself without any external processing.

The parameters of the model built, which we defined, are summarized in the following table. We can not include the other parameters determined by the software automatically in the table since they are not reported.

TABLE 1 PARAMETERS OF THE MODEL

The number of inputs	9
The number of hidden layer	1
The number of neurons in hidden layer	85
The number of neurons in output layer	1
Learning Algorithm	TurboProp2*

* An algorithm, peculiar to the software we used, "The NeuroShell® Predictor."

Hidden neurons are automatically added to the net during the training process by the software until the net is able to make good predictions. In our analysis, 85 pieces of hidden neurons were added while the net was learning. The optimal number of hidden neurons, which is the number of hidden neurons that is required to add to the net to solve the prediction problem ideally, and that will be used when we apply the trained network to a new data file, is also 85.

3.4.2.2. Learning/Training Phase and Validation

Before we start the learning phase, we did not "normalize" or "scale" the inputs into the same range, different from many analyses with ANN. Because the software we used does this preprocessing automatically. However, we made another normalization preprocessing, which we mentioned in the section, titled as "About the Variables and Data Set". We represented the inputs as a monthly percent change since the values of the inputs are constantly growing over time.

The summary of the learning process with the software "The NeuroShell® Predictor" is given below:

> The network begins by finding linear relationships between the inputs and the output. Weight values are assigned to the links between the input and output neurons. After those relationships are found, neurons are added to the hidden layer so that nonlinear relationships can be found. Input values in the first layer are multiplied by the weights and passed to the second (hidden) layer. Neurons in the hidden layer "fire" or produce outputs that are based upon the sum of weighted values passed to them. The hidden layer passes values to the output layer in the same fashion, and the output layer produces the desired results (predictions). The network "learns" by adjusting the interconnection weights between layers. The answers the network is producing are repeatedly compared with the correct answers, and each time the connecting weights are adjusted slightly in the direction of the correct answers. Additional hidden neurons are added as necessary to capture features in the data set. Eventually, if the problem can be learned, a stable set of weights evolves and will produce good answers for all of the sample decisions or predictions.[130]

The statistical data obtained at the end of this phase, graphs of these data, and the interpretation of the data in question are as follows. We

[130] Ward Systems Group Inc. (1997), *NeuroShell Easy Predictor Instruction*, USA:Ward Systems Group Inc.

benefited from the user guide in the help menu of the software to interpret the data and the graphs.

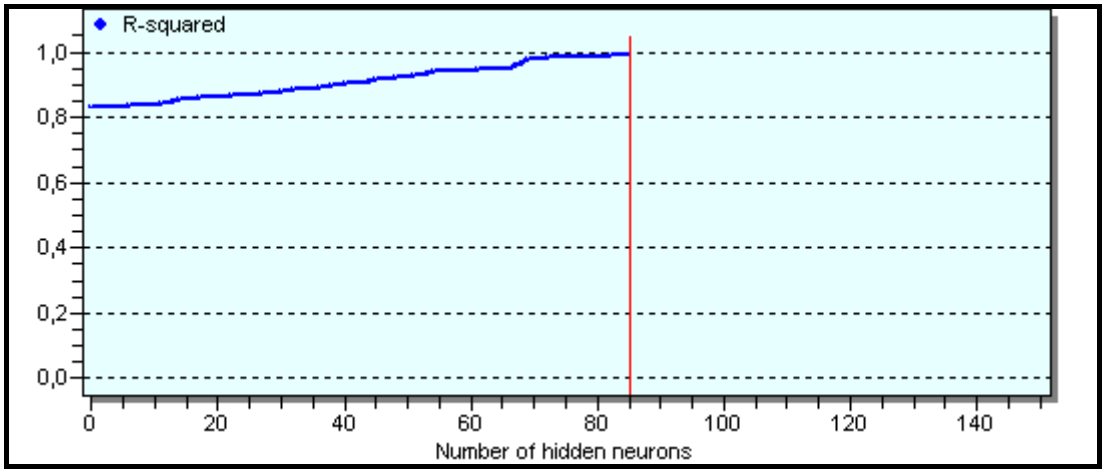
TABLE 2 BEST NET STATISTICS AT LEARNING PHASE

R-Squared	0.961132
Average Error	0.079671
Correlation	0.995556
MSE	0.013981
RMSE	0.118241

R-squared: It is the coefficient of multiple determination. It is an indicator of the network performance. "It compares the accuracy of the model to the accuracy of a trivial benchmark model wherein the prediction is just the average of all of the example output values."[131] The value of R-squared ranges from 0 to 1. The closer the value is to 1, the better the net is able to make predictions. The net is unable to make good predictions if the value is near 0. R-squared value of the model is 0.961132, which is a good indicator of the ability of the model to make good predictions.

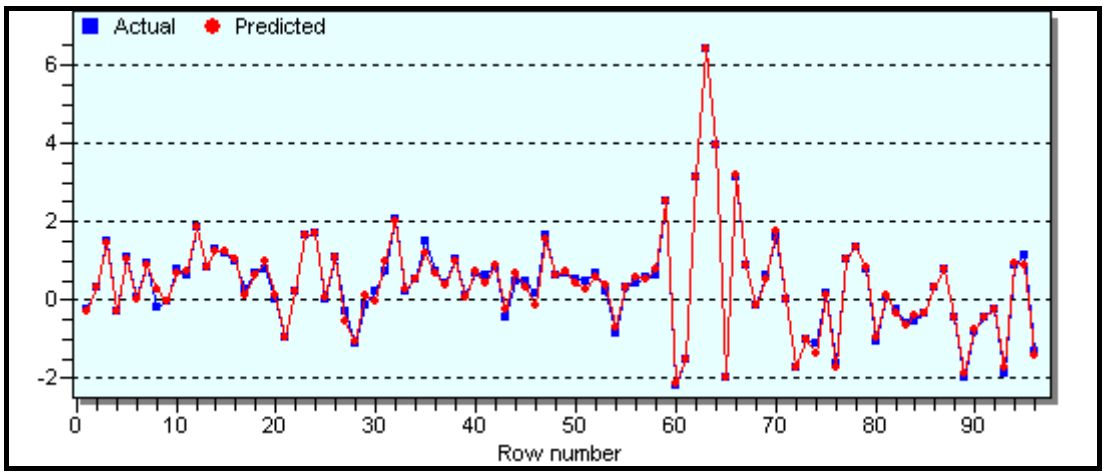
[131] Ward Systems Group Inc, ibid.

FIGURE 18 R-SQUARED BY HIDDEN NEURON



This graph displays the progress of network training performance against an increasing number of hidden neurons as they are added to the network. It performs a statistical measure of the "goodness of fit" between the actual and predicted outputs. As learning gets better, the graph shows higher values. As is seen from the graph, R-squared value reaches its maximum value when the number of hidden neurons is 85. The vertical red line represents the threshold beyond which the R-Squared value of the model does not increase any more.

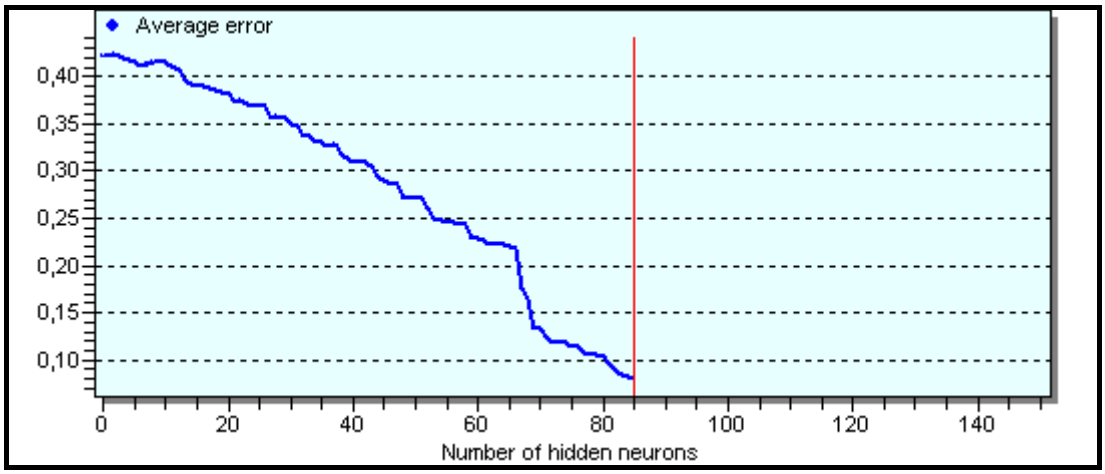
FIGURE 19 ACTUAL VS PREDICTED BY ROWS



This graph shows the actual output values against the output values network predicted at the learning phase. If the model is training successfully, the two values should come closer as learning continues. If the model is not training successfully, then what we ought to do is to use different inputs, add more data, or select a different training strategy. Concomitant of the high R-Squared value, the actual and predicted outcomes at the learning phase are very close to each other at each row. Each row represents the data from 1 to 96. (The dataset constitutes 96 data) As is seen from the graph, the actual pressure indice of the crisis dates, November 2000, February, March, April and June 2001, are captured almost accurately by the model. The rows between 59 and 66 (including 59 and 66) are the actual and predicted pressure indice of the crises dates, where the red lines represent the predicted, and the blue lines represent the actual indice.

Average Error: "The value of average error is the absolute value of the actual values minus the predicted values divided by the number of patterns." The average error value of the model is 0.079671.

FIGURE 20 AVERAGE ERRORS BY HIDDEN NEURONS

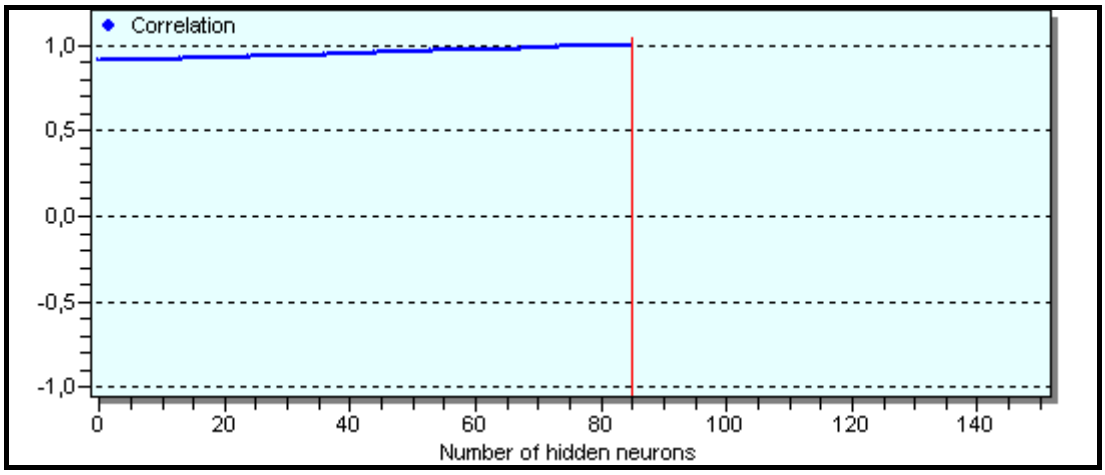


This graph shows the average error against an increasing number of hidden neurons as they are added to the network. The average error is calculated each time a hidden neuron is added. As learning gets better, the graph shows lower values. As is seen from the graph, the average error reaches its lowest value when the number of hidden neurons is 85. The vertical red line represents the threshold beyond which the average error value of the model does not decrease any more.

Correlation(r): This value measures how the actual and predicted outputs correlate to each other in terms of direction (ie, when the actual value decreases, does the predicted value decrease and vice versa). It is not used to measure the magnitude. Its values range from -1 to 1. The closer the correlation value is to 1, the more correlated the actual and predicted values

are. The correlation of the model is 0.995556, which is again a good indicator of the accuracy of the model.

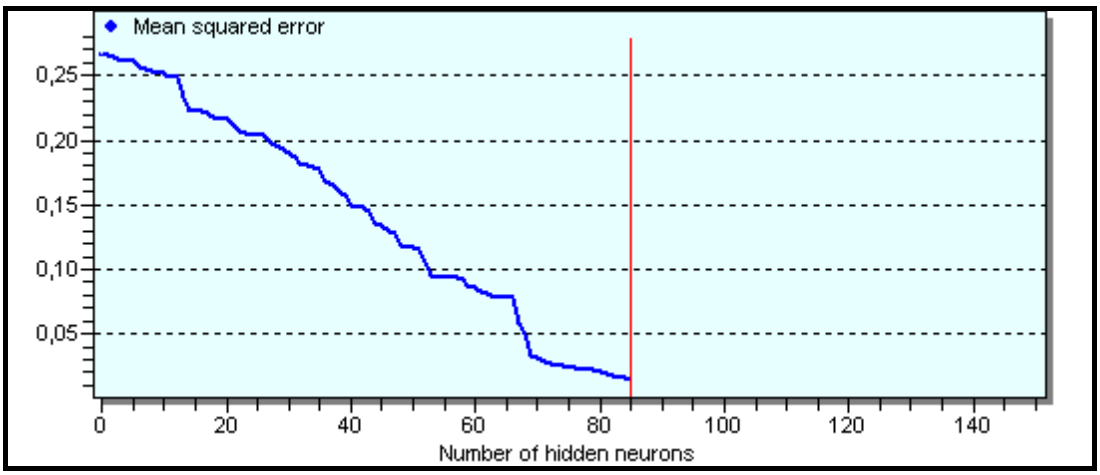
FIGURE 21 CORRELATIONS BY HIDDEN NEURONS



This graph shows the correlation (r) between the actual and predicted outputs against an increasing number of hidden neurons as they are added to the network. The correlation factor is calculated each time a hidden neuron is added.

Mean Squared Error (MSE): This value is used to measure the differences between actual values of the outputs and the output values the network predicted. Therefore, MSE value of the model is required to be very low for the accuracy of the model. The MSE value of the model is 0.013981.

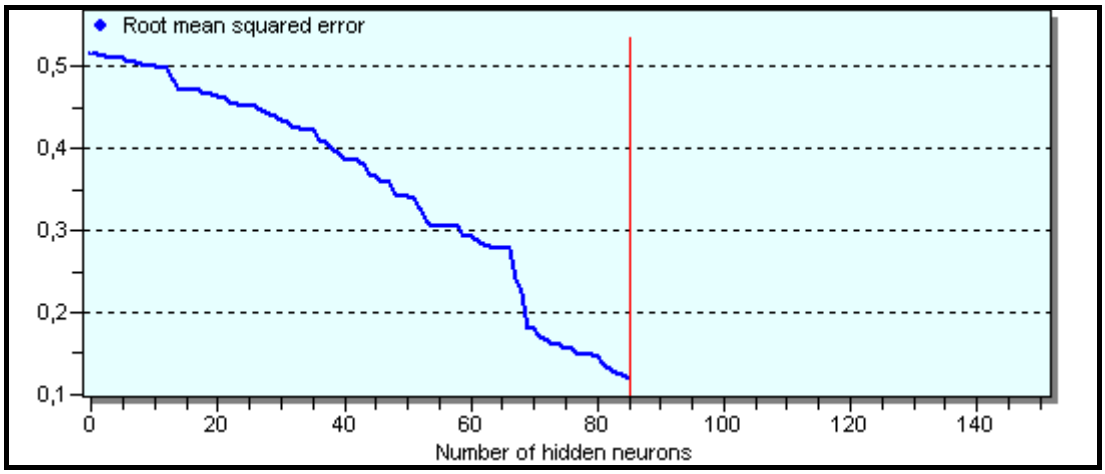
FIGURE 22 MEAN SQUARED ERRORS BY HIDDEN NEURONS



This graph shows the mean squared error (MSE) between the actual and predicted outputs against an increasing number of hidden neurons as they are added to the network. The MSE is calculated each time a hidden neuron is added.

Root Mean Squared Error: This is the square root of the MSE. RMSE value of the model is 0.118241.

FIGURE 23 ROOT MEAN SQUARED ERRORS BY HIDDEN NEURONS



This graph shows the root mean squared error between the actual and predicted outputs against an increasing number of hidden neurons as they are added to the network. The RMSE is calculated each time a hidden neuron is added.

As to the significance of each input in the predictive model, we use the value of relative importance of each input.

The Relative Importance of Inputs: This parameter is an indicator of how significant each of the inputs in the predictive model is. The values of this parameter range from 0 to 1. Higher values are associated with more important inputs. If the importance value of input is zero, then that input is useless and might be omitted. We should pay attention to the following warnings while evaluating the importance values of the inputs.[132]

Firstly, we can not assume that input 1 is twice as good as input 2 if the importance value of input 1 is 0.2 and the importance value of input 2 is 0.1. All we can say with confidence is that input 1 is more important than input 2.

Secondly, the sum of the importance values of all inputs is approximately 1. Therefore, these importance values may be thought of as the percent contribution to the model of each variable.

Thirdly, it is not appropriate to compare the importance values of inputs from different networks. The comparison of the relative importance values of

[132] Ward Systems Group Inc, ibid.

inputs is meaningful only when the comparison is made within the same network.

The importance of each variable in the predictive model is shown graphically and by table as follows:

FIGURE 24 THE RELATIVE IMPORTANCE OF INPUTS

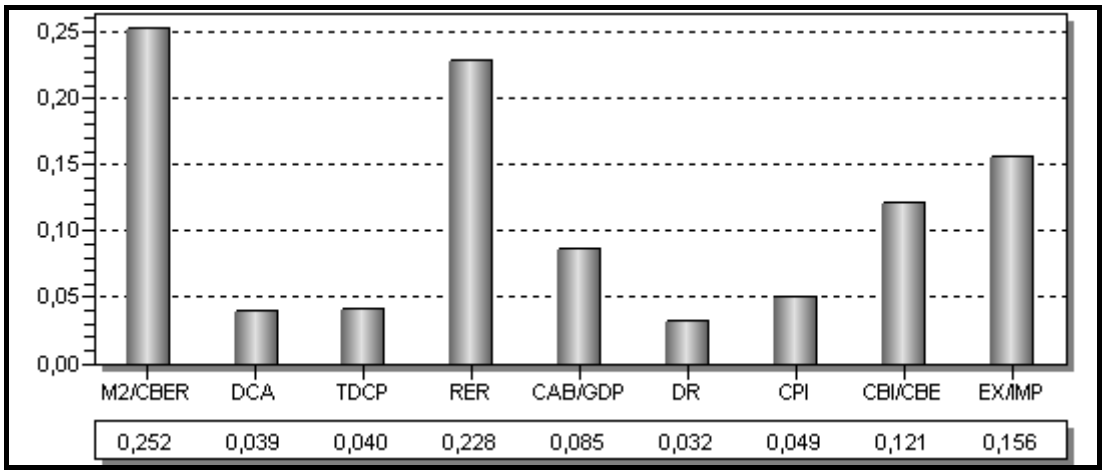


TABLE 3 THE RELATIVE IMPORTANCE OF INPUTS

M2 (Money Supply) / Gross Int. Reserves of Central Bank (M2/CBER)	0.252
Real Exchange Rate (RER)	0.228
Export Coverage Import Ratio (EX/IMP)	0.156
Consolidated Budget Income/ Consolidated Budget Expenditure (CBI/CBE):	0.121
Current Account Balance/ Gross Domestic Product (CAB/GDP):	0.085
Consumer Price Index (CPI):	0.049
Total Deposits of Commercial Banks (TDCP)	0.04
Domestic Credit Amount (DCA)	0.039
Deposit Rate (DR):	0.032

The importance values assigned to the inputs and shown in the bar graph and in the table indicate the significance of each input in predicting the output.

As is seen from the graph and the table, the most important input in predicting the output is the input of *M2 (Money Supply) / Gross Int. Reserves of Central Bank (M2/CBER).* Because its value of importance is the greatest. On the other hand, the input which is the least important in predicting the output is the input of Deposit Rate (DR). Because its value of importance is the smallest of all.

3.4.2.2.1 Validation Phase

This phase is to validate whether the prototype built in the previous phase is learning successfully. The best net statistics at this phase is shown in the following table.

TABLE 4 BEST NET STATISTICS AT VALIDATION PHASE

R-Squared	0.940628
Average Error	0.245641
Correlation	0.97038
MSE	0.093607
RMSE	0.305952

As is seen from the table, the R-Squared value at the validation phase is 0.940628. This value proves that the prototype is very succesfull in learning the relationship between the inputs and the output and in predicting the actual output. Table 5 shows how successfully the net learnt the relationship and predicted the actual output values.

TABLE 5 ACTUAL VERSUS PREDICTED RESULTS OF TRAINED NET

Date	Actual	Predict		Date	Actual	Predict		Date	Actual	Predict
J-96	-0,2507	-0,0393		S-98	0,2433	0,4752		M-01	-1,9956	-1,7855
F-96	0,2984	0,3359		O-98	0,5102	1,0621		**J-01**	**3,159**	**3,093**
M-96	1,4763	1,5988		N-98	1,5167	1,1459		J-01	0,9035	0,5942
A-96	-0,2977	-0,1603		D-98	0,7251	0,6689		A-01	-0,1589	0,0477
M-96	1,0762	1,0839		J-99	0,4044	0,3884		S-01	0,6334	0,7841
J-96	0,0722	0,1731		F-99	1,0317	0,3865		O-01	1,6232	1,079
J-96	0,9285	1,3219		M-99	0,1081	-0,1679		N-01	0,0328	-0,2803
A-96	-0,1959	0,2576		A-99	0,6727	0,7175		D-01	-1,7388	-1,9649
S-96	-0,0361	-0,1181		M-99	0,6243	0,2617		J-02	-1,0114	-0,9823
O-96	0,7978	0,7521		J-99	0,8241	0,4022		F-02	-1,1279	-1,2345
N-96	0,6544	1,0069		J-99	-0,4414	-0,0543		M-02	0,1552	-0,3814
D-96	1,8357	1,7915		A-99	0,4669	1,0742		A-02	-1,6298	-1,3847
J-97	0,8207	0,695		S-99	0,4714	0,5954		M-02	1,0448	0,9755
F-97	1,2911	0,5995		O-99	0,1496	0,1605		J-02	1,37	1,3271
M-97	1,1935	1,1456		N-99	1,6703	1,2741		J-02	0,78	1,0657
A-97	1,0066	0,9761		D-99	0,6487	0,4631		A-02	-1,037	-1,2364
M-97	0,259	0,5372		J-00	0,6952	0,7636		S-02	0,0759	-0,038
J-97	0,659	0,5461		F-00	0,505	0,1093		O-02	-0,2251	-0,5338
J-97	0,7907	1,0365		M-00	0,4602	0,0545		N-02	-0,5864	-0,3569
A-97	0,0114	-0,0285		A-00	0,7053	0,4224		D-02	-0,5533	-0,3323
S-97	-0,98	-0,7111		M-00	0,2456	-0,2604		J-03	-0,3405	-0,3014
O-97	0,2437	0,5035		J-00	-0,8408	-0,2526		F-03	0,2998	0,5075
N-97	1,638	1,3747		J-00	0,32	0,2699		M-03	0,795	0,6383
D-97	1,6973	1,5409		A-00	0,4437	0,2422		A-03	-0,4378	-0,3418
J-98	0,0278	0,2129		S-00	0,5765	-0,1319		M-03	-2,0057	-1,3339
F-98	1,1103	1,1369		O-00	0,6248	0,3928		J-03	-0,7947	-0,4957
M-98	-0,306	-0,6935		**N-00**	**2,5187**	**2,5147**		J-03	-0,4285	-0,769
A-98	-1,1107	-0,4907		D-00	-2,2076	-1,6993		A-03	-0,2585	-0,3491
M-98	-0,1408	0,1727		J-01	-1,5338	-1,2872		S-03	-1,8843	-1,6449
J-98	0,2397	0,2648		**F-01**	**3,1442**	**3,1133**		O-03	0,8723	1,1915
J-98	0,7492	1,1576		**M-01**	**6,4391**	**6,2954**		N-03	1,1318	0,785
A-98	2,0819	2,0155		**A-01**	**3,9491**	**3,7211**		D-03	-1,3161	-0,7925

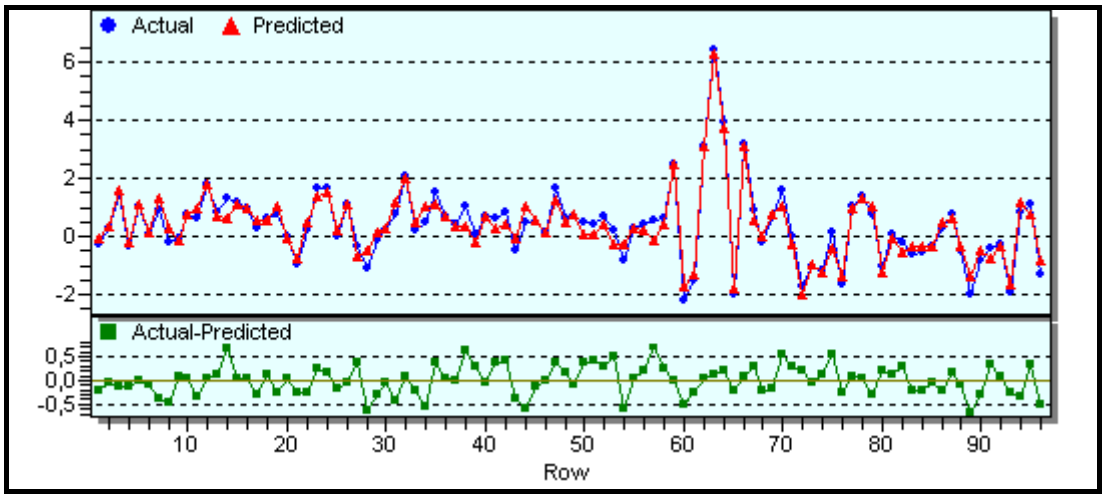
In the table above are the actual and predicted values of the output, pressure index. The values in bold are the corresponding values of the pressure index at crisis dates. As is seen, the model predicted the actual values of pressure index at crisis dates very closely and greater than the value of the threshold, which is equal to 2.514596. On the other hand, the values of the pressure index at non-crisis dates are also predicted very

closely to actual values of the pressure index and lower than the value of the threshold. Therefore, we could infer that the model learnt and predicted the crisis and non-crisis dates very well.

As a result, reconsidering the importance values of inputs, we could conclude that the input of *M2 (Money Supply) / Gross Int. Reserves of Central Bank (M2/CBER)* played the greatest role on the financial crises in the early 2000s whereas the input of Deposit Rate (DR) played the smallest role.

The following figure displays the actual versus predicted values at Validation phase. As is seen, the actual values of the pressure index at crisis dates are captured by the predicted values of output very closely.

FIGURE 25 ACTUAL VERSUS PREDICTED VALUES BY GRAPH



3.5. Conclusion

The prediction of financial crises, taking necessary precautions against them and minimizing the effects and duration of the erupted crises are crucially important. The number of studies on financial crises has increased substantially particularly after 1980. The occurence of financial crises after 1980 more frequently is effectual on this situation undoubtedly. As a consequence of these studies, financial crisis models and financial crisis theories have been developed. Each model and theory has explained the reasons, and eruption processes of financial crises in various ways.

In this chapter of the thesis, November 2000 and February 2001 financial crises that erupted in Turkey were analyzed by making use of the method of Artificial Neural Network. Before the analysis, the studies, which analyzed the financial crises in question including the 1994 crisis were dealt with in literature review part.

Artificial Neural Network (ANN) is a method of artificial intelligence based upon cognitive models. It mimics the way in which the biological brains function. It is composed of interconnected processing elements, which are called neurons. These elements work in unison to solve problems. ANN learns by example. The ability of modelling a non-linear structure, making generalization by learning a sample, and forecasting are the important features of ANN. Marketing, credit evaluation, price estimation, estimation of exchange rate path are a few of the fields wherein ANN has been used. The

number of studies using ANN has been increasing day by day although its usability has been continuing to be discussed.

We used nine inputs, that is independent variables in the analysis. Comparing the importance and significance of all variables in the model, it was discovered that the variable of deposit rates was the least significant variable of all. Because the importance value of the variable of deposit rate in the model was found lower than that of other variables. On the other hand, the variable of M2(Money Supply)/Gross Int. Reserves of Central Bank (M2/CBER) was found out to be the most significant variable in the model since its importance value was the highest of all.

CHAPTER 4

CONCLUDING REMARKS

Financial crisis is a situation wherein the equilibrium in financial markets is disrupted, and the economic units such as households, firms, and the government change their preferences. Financial crisis reflects the deterioration in financial structure. Financial crises have effected many developed and developing economies, including Turkish economy. Three financial crises in the years of 1994, 2000 and 2001 have taken place in Turkey so far. Many theories and models have been developed to explain the reasons and dissemination mechanisms of financial crises. The financial crisis models can be classified under three titles: The first, the second and the third generation financial crisis models. The first generation financial crisis model, under some assumptions, argues that an increase in money supply decreases the interest rates and increases the inflation rate and these two situations trigger the crisis by leading to exhaustion of foreign exchange reserves. In addition, it claims that high interest rates set an appropriate environment for financial crisis by causing some structural problems.

This study is intended to analyze the concept of financial crisis and November 2000-February 2001 financial crises theoretically and empirically. For theoretical analysis, financial crisis models, the reasons of financial crises, and the reasons of November 2000 and February 2001 financial crises

are investigated. In empirical analysis chapter, the financial crises of November 2000 and February 2001 are analyzed empirically by using the method of Artificial Neural Network. Artificial Neural Network is a system of neurons. It makes new decisions, predictions or classifications based on previously experienced problems or situations. 9 variables were used as independent variables. M2 (Money Supply) / Gross Int. Reserves of Central Bank (M2/CBER), Total Deposits of Commercial Banks (TDCP), Domestic Credit Amount (DCA), Consolidated Budget Income/ Consolidated Budget Expenditure (CBI/CBE), Real Exchange Rate (RER), Deposit Rate (DR), Consumer Price Index (CPI), Current Account Balance/ Gross Domestic Product (CAB/GDP), Export Coverage Import Ratio (EX/IMP) are the independent variables used in the analysis. Comparing the importance and significance of all variables in the model, it was discovered that the variable of deposit rates was the least significant variable of all. Because the importance value of the variable of deposit rate was found lower than those of other variables. On the other hand, the variable of M2(Money Supply)/Gross Int. Reserves of Central Bank (M2/CBER) was found out to be the most significant variable in the model since its importance value was the highest of all.

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