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PREDICTING FINANCIAL CRISES: EVIDENCE FROM TURKEY USING THE SIGNAL APPROACH

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THESIS APPROVAL PAGE

DECLARATION

I hereby declare that this master's thesis titled as "**Predicting Financial Crises: Evidence From Turkey Using The Signal Approach** " has been written by myself in accordance with the academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resourses in the reference list. I verify all these with my honour.

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ABSTRACT

Master's Thesis

Predicting Financial Crises:

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In this study, the crises in the Turkish economy are analyzed using the KLR signal approach between 2002-2018. The primary purpose of the study is to determine macroeconomic and financial indicators, predicting any possible economic crisis for the Turkish economy. Besides the KLR signal approach, a variation of this model, the 1.5 standard deviation threshold value approach, is applied, and the empirical results are reported.

For the Turkish economy, four crisis dates between 2002 and 2018 are determined by exploiting a financial pressure index; then, abnormal movements of indicators before these crisis dates are monitored. It is observed that real sector indicators react much later than financial indicators and react during or after the crisis point(s). In this respect, real sector indicators are evaluated as worst-performed indicators. These are the industrial production index, unemployment rate, the ratio of exports to imports. The indicators signaling before all crisis periods and resulted in a low error signal ratio below (1) are considered the best estimators. The producer prices index, foreign exchange deposit accounts position, Republican Gold price, and the current account to foreign exchange reserves ratio are among the successful indicators. Nevertheless, the best three indicators with the lowest level of error signal rate and high signaling success are the CPI-based effective exchange rate, short-term external debt to foreign exchange reserve ratio, and domestic debt expansion. Lastly, according to the analysis results, it is observed that the KLR signal approach has a higher and more consistent prediction potential than the 1.5 standard deviation threshold value approach.

Keywords : signal methods, KLR signal approach, financial crises, economic crises, logit-probit

ÖZET

Yüksek Lisans Tezi

Finansal Krizlerin Tahminlenmesi:

Sinyal Yaklaşımı ile Türkiye Uygulaması

Ahmet Yasin KUZUCU

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Bu çalışmada 2002-2018 yılları arasında yaşanan krizler ve Türk ekonomisi KLR sinyal yaklaşımı ile analiz edilmiştir. Analizler sonucunda, Türk ekonomisi için oluşacak herhangi bir olası ekonomik krizi tahmin edebilme gücü yüksek makroekonomik ve finansal göstergeler belirlenmesi amaçlanmıştır. Bunula beraber KLR sinyal yaklaşımı ve bu yaklaşımın bir varyasyonu olan 1.5 st sapma eşik değer yaklaşım kıyaslanmış ve sonuçlar paylaşılmıştır.

Türk Ekonomisi için 2002-2018 yılları arası 4 kriz tarihi finansal baskı endeksi oluşturularak belirlenmiş, ardından bu kriz tarihleri öncesi göstergelerin norm dışı hareketleri izlenmiştir. Reel sektör göstergelerinin, finansal göstergelere göre çok daha geç tepki verdiği ve krizlerin bir sonucu olarak, kriz noktası sırasında veya sonrasında tepki verdikleri gözlenmiştir. Bu bağlamda bu göstergeler performansı en kötü olan göstergeler olarak değerlendirilmiştir, bunlar; sanayi üretim endeksi, işsizlik oranı, ihracatın ithalata oranıdır. Tüm kriz dönemleri öncesi sinyal vererek ve hata sinyal oranı (1) bir değerinin altında olan en iyi tahminci olarak değerlendirilen göstergeler sırasıyla şunlardır üretici fiyatları endeksi , döviz tevdiat hesabı hacmi, Cumhuriyet Altını fiyat ve cari işlemler hesabının döviz rezervlerine oranıdır. Bununla beraber, sinyal verme güvenilirliğini ölçen hata sinyal oranının en düşük düzeyde olduğu, sinyal başarısı yüksek en iyi üç gösterge sırasıyla Tüfe bazlı efektif döviz kuru, kısa vadeli dış borçların döviz rezervine oranı ve iç borç genişlemesi olarak tespit edilmiştir. Son olarak, Analiz sonuçlarına göre KLR sinyal yaklaşımının, sabit eşik değerli 1.5 st sapma ile yapılan yönteme göre

daha önceden tahmin edebilme potansiyelinin daha yüksek ve tutarlı olduğu gözlenmiştir.

Anahtar Kelimeler: Sinyal yöntemi, KLR sinyal yaklaşımı, finansal krizler, ekonomik krizler

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INTRODUCTION

With the impact of liberalization, technology, and globalization in the 1980s, national economies have become more interconnected, and capital flow has accelerated. Although all these developments have enhanced the world economy and strengthened international trade, it has increased the number of crises with their destructive effects. The costs of crises are enormous for economies, as well as in social damage.

The ultimate issue of economics is allocating scarce resources to human needs to provide the highest satisfaction. In economic terms, equilibrium in every market occurs at the intersection of supply and demand, called economic equilibrium. (Eğilmez, 2018:60) This equilibrium depends primarily on human behavior and other factors like natural disasters, wars, and speculations. This equilibrium can be rebalancing for many reasons that we assume affect it. If this newly formed balance supports the well-being of all units, it becomes sustainable and healthy, without crises. Moving away from the balance may bring crisis and chaos. The essence of the issue is that perfect balance just has not been achieved. Moreover, the frequency and impact of the emerging crises have increased, as we might call it, paradoxically.

For this reason, understanding and predicting crises have become increasingly important since the 1980s. Kaminsky, Reinhart, and Lizondo (1998) developed a framework, the KLR signal approach, to detect financial and economic crises. Compared to other statistical approaches in the literature, the KLR signal approach gives more effective results since it is a mechanism that can specifically be adapted to an economy. Therefore, the KLR signal approach is used in this thesis.

The Turkish economy started in the 2000s with an economic crisis and political turmoil. Then, in 2002, political stability was achieved with a single-party government. In the following years, liberalization and privatization accelerated, attracting foreign capital flow into the country. This thesis analyzes the macroeconomic data of the Turkish economy between 2002 and 2018. The primary purpose of the thesis is to measure the predictive performance of macroeconomic indicators for any crisis that may occur in the Turkish economy. The consistency of the KLR signal approach and its derivative signal approach method was also compared in the detailed analysis.

In the first part of the study, the etymology of the word “crisis” and types of crises have been examined. The crisis models which Krugman (1979) pioneered are analyzed and compared. The crisis models with different features are explained as

the first, second, and third generations. Later the crises that inspire these models are analyzed and compared in the first chapter.

In the second part, we presented a literature review, covering the studies on developed and emerging markets, using several econometric frameworks. In the third part of the study, the KLR signal approach is presented.

In the fourth part, 13 different indicators, which are among the early warning indicators for the Turkish economy, are analyzed between 2002 and 2018 for 201 months of observations. Four different crisis dates have been determined by the financial pressure index (FPI) developed by Eichengreen et al. (1996) using the nominal exchange rate, interest rate, and change in reserves data. These are the dates 05: 2004, 06: 2006, 10: 2008, 08:2020, respectively. Eichengreen, Rose, and Wyplozs (1996) To evaluate the performance of the specified indicators, the 24-month pre-crisis observation period is determined; following the KLR signal approach, the 201-month past period data between 2002 and 2018 was examined.

The analysis is based on four main stages following the KLR signal approach. The first is defining the concept of crisis for the Turkish economy. In the second stage, 13 potential leading indicators considered highly sensitive to changes in the Turkish economic conditions are determined. These are; M2/net reserve, real effective exchange rate, BIST100 index, current account / foreign exchange reserves, Republican Gold price changes, unemployment rate, short term external debt stock/foreign exchange reserves, export/import, domestic loan expansion changes, foreign exchange deposits percentage change, producer price index price changes, industrial production index changes, domestic debt position changes. In the third stage, each indicator's most sensitive threshold values are determined according to the percentile method, adhering to the KLR signal approach. Besides, the median ± 1.5 standard deviation value is also accepted as the threshold for all indicators. In the last stage, leading indicator performances were evaluated, and method performances were compared.

CHAPTER ONE
CRISIS

1.1. DEFINITION

“Crisis” is a Latinized version of the Greek word "*krisis*", which means a sign of disease or an advanced stage of the disease in terms of its etymological origin. The word “crisis” in social sciences is defined differently, but generally, it can be defined as a suddenly evolving worsening fact. (Aktan and Şen, 2001:1)

Economic crises can occur on any platform where economic activities exist and are increasingly threatening national economies. The economic crisis is an imbalance caused by any instability, bubble, or shock. According to Kibritçioğlu (2001), it can be defined as “severe fluctuations beyond any acceptable limit of change in prices and/or quantities in any goods, services, production factor or foreign exchange market” (Kibritçioğlu, 2001:1)

A crisis is a turning point that gets better or worse; final decisions must be made. First of all, the crisis is an abnormal situation in the economy, and it causes large fluctuations in the market mechanism by not working, locking, or becoming overly sensitive. Therefore, the crisis is a particular moment of capitalist evolvement dominated by the market mechanism. So, the crisis is a concept of action. (Eroğlu and Albeni, 2002:97)

People have tried to explain crises based on exceptional events or serious political interventions in empirical studies as a methodology throughout the literature. For example, compulsory bank mergers or state guarantees for banks can give misleading results in this context to define the crisis, so much so that these events may occur in typical situations. What can be defined as a crisis, and what cannot be, is a complex issue, so the definition of crises may not be objective (Von Hagen and Ho, 2007:1038)

The Tulip Crisis in the Netherlands during the 16th century is one of the oldest known examples, though economic crises have existed for centuries. Economic crises sometimes occur as a financial crisis, and sometimes as a real sector crisis or both. For instance, the 2008 subprime mortgage crisis was a crisis that started in the financial sector and shifted to the real sector. In this context, the crisis was the investment bank crisis. Hedge funds created turbulence with limited control, aiming to

generate more income through leveraged transactions in the short and long term. (Akgüç, 2009:6-7)

In today's world, globalization, technology, and fast-moving capital bring out the contagiousness of crises. Besides the contagious nature of crises, it inevitably affects political, financial, and macroeconomic phenomena established on balance according to their connection and size.

1.2. TYPES OF CRISIS

There are different approaches in the literature regarding the classification of economic crises. The main distinction is between sectors, the real sector crisis and the financial crisis, which are examined under two main titles. However, crises have been evaluated in many sub-sectors. It is not correct to observe the types of crises separately since economics is a human-based concept and operates in many sub-sectors, and it has a balance in its mechanism. For example, the inflation crisis will have an impact on the real sector and financial structure. Crises are explained as the form of real sector crises, including goods, service markets, and labor markets, based on inflation, recession, unemployment, and financial crises associated with banking, money-foreign exchange, foreign debt payments balance, and the stock market. Therefore, the interconnectedness of these concepts and the fact that one might be the cause or result of the other makes it difficult to classify crises. (Bayraktutan, 2006:25)

Regarding the sectors they affect, economic crises can be subjected to a dual distinction as real sector crises and financial sector crises. Real sector crises occur as significant contractions in production and employment. Financial crises are financial market collapses that can have destructive effects on the real sector of the economy and disrupt the effectiveness of the markets. (Delice, 2003:58)

In their book, Reinhart and Rogoff (2010) classified economic crises as crises defined by quantitative thresholds and crises defined by events. However, under these two main headings, inflation crises, currency collapse, devaluations, non-payment of foreign and domestic debts, and banking crises were mentioned as sub-sectors. (Reinhart and Rogoff, 2010:52-56)

1.2.1. Real Sector Crises

Real sector crises occur as shrinkage in production or employment, so there is a decline in quantities of goods, services, and the labor market, which might result in stagnation or unemployment. Inflation is defined as the continuous increases in the pricing level of goods and services; if this reaches over a particular value, it will lead to an inflation crisis. (Kibritçioğlu, 2001:2)

Political instabilities, weakness of financial infrastructure, natural disasters, wars can trigger real sector crises, depending on the economic structure of the observed economy and its commercial relations with other economies.

1.2.2. Financial Crises

There are two pioneer definitions for financial crises in the literature by Minsky (1977) and Kindleberger (1978). The concept they define as financial vulnerability will bring inevitable contraction or crisis, which is formed or created due to the natural functioning of the financial structure *"According to Minsky (1977), forced liquidation, credit crunch, and then a sharp drop in asset prices, leading to depression. A lack of prudence and undue financial fervor (a mania in Kindleberger's term) bring about a financial crisis"* (Hsu, 2017:2)

Minsky (1982) defines financial instability as the failure to fulfill debt obligations. The main factor that prevents the fulfillment of the obligations is the insufficiency of the cash flows or asset values determined by the market. leading the emergence of financial crises. (Tokucu, 2002:201)

According to Mishkin (2000), *"financial crisis is a disruption to financial markets in which adverse selection and moral hazard problems become much worse so that financial markets are unable to efficiently channel funds to those who have the most productive investment opportunities"*. Mishkin (2000) interpreted the financial crises with the asymmetric information theory, moral hazard, and adverse selection. Accordingly, the different opportunities regarding information and misinformation access to the market agents argued that the source would lead to the wrong channels and cause a crisis. (Mishkin, 2000:3)

Across the literature, there is more than one approach that explains financial crises. They have been grouped under four headings: money crises, banking crises, foreign debt crises, and systematic financial crises.

1.2.3. Currency Crisis

A currency crisis can be characterized as foreign funds beginning to leave the economy quickly and economic individuals demanding more reliable foreign currency due to the loss of trust in the national currency, following speculations depending on various reasons. As a result, the central bank cannot protect the parity rate against speculative attacks and is forced to devalue or fluctuate the national currency.

Currency crises occur when the national currency devalues and depreciates, or the authorities spend significant amounts of international reserves or force them to defend the national currency by raising interest rates rapidly due to attacks. (Eichengreen et al., 1995:253)

Kibritçioğlu (2001) has identified five reasons for currency crises: weak macroeconomic indicators and incorrect economic policies; insufficient financial infrastructure; moral hazard and asymmetric information phenomenon; incorrect feelings and foresight of creditors and international financial institutions in the market; unexpected, shock phenomenon such as political assassination, terrorist attack, natural disaster. At least one of the factors occurs before almost every currency crisis. (Kibritçioğlu, 2001:2)

1.2.4. Banking Crises

Banking crises occur when banks fail to perform their obligations due to bankruptcies or bank failures, or if the banking sector crisis has to be prevented by government interventions. Crises in banking are considered comparatively much more critical due to the impact of the banking sector crisis on the overall economy. Banks are the institutions that determine the distribution of resources in the economy. In emerging economies, where the banking system dominates financial intermediation, as in Turkey, “Banking Crisis” and “Financial Crisis” may have the same meaning. (Ersoy, 2012:76)

Banking crises usually occur when three events happen simultaneously: Banks cannot perform their obligations; with the feeling of mistrust and fear that deposits will not be repaid to them, bank customers withdraw their deposits in panic; a large amount of credit is not repaid, and the government intervenes to rescue or expropriate. (Turgut, 2006:37)

Banking crises often occur simultaneously as a decline in economic activity and a decline in economic growth, so it is not easy to identify the causal relationship between banking crises and production and distinguish the real effect of bank crises. Banking crises affect production and national income through two channels. First, the banking crisis creates an unexpected contraction in the money stock, leading to an economic recession. Secondly, as the banking system weakens, some banks withdraw from the market, and the existing banks are under capital pressure, causing a decrease in loan supply. The decline of the loan supply leads to a decrease in the expenditures of households and enterprises, thus a decrease in production. (Çinko and Ak, 2009:63)

Goldstein and Turner (1996) listed the factors that caused banking crises, including volatility in external and internal macroeconomic variables; increase in the liabilities of the banking system due to maturity and exchange rate mismatch; excessive increases in loans and capital inflows; sudden losses in asset prices; weak financial liberalization practices; excessive public intervention and poor of control over loans; wrong exchange rate regimes; transparency, and legal structure deficiencies. (Goldstein and Turner 1996:9-18)

1.2.5. External Debt Crises

External debt crises are simply the inability to pay a country's public and private sector external debt due to a liquidity shortage. It may be for an extended period if there is a lack of credit. External debt crises begin with the declaration of governments.

An economy experiencing a liquidity crisis may have difficulties paying its external debt, so there is a connection between liquidity crises and external debt crises. An external debt crisis is considered to have started with the state's declaration that it cannot perform its liabilities in external debt repayments, either in full or in part. This disruption may be temporary or for a longer period; however, this situation is perceived as a crisis by creditors. (Çalışkan, 2012:225-226)

1.2.6. Systematic Financial Crises

Systematic crises cause severe deterioration and fragility in the structure of the financial system. Systematic crises are formed by changes in economic, political, and social life. The main feature of these crises is that they are not independent of each other, starting in different areas, triggering each other, and finally causing the system to fail altogether. For example, a crisis occurring in the foreign exchange market may negatively affect the banking sector and create a banking sector crisis. (Delice, 2003:62)

1.3. FINANCIAL CRISIS MODELS

Financial crisis models have been emerging since the late 1970s. As a result of the studies carried out so far, first, second, and third-generation crisis models have been developed. All these models were developed specifically to explain the features of financial crises. As world economies experience new crises, the shortcomings of the previous models that are insufficient to explain the crisis were evaluated; and new models have been created based on their predecessors.

The first-generation financial crisis model was developed to explain the crises in Latin America in the 1970s-1980s. The main reason for the crisis was that expansionary monetary policy is not compatible with exchange rate policies, first modeled by Krugman (1979), based on Salant and Handerson (1978).

The second-generation financial crisis model was developed by Obstfeld (1994) based on the first-generation model, which was insufficient to explain the 1992 European Exchange Rate Mechanism (ERM) crisis. It has been emphasized that multiple equilibria caused concerns; the expectations of economic agents may impact the economy while governments sought to balance political and economic agendas.

The third-generation financial crisis models were developed after the Asian crisis, which occurred in the second half of the 1990s; the previous models were insufficient to explain the dynamics of the crises. It was emphasized that the contagious feature of the crises, the money and banking crises affect each other with a vicious circle. Besides, that financial liberalization, one of the blessings of globalization, led to financial vulnerability.

1.3.1. First Generation Crisis Model

Salant and Handerson (1978) created a model that examines gold pricing between 1968-1974, resulting in the collapse of the Bretton Woods system. The study that inspired Krugman showed how the price stabilization programs for the gold market caused the collapse of the gold-money system with destructive speculations. In the model, it was considered that gold reserves could be depleted by accepting gold as an exhaustible resource. In the crisis environment, the price set in the gold market tends to rise with the expectation of speculators that gold prices will increase. To avoid abnormal fluctuations, the balance of prices depends on the sale of government reserves. However, if this process is prolonged and sales interventions increase, price control will become unsustainable with the prediction of reserves depletion. (Sevim, 2012:26)

In his research, Krugman (1979) contended out that foreign currency reserve is as exhaustible as gold reserves. Thus, foreign currency sales made by governments to protect national currency value will lead to depletion in foreign exchange reserves. Besides, poor macroeconomic policy is a cause of fragility and speculation in economies. One example is the expansionary monetary policy. While the aim is to finance the budget deficits, the expansion of money will result in more national money than demand, a rise in inflation, capital outflow, and negative expectations. The excess money in the market will be channeled to foreign currency, resulting in foreign currency reserve sales to maintain the economies with crawling peg or fixed exchange rate regimes. The decline in foreign exchange reserves will cause the perception that the fixed exchange rate cannot be maintained. (Krugman, 1979:311-312)

There are two limitations to the model. The first one is that it is a simple macroeconomic model; although this helps to achieve certain conclusions, the causes of the balance of payment crisis are not explained. Secondly, only the intervention with foreign exchange sales has been evaluated to balance the exchange rate value, whereas various interventions can be applied to the markets. (Krugman, 1979:324)

The pioneering work of Krugman (1979), whose model has been named as first-generation crisis or canonical models in the literature, has inspired many other models. One of the important works is the model of Flood and Garberin (1984). In the study, perfect foresight continuous-time, discrete-time models were developed based on Krugman's non-linear model. It is accepted that collapse of fixed exchange rate

regimes is inevitable. Thus, the period for the collapse can be estimated depending on the reserves. (Flood and Garber, 1984:1)

In general, these models were developed to explain the external debt and balance of payments crises that began in 1973, when oil and energy prices began to rise tremendously, triggered by the 1982 Mexican moratorium, and often occur in Latin American countries. Among the causes of crises are fundamental economic factors such as exchange rate imbalance, budget deficit, and balance of payments. The causes of the crises are fundamental economic factors, such as exchange rate imbalance, budget deficit, and balance of payments. The main thesis in these models is that the deficit financing pathways and expansionary macroeconomic policies that governments use to sort budget deficits eliminate the possibility of maintaining a fixed exchange rate policy. (Gür and Tosuner, 2002:14)

The first-generation crisis models used to explain the currency crises in 1973-1982 Mexico and 1978-1981 Argentina are described as the deterioration in the fundamental macroeconomic indicators resulting from the wrong economic policies implemented in the fixed exchange rate system. Turkey's 1994 crisis is an example of the first-generation models. (Alpdoğan, 2019:15)

1.3.2. Second Generation Crisis Models

In the first-generation crisis models, unsustainable exchange rate policies and fundamental macroeconomic imbalances of the governments are explained mechanically. Second-generation models were developed following the first generation of crisis models, which were insufficient to explain the 1992 European Exchange Rate Mechanism (ERM) crisis and the 1994 Mexican crisis. Second-generation crisis models tried to explain the self-fulfilling expectations of economic actors.

Obsfeld (1994) emphasized that, unlike Krugman’s (1979) first-generation crisis model, the depletion of the reserves and the collapse of the fixed exchange rate regime did not occur in the 1992 ERM crisis. In the ERM 1992 crisis, European governments faced a challenge of, on the one hand, high interest rates and unemployment causing economic and political pain and, on the other, the political objective of a target rate. The critical issue for governments here is to compare the cost of maintaining a fixed exchange rate with the macroeconomic advantages of staying in the union. Even though the reserves of industrialized European countries

were sufficient, self-fulfilling expectations and multiple equilibria notions have been suggested in explaining the crisis. Accordingly, it was stated that economic agents, who made a move with the motive of a pessimistic scenario, took positions considering the future, not the present. In the ERM crisis, the macroeconomic indicators (increasing interest rates, unemployment) worsened daily, creating multiple equilibria. Speculators looking at the increasing cost of maintaining the fixed exchange rate took positions to expect the exchange rate to be devalued. Obstfeld (1984) conducted that predicting the peak point in the context of macroeconomic deterioration and self-fulfilling expectations as a crisis cannot be calculated, unlike in the previous models. So, the exact crisis date is uncertain (Obsfeld,1994).

In these models, which are also called self-fulfilling crisis models, the policies developed for the solution to macroeconomic problems such as decreases in production levels, high unemployment rates, public debt stock, and the crises that emerge due to the high interest rate caused by the increase in financial vulnerability, caused problems in the banking sector. The speculators observed the change in macroeconomic conditions and policies implemented by the government, which influenced expectations. As the speculative attacks increase, the cost of maintaining the fixed exchange rate system will increase. Therefore, economic individuals perceive that such attacking costs mean that the fixed exchange rate system will be abandoned. If this situation is believed to lead to devaluation, speculative attacks will have become self-fulfilling attacks. Second-generation crisis models are referred to together with third-generation Crisis models because they address the countries in which macroeconomic balances are disturbed and the spreading effects that lead to the emergence of the currency crisis even though no crisis is observed in the economic indicators. (Doğan, 2013:504)

The formation of multiple equilibria can be explained by the fact that the exchange rate has more than one value, each of which is in balance, depending on the expectations of the speculators. In other words, there are several possible exchange rate balances, and which one will depend on expectations. Obstfeld (1994), Cole and Kehoe (1996 and 1998), Chang and Velasco (1998) argue that the formation of multiple equilibria depends on macroeconomic data. If macroeconomic results are good (for example, there is no unemployment problem, foreign trade deficit, and liquidity problem in the banking system), the cost of defending the fixed exchange rate system will be very low. Therefore, there is no feedback process between expectations and costs. If macroeconomic indicators are poor, devaluation is

inevitable, as in first-generation models. When macroeconomic data have moderate values, multiple equilibria may occur depending on expectations. In other words, while a balance occurs due to negative expectations, leading to a high exchange rate, positive expectations may result in a low exchange rate. (Bastı, 2006:13)

Krugman (1996) compares the classic (canonic) model with Obstfeld's (1994) self-fulfilling approach. The former stated that a crisis occurred where the fundamentals of the economy were deteriorating. The question was when it would collapse, whereas there was a range of methods to prevent a crisis that the government would consider in the new model. If this is the case, Krugman claims that the crisis as an outcome is not predictable but consequent on speculations that realized expectations instead of an utterly self-fulfilling mechanism. Krugman concluded that it is correct that the government does have a greater range of concerns beyond mechanically pursuing credit creation until reserves run out. However, there is insufficient evidence to support the idea of multiple equilibria and self-fulfilling crises. There were apparent reasons for speculative attacks, and that the governments had been warned ahead of these risks. (Krugman, 1996:345-375)

First-generation crisis models consider weak economic data (budget deficit, overvalued domestic currency) as necessary in explaining the causes of a speculative attack on the exchange rate. However, the second-generation crisis models point to a speculative attack on the exchange rate and monetary policy authority that has lost the reliability of the financial system. In other words, the central bank's contractionary monetary policy to prevent the speculative attack on the exchange rate will decrease the total supply, increase the unemployment rates, and damage the reliability of the monetary policy. Therefore, monetary policy management needs to correctly analyze the benefits and costs of defending the exchange rate regime. (Özçelebi, 2018: 40)

Table 1: Comparing the first- and second-generation crisis models

First Generation Models	Second Generation Models
✓ The crisis date can be estimated. ✓ Crises are inevitable ✓ Inconsistent fiscal and monetary policies cause crisis ✓ Fundamental macroeconomic indicators are in poor condition	✓ The crisis occurs unpredictably ✓ The crisis is contagious in the regional sense. ✓ Within the multiple equilibria formed, self-fulfilling expectations cause a crisis. ✓ Fundamental macroeconomic indicators have deteriorated over time.

1.3.3. Third Generation Crisis Models

The first- and second-generation crisis models' inability to explain the Asian crisis in 1997 led to developing a new model based on previous ones. Compared to the economies in previous models, Asian economies had better macroeconomic conditions. The crisis started in Thailand and spread to other East Asian countries. There was no underlying economic reason for a crisis; the fundamentals were sound; however, fear and panic resulted in a crisis. One explanation is moral hazard, which is a decisive argument in third-generation crisis models. Besides, the contagion was a feature of third-generation crisis models. The banking and currency crises trigger each other in a vicious circle; the impact of the crisis was felt in all sectors and regions.

The Asian crisis is not like those caused by financial deficits like the first generation crisis models nor the second generation crisis models in terms of its macroeconomic structure. However, it can be explained by financial excess and financial collapse. The Asian story signifies the subsequent collapse of asset values followed by a bubble and the currency crisis. The problem started with the excessive amount of lending, particularly debts unregulated or perceived as guaranteed by the state, which encouraged risky investments, a moral hazard. Excessive risky lending caused inflation, which caused the overpricing of assets. As a result, the bubble burst. Falling asset prices created insolvency, and financial intermediaries had to stop their operations. Krugman (1999) notes the apparent vulnerability of the Asian economies to the self-fulfilling crisis which resulted in such an extreme crisis for the region and how the contagion spread from the initial crisis to other countries, even those which seemed to have few economic links with the original country. (Krugman, 1999:1-10)

After financial liberalization, poor auditing and regulation in the banking sector led to the deterioration of risk management and a low capital adequacy ratio. In such an environment, dense foreign capital inflows may lead to excessive lending of banks to domestic markets, drastic increases in consumption expenditures, and soaring prices in the stock exchange and real estate market. After, the recession of the economy due to any internal and/or external shock makes the banking sector even more fragile. Another highlight of such models is the expectation that the banks' credit expansions by crony capitalism will turn into hidden state debt during a possible severe crisis (Yay, 2001:1239). At the end of the morally corrupted financial management, there is a heavy burden for the public to pay. (Çakmak, 2013: 21)

If the maturity of bank liabilities is shorter than the maturity of assets, this will cause negativity in banks' reserve system. In such cases, a bank run begins. Banks' funding sources and usage areas of these funds can be different from each other. Different funding sources and different usage areas will cause currency and maturity crises simultaneously. These crises will trigger each other and create a liquidity problem for banks. The macroeconomic variables that form the basis of the country's economy (such as money supply, high inflation rate, budget deficits, disruption in the balance of payments, employment, and unemployment) will deteriorate for the crisis's occurrence even if they are not negative. The 1997 Asian crisis was also caused by liquidity problems, not the countries' failure to pay their debts due to negativities in macroeconomic indicators. (Işık, 2004:266)

The most important feature of the third-generation crisis models is the effect of contagion. Contagion is seen in both the 1997-98 South East Asia crisis and the 1998 Russia crisis; together, they inspired the third-generation crisis models. As a matter of fact, the crisis wave started with the fluctuation of the Thai Baht on July 2, 1997, and spread to South Korea, the Philippines, Indonesia, and Malaysia, in a short time. Similarly, upon the announcement of Russia on 18 August 1998 that it could not fulfil its obligations for the government bonds, the crisis extended to other countries such as Mexico and Brazil, putting them into crisis. The third-generation crisis models can explain this contagion effect. (Alpdoğan, 2019:18)

If the cause of the financial crisis in one country is a financial crisis or speculative attack in another country, the crisis is transmitted from one country to another. However, the reason for the crisis in the second country is not only a crisis in the first country. After the first country crisis, the macroeconomic indicators have to deteriorate and/or the private sector expectations should change in the second country. In other words, the first crisis alone does not initiate a crisis in the second country. (Bastı, 2006:17)

Masson (1998) categorized the contagious effects of financial crises in three elements: a monsoonal effect, spillover, and pure contagion. If financial decisions and policy changes in one country negatively affect the second country’s economy, this is considered a monsoonal effect. The negative impact in developing countries due to the decisions taken in developed countries can be evaluated within this scope. Financial crises can transmit from one country to another, directly or indirectly, through spillover or pure contagion. If the financial crisis in one country disrupts the macroeconomic balances in another country and causes a financial crisis, it is a

spillover. Devaluation in one of two countries with a commercial connection may lead to loss of competition, which can cause a foreign trade deficit and loss of reserve in another country. In this case, spillover occurred. The financial crisis in a country may not cause any changes in the second country's macroeconomic indicators. However, the first country crisis may change investors' opinions or risk tolerances regarding the second country's macroeconomic indicators. As a result, private-sector expectations may change, resulting in a financial crisis of self-fulfilling expectations. In this case, the crisis has spread from the first country to the second country through pure contagion. (Masson, 1998:4-5; Bastı, 2006:18-19)

1.4. HISTORY OF FINANCIAL CRISES

Since history is a recurrence, financial crises have existed since the Dutch tulip crisis (1637), the oldest financial crisis known. The causes of crisis formation are generally similar to each other yet, scenarios and actors are different. Despite the improvement of the science of economics and finance and thousands of research works, the fact that financial crises occur more frequently and have more profound effects as of the 20th century is a paradoxical question mark for the scientific world.

The first crises in the world economy are seen in the 17th and 18th centuries. Crises occurring in these centuries are random fluctuations that occur outside of production activities in general. At the same time, the economic fluctuations that occurred in this period differ from the fluctuations caused by the structure of the capitalist system, arising from cyclical speculative attacks that sometimes occur in wholesale trade or securities. Therefore, such fluctuations are not seen as real economic fluctuations. With the change in the economic structure, the effects of the economic crisis have also expanded. (Parasız and Bildirici, 2006:31)

1.4.1. Latin America Crises: The lost decade

Coming into the 1980s, Latin America looked economically healthy, growing on average about 6% per year between 1950 and 1980, almost at the rate of the East Asian countries and faster than the industrialized countries. As with other countries known as developing nations Latin America borrowed heavily in the 1970s, with long-term foreign debt increasing from $45.2 billion in 1975 to $176.4 billion in 1982. Altogether, in 1982 the region’s debt was $333 billion. Despite the increasing debt,

there was no great anxiety about the risk because much of the growth of LDC (less-developed-country) debt reflects the investment and should not pose a repayment problem. (Edwards, 1995:1-19)

Warnings of excessive risk-taking were given as early as 1977 to commercial banks by Burns, the Federal Bank Chair, but ignored. In the 1970s, the low interest rates enabled countries to manage their repayments. Fiscal measures to tackle inflation in the late 1970s and the global recession of 1981 resulted in shorter repayment times and higher interest rates, putting pressure on the LDC economies. In August 1982, Herzog, the Mexican Finance Minister, declared to the US and the IMF that Mexico could not repay its $80billion debt. The crisis spread across less developed countries, with sixteen countries in Latin America forced to reschedule their debt. Ferguson, the US Federal Reserve Governor, blamed the problems on: *"high domestic consumption, heavy borrowing from abroad, unsustainable currency levels, and excessive intervention by government into the economy."* As a result, access to credit was cut, and Latin America went into recession. The US and other national central banks with the IMF acted as an international lender of last resort, covering interest owed but not the principal. Reforms were demanded, but as jobs and spend on infrastructure were cut, unemployment rose, and the performance of economies declined. Eventually recognizing the countries were never going to pay off the debt, in 1989 Brady, The US Secretary of the Treasury, proposed the Brady Plan to reduce the loan principal. Commercial lenders forgave about one-third of the outstanding debt, $61 billion, in return for further reforms. (Sims and Romero, 2014)

This decade of the debt crisis as the most traumatic economic event in Latin American economic history. This debt crisis led to the 1980s being described as a "lost decade" for Latin America, with GDP for the region falling from 112% of the world average to 98%. Debt crises were common problems for Latin America throughout the nineteenth century; in the twentieth century since the 1930s, they have primarily been dual crises of both debt and balance-of-payment; since the 1980s, they have also been banking crises a triple crisis. There is also a history of high inflation. The lack of macro-economic discipline was evident in Brazil and the Southern Cone countries of Argentina, Chile, and Uruguay until the 1970s. Inflation was lower than the IMF had predicted with Argentina and Chile's three-digit inflation associated with political crises, while the US and IMF-led reforms targeted State-led industries. Although these industries are inefficient, this would not be the reason for the economy's collapse without the debt crisis. Latin American countries, especially the

most liberalized countries in the 1970s, were affected as much as the rest of the region and more than the others concerning the banking system. (Ocampo, 2014:1-9)

1.4.2. ERM Crisis (1992-1993)

The aim of creating a single market was part of the European project from the 1950s as the region sought political and economic integration. The European Monetary System (EMS) was launched in 1979, with the primary purpose of stabilizing inflation and fluctuation of rates between member countries. It had features similar to the gold standard in function. In 1988, 7 member countries (Germany, France, Netherlands, Belgium, Denmark, Luxembourg, and Italy) connected their currencies to the German Mark with an adjustable fixed exchange rate system (crawling peg) a +/- 2.5 fluctuation margin. Later, Spain, Britain, and Portugal joined this union. Inflation rates between countries converged and stabilized exchange rates. The resulting stability increased the capital movement in these countries. However, some political incidents and some disrupted macroeconomic indicators caused an environment of panic, which led to devaluation expectations among speculators and thus to a self-fulfilling crisis.

There were multiple factors, according to the literature, that triggered the ERM crisis, which led to second-generation crisis modeling. UK, Italy, and Spain had joined the EMS later and had higher interest and inflation rates than Germany due to the structure of their national economies. Speculators could find capital with low interest from Germany and invest this capital at a high interest rate in British banks to make a profit. As a result, pounds, pesos, and lira were appreciated, and the current account deficits were increasing. In 1990, due to West Germany's merger with East Germany, financial aid transfers increased the budget deficits while maintaining tight monetary policies. Until 1992, interest rates, inflation, current deficit, and growth figures in Germany continued their upward trend. At the same time, Deutsche Mark (DM) appreciated about 30% against the US dollar. Due to all these factors, EMS members would typically devalue or implement deflationary policies; however, they stuck to ERM because of unemployment and high-rate inflation fear. This situation revealed contradictions in terms of monetary policies within the EMS and strengthened the perception that policies will not be successful across the union. In 1992, the rejection of the Maastricht agreement in Denmark in the referendum and its failure in France

led to panics that reduced the ERM system's reliability by increasing uncertainty and instability. (Yay, Yay, and Yılmaz: 2001:31-32)

The start of the crisis was in September 1991 when Finland, not a member of the exchange rate mechanism (ERM) but pegged to the European Currency Unit (ECU), was forced to devalue its currency by 12%. The Soviet disintegration had led to declining exports for Finland as an external shock. By August 1992, both the Italian lira and the United Kingdom pound had fallen to their respective ERM floors. Italy raised interest rates to 30%, depleted its reserves, and devalued the lira on September 13th. On 16th September 1992, Black Wednesday, as recorded in the literature, the UK raised its rates only marginally. That evening, both the lira and the pound left the ERM; the peseta was devalued with ERM agreement the same evening. To defend the rate, France spent 32 billion dollars in one week. Sweden floated in November and Norway in December while Denmark, Spain, and Portugal, devalued. As attacks continued, Ireland devalued in January 1993. By July, France had depleted its reserves and could no longer spend more defending the rate. The crisis ended with ERM bands widening and Germany reducing interest rates, and with some European national currencies no longer pegged to the ERM. (Eichengreen: 2000, 7-14)

The conditions of this crisis do not match the first-generation crises model (canonical models). Krugman describes the ERM crisis of 1992 -1993 as one of the classic episodes of a speculative attack. That means that the ERM crisis demonstrates the model that builds upon the first-generation crises (canonical) model. Unlike first-generation crisis models, the ERM countries did not have exceptionally high interest rates, and they had access to capital markets. They could have stabilized their currencies by raising interest rates. However, the governments were torn between a political commitment to monetary union with a long-term gain and the current political threats associated with unemployment and inflation. This dilemma brings uncertainty and self-fulfilling perception together that ends up with the ERM crisis (Krugman, 1996:367-372)

Akdiş (2000) evaluated the ERM crisis in four conclusions (Akdiş, 2000:61)

- Speculation-based effects are at the forefront of crises. In many studies, the name George Soros is mentioned with the ERM crisis.
- In a world where capital movements are high, it is understood that foreign exchange reserves do not have a preventive function. The foreign currency reserves of the industrialized European states in the U.K. and Italy's central

banks were sufficient. Also, due to ERM conditions, they could obtain credit from Germany.

- Crises arise in unexpected moments. As in the first-generation crisis models, it is not possible to predict the crisis date according to the reserves. The expansion of currencies exposed to speculative movements out of the band begins sometime before the collapse.
- The countries affected by the crisis and exiting from the ERM system were less affected than those in the ERM system, and the measures they take are effective.

1.4.3. Mexican Peso Crisis

After generations of currency and banking crises, Latin America had reformed economically; state-owned companies had been privatized, budget deficits reduced, inflation tackled. With new confidence came new investment across Latin America, including the “Mexican miracle,” which in 1993 saw the foreign capital investment of more than $30 billion. Mexico was the favorite of international investors. Nevertheless, in December 1994, Mexico was subject to a speculative attack; the Mexican peso was devalued, and the Tequila Crisis had begun. (Krugman, 2009:31-32)

While Mexico was being the favorite for international investors and receiving investment and capital inflow, there were early warning signs of problems: the real growth was lower than other Latin American countries, averaging just 2.8%; the productivity rate was almost flat, only rising in 1993; export rates were not rising; real wages were barely at the 1980 level; the real exchange rate appreciated; private saving had declined; poverty remained as an issue. Institutions such as the World Bank and the International Monetary Fund, and other experts and academics believed so much in the reforms of Mexico were implemented before that they were inevitability of success. However, this created a bubble. (Edwards, 1998:3-4)

Mexica was subject to speculative attack; it was unexpected and self-fulfilling. There were reasons to devalue the peso, but Mexico’s speculative attack and peso depreciation went far beyond. Peso holders suffered significant losses. After the depreciation of the Peso, expectations had become pessimistic. This speculative panic caused capital withdraws from Argentina, Brazil, and the Philippines. The

spreading panic is called in the literature the “Tequila Effect”. Sachs et al. (1996) examined 20 emerging countries, and they identified three factors that make countries vulnerable to financial crises: high real exchange rate appreciation, a weak banking system, low reserves. (Sachs et al., 1996: 3-4)

1.4.4. Asian Crisis (1997)

The Asian crisis, which took its place in literature by panic, speculation, and contagion, started in Thailand in 1997 and spread to southeast Asia, Malaysia, Indonesia, South Korea, the Philippines, Taiwan, China, and Hong Kong. Economies were affected by the crisis according to their eco-political and financial vulnerabilities. The Asian crisis could not be explained by the first or by the second-generation crisis models. It has been the subject of third-generation crisis modeling with moral hazard problems and the impact of contagion.

The crisis that emerged in South Asia was mainly the large-scale imbalance of the currency and financial markets in the regional countries. In this period, the national currencies of the countries in the region depreciated, and the private sector's debt payment capacity decreased. The crisis took place in the fastest-growing region in the world of that period. The recovery package, which was more than $100 billion, failed. (Eroğlu and Albeni, 2002:104)

Countries in the crisis regions generally had good economic conditions without economic problems such as public deficits and high unemployment. They had had a high economic growth rate for years. These countries had exchange rates that linked the value of national currencies to the dollar. They formed the world's largest market (Asia Pacific market), combining the characteristics of export (production) and import (consumption) economies based on cheap labor, the main feature of the economic growth process for the East Asia Economies. (Eroğlu and Albeni, 2002:106)

Table 2: Asia Pacific Market Growth Rate, Per Capita Income Statistic

	1970-1996 Period Average Growth Rate Per Year	1996 Per Capita İncome(Dollar)
Thailand	7.5	8.370
Malaysia	7.4	9.730
South Korea	8.4	12.410
Indonesia	6.8	4.280
Philippines	3.6	3.060
Singapore	8.2	25.650
Taiwan	8.3	17.720
China	9.1	3.120
Hong Kong	7.5	25.400
Developed Countries Average	2.7	22.700

Source: World Bank, OECD, The Economist, March 7th, 1998

Since the second half of the 1980s, the amount of international capital that flowed to developing countries increased greatly, especially to South-East Asia countries. The surplus savings of Japan and Europe came to this region as foreign capital. Foreign capital inflows were mainly through the borrowing of banks and companies from abroad. Borrowing from abroad seemed to be a one-sided bet with no risk to banks or companies; due to the fixed exchange rate, the cost of borrowing was as low as half compared to the domestic markets. For this reason, banks and companies increased their debts in foreign currency as much as possible. Between 1990-96, foreign capital inflow to Asian countries amounted to 6% of the average GDP. With the increase in capital inflows, bank loans also expanded rapidly. The loans provided by the banks to the real sector in 1996 were equivalent to 140% of the GDP In Thailand, South Korea, and Malaysia. Although this figure was relatively low for the Philippines, it was still an average of more than 40% per year between 1993 and 1996. In Indonesia, local credit growth was low, yet, companies borrowing directly from abroad. As a result, liabilities of foreign currencies across Asia increased considerably. The share of short-term external debts within the external liabilities of the banking sector increased rapidly. Ten years before the crisis, there were current account deficits in the period of growth, which peaked during1995-96. The factors affecting the increase in current account deficits were the valuation of foreign

exchange rates, foreign capital inflows, and the slowdown in the increase in exports. In conclusion, the risk and vulnerabilities increased in South East Asia in the last few years before the crisis and caused uneasiness in international banks and fund managers. (Bastı, 2006:38-43)

If growth rates are high, there are several reasons which justify the current account deficit. If there is a high growth rate, the external debt / GNP ratio can be considered sustainable, and the country can manage its foreign debt. The high growth rate may result from the capital flow that continues with the expectation of high profitability. There might be a decrease in savings with the expectation of higher income in the future. The decrease in savings is believed to be temporary, and the current account deficit is ignored. In this respect, the sustainability of the Asian economies' current account deficit was not questioned. However, the deterioration in optimistic expectations may cause capital outflow and a currency crisis. (Alpdoğan, 2019: 35)

In general, the crisis symptoms seen in economies in the Asian crisis were: current account deficits, overvalued real exchange rate, decreases in export growth, excessive borrowing, increase in credit and asset prices, excessive short-term borrowing, currency and maturity mismatches, increase in unpaid loans and deterioration in company balance sheets, and low capital/asset ratios, especially in companies. The main causes behind these symptoms are unsupervised liberalization leading to short-term global private capital flows and macro and microeconomic policies that lead to a foreign credit burst from liberalization. (Yay, Yay, and Yılmaz, 2001:38-39)

Somprasong Land, the Thai company which could not pay its foreign debt on 5 February 1997, had already increased anxiety in the markets. By March, the Thai government announced that $3.9 billion of non-performing debt would be taken from financial institutions. Following the slowdown in growth data, political instability, and speculators, the Thai Baht suddenly depreciated in May. In the meantime, similar threats had been observed in Singapore and the Philippines. In June, the Thai economy minister resigned, and the overnight interest rate rose to around 15% due to speculative movements in the markets. The Thai government, which had resisted devaluing the baht before, and the Philippines, applied to the IMF in July. Malaysia intervened in the markets to protect the ringgit.

Consequently, 48 financial institutions in Thailand went bankrupt, and 16 financial institutions in Indonesia were closed. Malaysia and South Korea agreed with

the IMF. In this period, the Hong Kong stock market experienced the lowest level in its history. (Akdiş, 2000:67-68)

The collapse of the Thai baht in July 1997 led to a crisis that spread across Asia, specifically Malaysia, Indonesia, and Thailand, and the Philippines, and as far as South Korea. Krugman was skeptical of the Asian miracle, saying that it was overstated. However, no one had anticipated the scale of the crisis with bank failures, bankruptcies, or the severity of the crisis. The crisis did not conform to the first-generation model, no budget deficits, nor the criteria of the second-generation model. At the start of the crisis, the governments were in fiscal balance, responsible, and inflation rates were low, and there were no unemployment issues. There was no reason, therefore, to abandon the fixed rate. There was no model to explain what had happened in Asia. (Krugman, 1999:315-316)

The Asian crisis led to the development of third-generation models – Krugman (1999), Chang and Velasco (1998). These models looked at private-sector balance sheets, especially those with foreign-currency debt; in damaging the economy, it would decrease investment, increasing lack of confidence, and create a spiraling decline. Krugman summarizes in his Nobel Prize acceptance work in 2010, "*what happens in a third-generation currency crisis is a vicious circle of deleveraging. Hence the severe cost to the real economy."* (Krugman,2010: 7)

The structure and results of the Asian crisis can be listed as follows (Kaykusuz 2014: 237-238)

- The Asian crisis was unpredictable given the consistent growth and positive indicators for a decade before the crisis.
- The most important cause of the Asian crisis is uncontrolled liberalization and unsupervised financial infrastructure.
- The Asian crisis has shown that the real estate and construction sectors, which are unsustainable in the long term, may increase the probability of a crisis
- The Asian crisis has been the subject of next-generation crisis modeling with its moral hazard and impact of contagion.
- It has been shown that an economy that is heavily dependent on the exchange rate also has the potential for financial vulnerability.
- The Asian Crisis has demonstrated the importance of trust and the perception of economic balance formed by transparency, sustainable policies, and the conjuncture-related supervision of markets.

1.4.5. Russia Crisis (1998)

Russia, which implemented liberalization policies in the economy after the disintegration of the Soviet Socialist Republic, had to fight economic shrinkage, budget deficits, and inflation. In the literature, it is generally agreed that the main reasons that led the Russian economy to the crisis were the off-the-record economy, the corrupt relations between the government and a group of oligarchs, and the spiral of debt caused by high budget deficits and high-interest short-term borrowing. However, the incident that speculatively triggered the crisis is George Soros' article on the devaluation of the ruble in The Financial Times. The cautious approach of international capital, which panicked in the Asian crisis, to the Russian economy is the explanation of the high-interest rate short-term debt that increased in the pre-crisis periods.

Russia had started the 1990s in economic turmoil. Following the breakup of the USSR in 1991, the economy of the new state began with inherited problems: a budget deficit estimated at 20% of GNP; $65 billion in external debt, mainly accrued over just six years; about $2.6 billion in gold-stock; the Central Bank of Russia had foreign reserves of only a few hundred million dollars, enough to cover only hours of imports; Russia was defaulting on debt repayments. Adding to the balance of payment crisis, trade had declined, especially oil, gas, and military exports, with Eastern Europe. (Lipton and Sachs, 1992:220-224)

Despite the impact of the collapse of the USSR, the downward trend in inflation had accelerated, and some improvement in growth rate had been achieved as a result of the reforms of liberalization and the tight monetary policies implemented in the country at the end of 1994. Structural changes were achieved - foreign trade was liberalized, and most state enterprises transferred to the private sector. However, the high rate of the informal economy, the inability to collect taxes effectively, and the lack of transparency of the financial structure posed a severe problem. (Eroğlu and Albeni 2002:125)

Table 3: GDP and Inflation Rates in Russia 1991 to 1997

	1991	1992	1993	1994	1995	1996	1997
GDP	-5.0	-14.5	-8.7	-12.6	-4.0	-2.8	0.4
Inflation	92.7	1353	895.5	302	190.1	47.8	14.7

Source: IMF, World Economic Outlook, May 1998 (%Change)

The decrease in inflation and partial growth in Russia as of 1997 did not last long; the decline in Russia's oil revenues in the first half of 1998 caused the Russian government to suffer greatly. Oil prices, which were 22 dollars at the beginning of 1997, decreased to 16 dollars at the end of this year and to 9.41 dollars by the end of 1998. On the other hand, the escalation of the contestation between Russian financial groups caused the failure of the expected goal to privatize various state monopolies such as Rosneft and Gazprom. At the same time, other privatizations also created the problem of kleptocracy in the newly formed Russian democracy. The oligarchs exploited the economy and got richer. Instead of keeping these earnings at least in the Russian economy and thereby partially contributing to the solution of economic problems, these earnings were transferred abroad. As of January 1998, Russia started to disrupt foreign debt payments of nearly 180 billion dollars, of which 149 billion dollars was in the public sector and 30 billion dollars in the private sector. The ruble corridor was canceled, and the ruble devaluation was 70% on the black market between August 17 and September 7 in 1998. The Russian government declared a 90-day foreign debt payment moratorium. (İşcan and Hatipoğlu, 2010:198)

Chiodo and Owyang (2002) defined the Russian crisis as a currency crisis. They argued that it could be explained in different aspects by the first, second and third-generation crisis models within the scope of crisis modeling. They stated that fiscal deficits could be explained by the first generation and financial sector fragility by third-generation crisis models. As a result of the research, they stated that four elements triggered the crisis: a fixed exchange rate, fiscal deficits and debt, the conduct of monetary policy, and expectations of impending default. (Chiodo and Owyang, 2002:10)

1.4.6. Currency Crisis in Turkey: 1994

Turkey implemented protectionist trade policies until the 1980s, when the liberalization of the Turkish economy began. In the five years preceding the 1994 crisis, protectionist policies were removed to allow foreign capital to flow into the country. Turkey succeeded in attracting capital, but the economic vulnerability was increased by various factors: political instabilities, the high cost of counterterrorism, budget deficits, the Gulf War, and the inconsistent policies of both the government and Central Bank of the Republic of Turkey (CBRT). As a result, the crisis was inevitable.

Between 1989 and 1993, the total public debt of the Turkish economy increased 20 times. Moreover, while private sector savings increased continuously and stably, public savings recorded negative values in 1992 and 1993. In the atmosphere of distrust, four treasury bills and the government bond auctions were canceled in November 1993 because of the banks' demand for high interest rate. The government could not find any funds from abroad and increased the advance payment rate from the CBRT by law in August and November 1993. The atmosphere of insecurity in the markets brought about speculations. The Central Bank's policy of keeping interest rates low forced the Central Bank of Turkey to sell foreign reserves to balance the currency parity. This decreased the foreign exchange reserves of Turkey. Foreign currency was overly appreciated with the demand of individual economic actors. Consequently, on 5 April 1994, the government could no longer remain unresponsive, and a series of measures were announced to deliver stability. (Kaykusuz, 2014: 270-272)

Efforts to save the economy in the short run dragged the country into the crisis without comparing the cost of high-interest policies and the costs of using Central Bank resources. Undoubtedly, both financial options could have a negative impact. The important thing is the implementation of policies. In an economy where capital movements are free, the decrease in interest rates can increase demand for foreign currency and lead to capital outflow. One of the most critical factors that prevent the Central Bank from implementing effective policy in this period is the monetary policy being under the direction of the fiscal policy. (Kansu, 2006:166-169)

The only similarity between the 1994 crisis and the first-generation models is that the Central Bank finances the budget deficit. However, Turkey had implemented a managed floating exchange system, which allowed different intervention opportunities to the Central Bank. An essential feature of the currency crisis is the collapse of the fixed exchange rate system due to speculative attacks. Therefore, the 1994 crisis cannot be explained by any currency crisis model. (Kansu, 2006: 170)

1.4.7. Financial Crisis in Turkey: 2001

In the 1994 crisis, the Turkish economy experienced high inflation rates, budget deficits, structural problems such as dollarization, and the indirect effects of the crises in Asia (1997) and Russia (1998). At the end of the 1990s, Turkey's coalition government's economic priorities were to lower borrowing costs and establish trust in

the markets to find outside capital sources. Therefore, a close monitoring agreement was signed with the International Monetary Fund (IMF), followed by the 17th Standby agreement, signed by the Turkish government and the IMF, which agreed on some reforms to be implemented in the economy. However, both the reforms themselves and problems in implementing the reforms caused a liquidity shortage and a banking crisis in November 2000, which then evolved into the currency crisis of February 2001. Turkey experienced one of the most devastating crises of its history.

The Turkish government signed a close monitoring agreement with the IMF on June 26th, 1998, which did not include the credit. The objective of the agreement was to improve Turkey's external creditworthiness. It converted a portion of domestic debt to external debt and aimed to create an atmosphere of reliability. The Turkish economy had experienced a crisis in 1994 and was weakened by the effects of the Russian and Asian crises and suffered a further blow after the natural disaster in August 1999. The close monitoring agreement with the IMF in 1998 did not have the expected result. On 9th December 1999, a letter of intent was sent to the IMF, which stated that the Turkish Economy's biggest problem was inflation. Afterward, the 17th Standby agreement was signed by the new government and the IMF, which included the stabilization program implemented in the economy. The program's primary objectives were single-digit inflation figures, lower real interest rates, healthy and sustainable public finance, urgent structural reforms, and a sustainable growth rate in the economy. (Kaykusuz, 2014: 280-283)

As a result of the positive effects of the program's announcement, the annual compound interest rate of domestic treasury borrowing, which had reached an average of 106% in 1999, declined to a level of 36% in January 2000. The interbank market overnight interest rate average decreased from 67% to 34% in December 1999. Savings began to shift to consumption with the support of banks with low-interest rates retail loans. As a result, as the demand remained alive, the expected drop in inflation was not achieved; even so, inflation fell from 69% to below 40%. Whilst a -6.1% negative growth was experienced in 1999, growth figures of around 6.5% were observed at the end of October 2000; the main reason behind the growth was the demand for both the domestic market and imports. Although privatization did not reach the desired level, this period recorded the highest privatization levels of the previous 15 years; despite this change, the current account deficit was approximately 8-10 billion dollars. (Eğilmez, 2019:76)

In the last months of 2000, financial institutions wanted to reduce their deficits and close their accounts. However, the shortage of TL in the market had caused the interest rates to rise far beyond the norm, such that the nightly values, which were 35% in August, were recorded as 80.5% in November and 316% at the highest. The banks' foreign exchange demand, after TL supply, resulted in the launch of $5.5 billion in two months from CBRT reserves. Thus, possible depreciation in TL was prevented. Nevertheless, with the panic environment, the decrease in credit lines between banks and the outflow of foreign investors triggered the crisis. Various sized financial institutions had been taken over by the Savings Deposit Insurance Fund of Turkey (SDIF). Despite all these factors, the Central bank refused to supply TL to the market due to the IMF's crawling peg agreement. (Kazgan, 2017:229-230)

In November 2000, Turkey, at a vast cost, defended the national currency against intensive speculative attacks. Very high interest rates, significant foreign exchange reserve losses, and an additional IMF loan of 7.5 billion dollars helped overcome the speculative attack. While the November crisis was overcome, three months later, on 19 February 2001, a dispute between the Prime Minister and the President started a second speculative attack. This time, the currency crisis began. On February 21, the overnight interest rate in the interbank money market increased up to 6200%, with an average of 4018.6%. The Central Bank foreign exchange reserve, which was $27.94 billion on February 16, decreased to $22.58 billion on February 23, and the loss of reserves was $5.36 billion. In the crisis of November, the attack on foreign currency was limited to foreigners, and in the February crisis, it was seen that the locals, especially banks, attacked the currency. When the foreign currency could not withstand the attack on the night of February 21, the CBRT announced that the exchange rate would float. While the market selling rate of $1 on February 19 was 686.500TL, it was 920.000TL on February 23, 960.000TL on February 28, which means that the exchange rate soared up to 40% in ten days. The Financial Pressure Index made an even bigger leap than in November. The inflation reduction program, which had deteriorated in November, also finished. It was a currency crisis in February, and even the higher interest rate could not prevent the demand for foreign currency. (Uygur, 2001:22-23)

The agreement between the government and the IMF around the interest level and devaluation impacted economic decisions, but ultimately, the crawling peg had to be canceled, which indicated that the February 2001 crisis might be evaluated as a second-generation crisis. However, in an environment where insufficient financial

audits and guarantees create a moral hazard, the deterioration in bank and company balance sheets showed the third-generation crisis models' features. (Kansu, 2006:203)

1.4.8. 2008 Great Recession

Although experienced many times in history, the Great Recession was an asset bubble crisis that began in the United States of America (USA) and then spread all over the world. What differentiates the crisis from those similar in the past was that it was much more devastating and global. Real estate price increases, which started in 2002 in the USA, reached a peak in 2006. The underlying assumption was that property prices will always go up. If the asset price is inflated, however, this Is not the case. Problems arose in the repayments of subprime mortgages with mortgage loans higher than the value of the property due to declining real estate prices.

Moreover, an increase in unauthorized loans formed an increase in bad loans. This resulted in Lehman Brothers, one of the largest financial institutions in the United States, going bankrupt on September 15, 2008, at a massive cost to the economy. This bankruptcy first affected American International Group (AIG), which insured loans, and then spread to the entire American financial system, which fell into a liquidity shortage, offering similar subprime loans. To prevent this liquidity crisis from creating a domino effect, the FED intervened for financial institutions, especially for AIG. However, the air of panic caused a crisis worldwide, especially in developed markets, which had had investment funds in the USA. The main reasons for the crisis were the growth of unsupervised subprime loans and the housing bubble, securitization, and moral hazard.

Asset bubbles are the product of credit expansion that has become unsustainable. When credit expansion slows down, some asset prices decrease. Housing prices peaked in the USA at the end of 2006. The reason for this sharp increase in the asset price was readily available mortgage loans. Collateral Mortgage Obligation (CMO) securitization accelerated after 2000 and was divided into risk groups. Mortgage loans funded by Collateralized Debt Obligation (CDO) and CMOs created a huge financial volume. A real estate property registered as a mortgage, whose value is expected to increase day by day, was considered a guaranteed payback. Even individuals whose credit history was not suitable could access a mortgage loan. Moreover, banks had attractive offers such as very low interest rates,

negative amortization mortgages, adjustable interest rates. Another consequence of securitization was financial depth: the growth of mortgage-related securities at least twice the increase in the number of mortgages. (Kindleberger and Aliber, 2017:430-433)

The 2008 global crisis is a kind of credit crisis created by transactions derived from credits, but not from credit itself. This situation, which is considered derivative transactions, means that almost all internationally traded banks worldwide are guarantors for each other, and Lehman Brothers became the bank with the highest concentration of all these derivative transactions. The Government and the FED refused to save Lehman Brothers, who could not meet the contract terms against other banks and failed to pay the necessary payments. This was an enormous loss for banks that were creditors of Lehman Brothers. Briefly, the balloon burst. (Eğilmez, 2019:66-68)

Timothy Geithner's phrase expressing the risks posed by the dark banking system: *"Increasing long-term, risky and relatively illiquid assets financed by very short-term liabilities made many of the tools and organizations vulnerable to a classic attack in this parallel financial system, and they lack tools such as deposit insurance that the banking system uses to reduce risks. Once the investors in these financing arrangements, many conservatively managed money funds, withdrew or threatened the withdraw their funds from these markets, the system becomes vulnerable to a self-reinforcing cycle of forced liquidation of asset classes. In response, margin requirement was increased, or financing was withdrawn altogether from some customers, forcing more deleveraging"* Krugman (2015) referenced Geithner's speech in his book. Krugman (2015) compared this logic of deleveraging with that which led to the self-fulfilling crises in Asia's late nineties. Krugman (2015) gave more examples of the shadow banking collapse with auction-rated securities which had been responsible for $330billion of credit ending while asset-backed commercial paper reduced from $1.2trillion of credit to $700billion. Consumer credits became the latest affected in October 2008, insufficient access to credit or decreased credit card limits, credit applications rejected. The collapse of Lehman Brothers in September 2008 led to the mother of all currency crises affecting the whole world. (Krugman, 2015:151-162)

The first phase of the global financial crisis began with just one part of the financial market in 2007. In the summer of 2008, forecasters were predicting only a

mild recession. The second phase, beginning with Lehman Brothers' collapse on September 15th, 2008, led to a worldwide financial crisis. (Mishkin, 2011:49-66)

Mishkin (2011) gives three areas that need to be addressed by the government:

- Central Bank balance sheets. Liquidity loans are easy to reverse once the financial system returns to normal since no one wants to pay the high interest rates, thus are taken off the central bank balance sheets. However, the mortgage-backed securities are long-term, with over $1 trillion maturing in 10 years or longer. This exposes the Federal Reserve to credit and interest risk and the political risk of being accountable to the public for the housing market.
- Too-Big-To-Fail. Having bailed out Bear Stearns in March 2008, the government refused to bail out Lehman Brothers. The consequences of the subsequent collapse of that company open up the risk of a business being too-big-to-fail. The danger is in the interconnectedness of the financial system and the risk of excessive risk-taking, moral hazard if investors believe a company to be too important to be allowed to fail. Solutions for financial regulations going forward include limiting the size or scale of a banking institution.
- Retrenching fiscal policy. Financial crises usually increase government indebtedness that Mishkin (2011) believes needs to be resolved, giving the Greek sovereign debt crisis an example.

CHAPTER TWO
LITERATURE REVIEW

Studies on financial crises investigate the cause, structure, and consequences of financial crises. Crises are perceived as cases that suddenly happen; however, a crisis may signal with some economic indicators depending on its sort. It will be an essential step to predict, develop and eliminate policies to prevent crises. Specific methods have been developed to predict crises. These are the KLR leading signal approach, the linear probability model, probit model, logit model, MARS model, panel data analysis model, artificial neural network model, and the clustering model. In the literature, there are models developed by making certain assumptions on these methods. These methods are generally based on regression analysis, accepting crisis as a dependent variable, explaining the dummy variable according to the indicators.

Pioneering studies for both the signal method and the KLR signal approach have been examined in separate sections. Additionally, signal approach methods specifically applied to the Turkish economy are examined under another title.

2.1. KEY STUDIES IN THE WORLD

There have been many studies aimed at predicting crises. Eichengreen et al. (1996) evaluated the contagiousness of exchange rate crises in 20 industrialized countries with 34 years of data in the 1996 study. They developed the foreign currency pressure index, also known as the financial pressure index. In the analysis, exchange rate, government's political victory, government's political loss, capital control, budget balance /GDP, current balance /GDP, crisis elsewhere, inflation value, employment growth, unemployment rate macroeconomic, and political indicators are used. The results of the analysis breakdown of the best-performing indicators are inflation, employment growth, current account /GDP, capital controls, government loss, and past foreign exchange market crisis. It is concluded that the speculative attack on foreign currency elsewhere in the world strengthens the probability of an 8% attack on the domestic currency.

Frankel Rose (1996) evaluated the economies of 105 developing countries with at least 25% worth of devaluation and experienced at least a 10% increase in inflation compared to the previous year, between 1971-1992. In the analysis, sixteen different variables were used. As a result, they stated that conditions that indicate

crisis may cause severe recession where FDIs decreased, domestic loans increased, national reserves decreased, interest rates increased, and the real foreign exchange rate was overvalued. Also, they argued that the current account deficit and budget deficit do not have a strong relationship with the crises.

In their study, Kaminsky, Reinhart (1996) used 25 years of data of 15 developing and five developed, industrialized countries between 1970 and 1995. They analyzed 76 currency and 26 banking crises with an empirical signal approach that evaluates financial liberalization and banking crises as indicators in addition to 15 macroeconomic indicators. An index of market currency turbulence was created to identify moments of crisis by using the weighted average variables in the nominal exchange rate and reserves. As a result, they stated that the external sector variables and financial liberalization variables give the best results to predict the crisis.

Subsequently, Kaminsky, Reinhart, and Lizondo (1997) developed the KLR method by compiling empirical signal studies in the literature. Following the banking and exchange rate crises in Mexico and Asia, Kaminsky, Reinhart, Lizondo (1999) analyzed 76 currency crises and 26 banking crises. The results show that the currency and banking crises have a vicious circle that triggers each other. It was emphasized that financial liberalization increased the relationship between banking and currency crises. It has been suggested that hot money flows and short-term capital increase financial vulnerability. The environment conducive to exchange rate crises, after any speculative attack, triggers banking and balance of payment crises, resulting in very severe effects in a vicious circle. It has been stated that effective and balanced fiscal and financial policies can prevent interconnected crises. (Kamisky and Reinhart, 1996,1999) (Kaminsky, Rainhart and Lizondo 1997)

Berg and Pattillo (1999) examined the effects of the 1997 Asian crisis with 17 leading indicators in 20 countries. The successful leading indicators were selected with the KLR method. As a result of the study are listed as follows: real exchange rate, M2/reserves, exports, foreign exchange reserves, M1 account balance, domestic loan/GDP, terms of trade, current account/GDP, and M2/reserve ratios. The study aims to determine crisis predictors with a probit regression model as an alternative to the KLR method. According to the KLR method, when a signal was caught in 1995:5-1996:12, the probability of a crisis in 1997 is 37%, while this rate is 51% in the alternative probit regression model.

Glick and Rose (1999) examined the collapse of the 1971 Bretton Woods, the collapse of the 1973 Smithsonian Agreement, the 1992-93 ERM crisis, the 1994-95

Tequila crisis, and the 1997-98 Asian crisis by the probit model they created. They also modeled the impact of trade relations on the spread of the crisis using data from 161 countries. Besides, they examined the effect of the macroeconomic indicators to explain the crisis. It is concluded that seven defined macroeconomic indicators were statistically insufficient and insignificant in explaining crises: the growth rate of domestic loans, the ratio of the public sector budget to GDP, the growth rate of real GDP, the ratio of M2 to international reserves, domestic inflation rate, changes in the exchange rate and the ratio of the current account to GDP. However, it is concluded that the contagion effect of the crisis existed among countries with geographic proximity in the periods examined. The commercial partnerships established due to geographical proximity could cause speculative attacks that could cause a crisis in countries to spread to other countries.

Edison (2003) conducted a study as an optimal early warning system, a variation of the KLR model developed by Kaminsky, Lizondo, and Reinhart (1997). According to the analysis, the best estimators are determined as real exchange rates, the ratio of short-term debt to reserves, the ratio of M2 to reserves, foreign exchange reserve losses, and stock prices.

2.2. TURKISH ECONOMY PRACTICES

Çeviş (2005) analyzed 22 developing countries between 1990:2-2002:4. Using the Panel Data Analysis Method, five different models were created to establish the best estimators. As a result, growth rate, the ratio of the current account balance to the reserves, the ratio of portfolio investments to direct investments, the loans extended by the banking sector to the private sector, the ratio of foreign liabilities of the banking sector to the foreign exchange reserves, the budget balance to GDP budget imbalance and capital movements variables are stated as insignificant.

Kaya and Yılmaz (2005) tested the relationship between financial globalization and monetary crisis for the Turkish economy between 1990 and 2002 with 31 different variables. Logit regression models based on five different models were used in the analyses. In the study, analyses were made under the macroeconomic model's headings, financial model, external economic model, expectations model, and country risk model. The highest probability was calculated within the macroeconomic model for the currency crisis that may occur. Accordingly, in the macroeconomic model analysis, the budget balance/GNP, external interest payments/tax revenues,

domestic debt stockGNP, and consumer price index (CPI) indicators gave statistically significant results. Within the financial model's scope, the ratio of short-term external debt stock to reserves and the ratio of M2y emission to the gross national product was found significant. Within the Foreign Economic Model, only the indicator of the real effective exchange rate and the ratio of the foreign trade balance to gross national product provide significant results.

On the other hand, only the real sector confidence index performed significantly for the expectations model. For the country risk model, the net international reserve ratio of the short-term external debt stock and the short-term external debt stock ratio to the gross national product resulted significantly. Besides, Kaya and Yılmaz's hypothesis that “financial globalization is the granger cause of money crises” was found statistically significant at the level of 10%. In this context, it has been noted that financial liberalization, which may or may not be done with good timing and planning for the country's economies, may cause a monetary crisis. Post-1980 crises supporting this situation are shown as examples.

Altıntaş and Öz (2007) analyzed 20 developing countries between 1990-2002 with 16 variables by the logit to determine the leading variables which affect banking sector crises. Accordingly, the decrease in international reserves, increase in M2/international reserves and total deposit/GDP ratio, and increase in interest rate differences are determined as causing the increase in the probability of a banking crisis. However, real interest rates, domestic loan stock, and public indicators did not deliver significant results.

Karakayalı and Sayın (2010) conducted a KLR signal approach analysis using data from 2002:1-2009:12. Real effective exchange rate, export, import, foreign trade balance, current account balance, industrial production, real interest rate, reserve adequacy, domestic loan stock, and growth rate indicators were evaluated. As a result, the industrial production index and domestic loan position have been defined as the best estimators.

Ersan and Taşpunar (2011) analyzed data of 1997:01-12:2009 periods of the Turkish economy using the probit and logit method. This study's results reveal that an increase in the current account deficit appears to increase the probability of a crisis. The ratio of exports to imports and central bank reserves to imports ratio also were shown to increase the probability of a crisis in the Turkish economy. Besides, using both the logit and probit model in the analysis, both models' predictive power was similar.

Cebeci (2012) analyzed the Turkish economy from 1988 to 2009 using macroeconomic variables with probit models. In the results, interest rate and import variables did not deliver significant results. Inflation, exchange rate, unemployment rate, gross national product, and production variables are considered the best predictors.

Tarkun (2012) developed the probit model to predict the Turkish economy's financial crisis points between 1992:01-2011:11. The variables used for the probit model are the domestic loan stock, bond, industrial production index, money supply(M2), London gold selling price, BIST, banknote position in the economy, gross reserve/import, Republican Gold price, foreign credits, and dollar rate (TL/$). McFadden (80.15) and LR (167.8) values, which show the model's predictive power, are significant at the conventional levels. It is seen that the crisis expectation increased as of June 2008, the crisis probability increased again at the end of 2009, and the crisis probability decreased as of the beginning of 2010.

Sevim (2012) conducted of the economy of Turkey analyzed the data of 32 different macroeconomic indicators between January 1992 and March 2011 on a monthly or quarterly basis and evaluated the performance of predicting the crisis by creating a unified index for leading indicators using KLR and Artificial Neural Networks (ANN) methods. Each of the 32 macroeconomic indicators was analyzed and subtracted one by one, and the index was created with 16 macroeconomic indicators with the highest index probability value. In both ANN and KLR methods, signals supporting the dates when the financial pressure index marked the crisis were received. The leading indicators unified index was found successful in both methods. It was emphasized that the ANN model was more successful than the KLR model in terms of not giving false signals.

Avcı and Altay (2013) examined Turkey, Argentina, Thailand, and the UK economies between 1990-2010 by signal approach. In the study, 15 variables were used. Five have been considered successful indicators, predicting the 1994 and 2001 crisis in Turkey: exchange market pressure index, real interest rate, the real exchange rate, domestic stock prices, and domestic loan stock/industrial production. For Thailand, indicators that successfully predicted the 1997 crisis were the exchange market pressure index, terms of trade, and domestic loan stock /industrial production. For Argentina, real interest rates, trade balance, M2/reserves, and exchange market pressure index were noted as successful indicators in predicting the 2002 crisis. The

most successful indicators to predict the 1992 and 2008 crises for the UK were inflation, domestic loan stock /industrial production, real exchange rate, and industrial production.

The Turkish economy between 2004:01 and 2008:12 was examined with the data of 32 financial and macroeconomic indicators. A signal approach was developed as a crisis prediction model that differs from the KLR model by determining the threshold value by 1.5 standard deviations instead of the percentage levels threshold as KLR. As a result of the study, the most successful indicators for predicting the crisis were noted as the ratio of the foreign trade balance to Gross Domestic Product, consumer confidence index, producer prices index, and XU100 index. (KAYA et al., 2013)

Çakmak (2013) determined eight leading indicators while creating the financial pressure index: current Account/GNP, real exchange rate index, total exports/total imports, short-term external debt/foreign exchange reserves, consolidated budget balance/GDP, net public debt stock/GDP, short-term external debt/medium and long-term external debt and the annual increase rate of the BIST100 index. Turkey's financial pressure index is calculated for the 1989-2011 period by these eight variables of standardized values. According to the results, the value for the years 1993 and 2000 increased to 0.981 and 0.900, respectively, and it was observed that it was able to predict the crises in 1994 and 2001 by exceeding the threshold value of 0.40. However, it could not foresee the global financial crisis which started in 2008. This proves the crisis was dependent on external dynamics. So, external dynamics cannot be ignored in determining financial crises.

Ozturk and Göksel (2013) have identified the key variables that constitute Turkey's financial pressure index using data from 1998 January-December 2012. By creating the financial pressure index, they tried to predict the shrinkage periods three months ahead. The emerging markets bond index, trade balance deficit to reserves ratio and exchange rate volatility variables give the best results according to the significance and predictive power in the probit models. The financial pressure index successfully foresaw the crises for two consecutive quarters between 1998-1999, 2000-2001, and 2008-2009.

Kesbiç, Dündar, and Devrim (2016) developed an absolute signal approach based on the KLR method in their study. According to the KLR approach created by Kaminsky, Reinhart, and Lizondo (1997), crisis signals that occurred in the 24-month crisis window before the crisis date considered as a signal. However, in this study,

other signals were ignored by considering the signal received only for the same date before 24 months, determined as the crisis period. It was emphasized that the primary purpose is reducing the error signal rate in the analysis to have better results. In this context, a comparative analysis was made by the absolute signal approach, which has stricter rules and the KLR method with six macroeconomic indicators, including domestic loans, reel exchange rate, export, import, industrial production index, reserve adequacy. All indicators, except reserve adequacy and industrial production index, performed significant results according to the absolute signal approach, while all indicators gave significant results according to the KLR signal approach. In conclusion, while the highest performance for the KLR signal approach is the indicator reserve adequacy. Import is found as the highest estimation performance according to the absolute signal approach.

Akkaya and Kantar (2018) identify leading indicators for the Turkish economy, the data between 01:2005 and 01:2017 estimating the logit-probit model. In the analysis, Eichengreen et al.'s (1996) speculative pressure index was used. As a result of the study, the gross reserves, domestic debt stock, and monthly Turkish Lira deposit interest rate successfully predict the crisis. Accordingly, an increase in the domestic debt stock, a decrease in gross reserves, and an increase in the deposit phase increase the probability of a future crisis.

Turkish economy was examined by the KLR signal approach between 1990 and 2016. According to the financial pressure index developed by Eichengreen et al. (1996), the crisis dates were defined as February-April of 1994 and February-March of 2001, respectively. Consequently, the best performers among 13 macroeconomic variables were determined as the BIST100 index, international reserves, exports, M2/international reserves, imports, foreign trade balance, short term debt/reserves, real GNP growth, M2 emission multiplier, and bank deposits. Besides, inflation, industrial production index, and short-term portfolio investments were stated as not well-performed to predicting crises in advance. (Akal and Gündoğan, 2018)

In the study of Yıldız (2018), the Turkish economy was examined by the KLR signal approach between the years 1999 to 2017 based on 15 different indicators on a monthly and quarterly basis. The indicators were classified as real and financial indicators. A comparative analysis was performed to evaluate the signal performance of the indicators. To define the period of crisis, Eichengreen (1996) the financial pressure index was used; three different crisis points defined which are exceeds the threshold value in the dates of 2001:2, 2006:6, 2008:10 between 1999 to 2017. The

financial pressure index was formed with macroeconomic data, TL/$ nominal exchange rate percentage change, the TL interest rate percentage change, and net international reserves percentage change. According to Yıldız's (2018) research, the best estimators are; investment expenditures, current balance/national reserve, imports, M2/brut national reserve, a reserve ratio of short-term external debt, short-term capital outflows, and credit expansion. However, inflation, unemployment rate indicators, and export, which had significant results in many studies, did not show sufficient performance. Indicators with the best estimation performance are much more successful in predicting the crisis in the date 2001:2 than in 2008:10 since the 2001 crisis depended on the internal dynamics, whereas the 2008 crisis was related to external dynamics.

Between 1990 and 2016, 15 different indicators were used for 19 countries, and the performance of each indicator to predict the crisis was tested with the KLR signal approach for each country. In the study, the crisis dates were determined by using Eichengreen (1996) financial pressure index, each country was considered separately, and as a result, it was observed that the performance in the leading indicators changed depending on the development level, openness, socio-economic structure, and socio-cultural structure of each country. In this context, it should not be expected that a single crisis prediction model or any indicator will show the same prediction performance in all countries. However, it was observed that the crisis dates of emerging economies were similar in terms of the contagiousness of crises and the typical set of leading indicators was more than the developed economies. February, April 1994, and February, March 2001 were accepted as crisis points, according to the financial pressures index for the Turkish economy. The analysis showed the indicators with the highest performance are respectively: stock market index, unemployment rate, international reserves, export, M2/international reserves, net indebtedness, current account balance, import, short term debts/international reserve, foreign trade balance, and interest rate, net portfolio investments M2 and inflation. (Alpdoğan, 2019)

CHAPTER THREE
METHODOLOGY IN FORECASTING FINANCIAL CRISES

In their study, Kaminsky and Reinhart (1996) examined the connection between the banking crisis and the currency crisis. They analyzed 76 currency crises and 26 banking crises using data from the economic indicators of 15 developing and five developed countries. As a continuation of the study, Kaminsky Reinhart and Lizondo (1997) are described in detail in the KLR method developed in the study "Leading Indicators of Currency Crises".

The functioning structure of the KLR signal approach can be explained in 4 stages. First, it should be clearly stated what the financial crisis is and how it is described; secondly, potential leading indicators should be identified; thirdly, we have to decide what conditions the potential indicator's behavior accepted as a signal, should be determined by a criterion. Lastly, in the event of a signal, we should determine whether the crisis occurred within a reasonable period or the signal is a false alarm. Also, we need to define a reasonable period. (Kaminsky, Reinhart 1999: 487)

3.1. CRISIS DATE DETERMINATION

In previous studies regarding the crises and signal approach, empirical methods were used to determine the crisis dates. Pressure indices have been formed to define a crisis point. The indices change according to the economic and political structures of the countries. In general, financial pressure indices contain the data of changes in exchange rates and national reserves. Eichengreen, Rose, and Wyplozs (1996) created the Speculative Pressure Index (SPI), also known as the Exchange Market Pressure Index (EMP) or Financial Pressure Index (FPI). The index is calculated as standardized in the formulation by standardizing the nominal exchange rate (E), Interest rate (I), and change in reserves (R) data. The standardization process for the analyzed series uses the function "standardize" in the Excel spreadsheet program.

$$FPI = \frac{\left(\frac{\Delta E}{E}\right) - \mu_E}{\sigma_E} + \frac{\left(\frac{\Delta I}{I}\right) - \mu_I}{\sigma_I} - \frac{\left(\frac{\Delta R}{R}\right) - \mu_R}{\sigma_R}$$

Changes in the exchange rate and interest rates have a positive effect, while the change in reserves has a negative effect. In this respect, the foreign exchange value appreciates against the national currency, and the interest rate increases while the international reserves are declining; consequently, the financial pressure index value increases. The crisis period is explained by the fact that the financial pressure index gets extreme values higher than average, defined by Eichengreen, Rose, and Wyplozs (1996) as standard deviation distance to the median.

Crisis=1 ⟶ if $FPI \geq 1.5\sigma_{FPI} + \mu_{FPI}$

Crisis=0 ⟶ if $FPI < 1.5\sigma_{FPI} + \mu_{FPI}$

An index of market currency turbulence was created based on weighted average changes in reserves (R) and nominal exchange rate (E) to determine the crisis dates (Kaminsky, Reinhart 1999):

$$I = \frac{\Delta E}{E} - \frac{\sigma_E}{\sigma_R} \cdot \frac{\Delta R}{R}$$

In the currency turbulence index, changes in the exchange rate and reserves have positive and adverse effects, respectively. Therefore, the increase in the exchange rate and the decrease in reserves will increase the index.

Crisis=1 ⟶ if $CTI \geq 2.5\sigma_{FBI} + \mu_{FBI}$

Crisis=0 ⟶ if $CTI < 2.5\sigma_{FBI} + \mu_{FBI}$

The coefficients determined for standard deviations in the index range from 1.5 to 3.

In this thesis, Eichengreen et al.'s (1996) speculative pressure index is used. The formula is shown below for the Turkish Economy where standardized values have to be used:

$$FPI = {}^{₺}/_{\$}\, exchange\ rate\ percentage\ change + Interest\ rate\ percentage\ change - Net\ international\ reserves\ percentage\ change$$

3.2. DETERMINATION OF INDICATORS AND SIGNAL CRITERIA

While determining the indicators, previously conducted studies and the possibility of providing healthy data were taken into account. In Table 4, signal criteria and probability calculations to measure the potential and performance of indicators to be leading indicators are reported.

***Table 4**: KLR Signal Matrix*

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	A	B	A/(A+B)
No Signal	C	D	D/(C+D)
Probability	A/(A+C)	B/(B+D)	A+D/(A+B+C+D)

Source: Kaminsky, Lizondo, and Reinhart 1997:18

Kaminsky, Lizondo, and Reinhart (1997) contributed to the literature with the KLR signal approach. The method essentially evaluates any indicator's unusual movements in a certain period before the crisis as a signal. The 24-month period before the crisis date was specified as the period in which to look for significant (good) crisis signals. The signals occurring outside the 24-month crisis window were described as false signals.

This period was defined as 12 months for banking crises and 18 or 24 months to balance payment crises. The reason for this is that while the balance of payment crises has a more systematic structure than banking crises and policymakers have the opportunity to intervene in advance to data and political reasons that may cause currency crises, it was emphasized that there is no such systematic structure for banking crises. (Kaminsky and Reinhart, 1999:487)

In the matrix above in Table 4, part A shows the signal given by the indicator in the crisis window, which is a good signal. Part B represents the number of crisis signals that the indicator gives out of the crisis window; it is a false signal. Part C indicates the number of periods in which the indicator did not signal despite the crisis,

the number of periods in which the indicator failed to predict the crisis. On the other hand, Part D indicates the number of periods in the non-crisis periods that it does not signal. In the analysis, the results of the indicator statistically in sections A and D are perceived as *true signals*, and the signals formed the sections B and C are considered as false signals because they conflict with the result.

Kaminsky, Reinhart, and Lizondo (1998) evaluated signal data with seven different probability formulas. In the first column of Table 5, A/(A+C) represents the probability of correct signal when there is a crisis; in the second column, B/(B+D) indicates the probability of signal when there is no crisis, that is, the probability of a false signal among the recorded signals. In the fourth of Table 5, A/(A+B) shows the probability of a crisis when the signal is recorded; D/(C+D) the probability of no crisis when there is not any signal recorded. (A+D)/(A+B+C+D) shows the ratio of correct signals to all periods analyzed; it represents the correct signal rate.

Table 5: KLR signal approach, probability

Probability of signaling in the event of a crisis	A/(A+C)
Probability of signaling in the absence of a crisis	B/(B+D)
Error signal rate (ESR)	B/(B+D) / A/(A+C)
Probability of crisis when there is a signal	A/(A+B)
Probability of a Crisis When There is a Signal - (Probability of a Crisis)	A/(A+B) - [(A+C) / (A+B+C+D)]
Probability of no crisis	D/(C + D)
Probability of the correct signal	(A+D)/(A+B+C+D)

In the third column of Table 5, the formula of [B/(B+D) / A/(A+C)] means that the probability of signal when there is no crisis to the probability of signal when the event of a crisis. Thus, it is the ratio of false signals to the *true signals*, defined as, the error signal ratio (ESR). The indicator's performance depends on the error signal rate; for reliable crisis estimation, the ESR has to be as small as possible. It is unacceptable that the error signal ratio is equal or higher. This ratio is generally expected to be less than one (1). (Yıldız, 2016:84)

The numerical difference between the probability of a crisis and the probability of a crisis [A/(A+B)] - [(A+C)/(A+B+C+D)] tests whether its performance is random, or it is a real event. If too many crises observed in the economy, in this case, the recorded signals are in the crisis window and the signal performance is observed to

be high. But even if this interpretation is correct, it does not reveal the truth, Because the small difference between the probability of a signal-dependent crisis and the probability of a contingent crisis is weakening the leading indicator performance. Therefore, [A / (A+B)] - [(A+C) / (A+B+C+D)] value is expected to be greater than 0 (zero). (Sevim, 2012:67)

3.3. THRESHOLD DETERMINATION FOR INDICATOR

For the economy to be analyzed, determining the threshold value in the studies is performed with the data set over the years. In some cases, over decades, the only purpose is to evaluate the unusual increases or decreases or both, according to the indicator's character, the signal period can be determined. However, when determining the unusual situation, a threshold that is too high will result in missed true signals. A threshold value that is too low will result in false signals.

Kaminsky, Lizondo, and Reinhart (1997) divided the data set into percentiles. Depending on the indicator's expected signs, positive or negative, Kaminsky, Lizondo, and Reinhart (1997) accepted a value between 10% and 20% slices for the threshold value during pre-crisis periods. This value has to match the minimum signal error rate. Thus, the lowest error rate and the optimum threshold definition will be realized in each country's economy for each indicator.

There are different studies to determine the threshold value. While determining the threshold value, the aim is to have a low error signal rate stated earlier. (Sevim, 2012: 63), in the study, the threshold value for indicators determined by the code is written in MATLAB; the value with the least false signal at 32 different thresholds for 32 different variables was determined as the threshold.

In another study, regardless of the error signal ratio, as the threshold value, 1.5 standard deviation surplus or minus the average of the indicator's unit data was determined as the lower or upper threshold value. The threshold takes values depending on the pre-crisis trends of the indicators, positive or negative; accordingly, the performances of the indicators were evaluated. (Kaya, Gülhan and Güngör, 2013)

In this thesis, as a method, the threshold values of the indicators are determined by the percentile method, following the KLR signal approach. At the same time, the second analysis is conducted by the 1.5 standard deviation method. Consequently, the results are compared.

CHAPTER FOUR
EMPIRICAL APPLICATION

In this chapter, a financial pressure index for the Turkish economy is developed, using Eichengreen et al.'s (1996) methodology. After determining the crisis points, we measure the prediction performance of 13 different indicators measured, following the KLR signal approach. The analyses conducted using key macroeconomic indicators between 2002 and 2019.

4.1. FINANCIAL PRESSURE INDEX

The financial pressure index created with the data between 2002-2019 for the Turkish economy is also shown in Figure 1. According to the financial pressure index, 05: 2004, 06: 2006, 10: 2008, 08: 2018 were determined as crisis points. In terms of threshold determination, the analysis was carried out following the Eichengreen et al. (1996) method. A 1.5 standard deviation excess of the index's median value is accepted as the threshold value. Consequently, values that exceeded the threshold value are respectively 2.10; 2.69; 3.60; 3.39.

Figure 1: Financial Pressure Index of Turkish Economy (2002-2019)

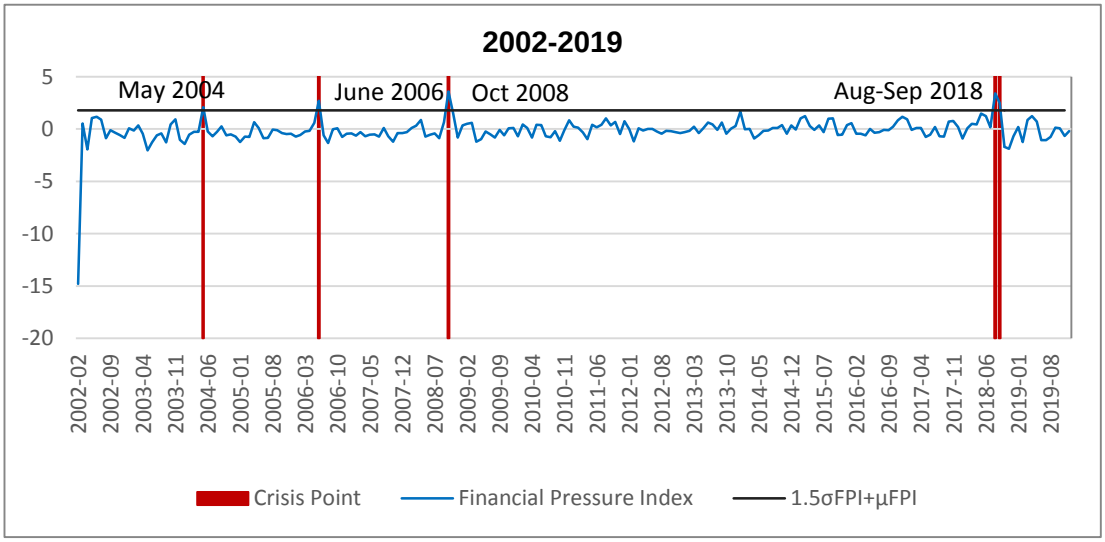


Figure 1 shows an unusual increase in FPI in May 2004. In the literature on the Turkish economy, 2004:05 has not been regarded as a crisis period; however, the 2004 Central Bank report explains the reasons for this unusual increase. According

to the report, there were a number of drivers for this: the political uncertainties in Cyprus in April-May 2004 (the Cyprus referendum); strong signals in the U.S. Central Bank statement in March 2004 that interest rate might be increased and the expectation that it might increase the interest rate in the markets; the expectation that the current balance will give a deficit above the projected changes especially the risk perception towards emerging markets. All of these resulted in fund outflows, increasing the pressure on emerging currencies. All these factors caused the borrowing cost of the Turkish treasury to increase by 5 points in May compared to the previous month. Subsequently, in the second quarter of 2004, the signals that the Federal Reserve Bank of America approached the interest rate increment cautiously. The Turkish Central Bank reacted by reducing the amount of buying auctions of foreign exchange on April 15, 2004. Lastly, due to strong fiscal policies with direct selling intervention, on May 11, 2004 TL depreciation stopped. As a result, crisis effects faded without being felt profoundly. (CBRT, 2004)

The second crisis date claimed in our study is June 2006. This alleged crisis has the appearance of more severe and permanent effects than the fluctuation in 2004. The fact that the central banks of developed economies increased interest rates in early 2006 caused hardship in the developing markets. To avoid volatility experienced during the year, the Republic of Turkey Central Bank reacted by buying foreign exchange currencies on one occasion and selling foreign currency on three occasions. Over four sessions, there was an increment of 400 base points interest rate, with the highest two Interest rate increases of 175 and 225 base points respectively on June 7, 2006, and June 25, 2006. Yıldız (2016), using the KLR approach, evaluated June 2006 as the date of the crisis and associated this unusual increase in the financial pressure index with the interest rate increase of the Federal Bank of America. Kesbiç, Dündar, and Devrim (2016) stated that July 2006 had been determined as the crisis date; the slowdown in Turkey's economy in 2005 became recognizable in the second half of 2006. Alpdoğan (2019) detected June 2006 as the crisis period in her study. In June 2006, there was a severe risk perception for the Turkish economy in the EMBI+ index, resulting in negative divergence, supporting the June 2006 crisis.

The subprime mortgage crisis, or the Great Recession, which began to appear in 2007, broke out in September 2008 when many financial institutions went bankrupt. It affected the world economies to a certain extent depending on its structure in global markets where hot money is easily circulating. Arduini, De Arcangelis, and Del Bello

(2012) examined the performance of the early warning system. They noted that some emerging economies' currencies experienced a sharp decline against the dollar and the euro. With the crisis's contagious effects, the Turkish economy also experienced the crisis; the growth rate plummeted. Thus, GDP grew by 0.5 in the third quarter of 2008, the smallest growth since the second quarter of 2002. In this period, the slowdown in domestic and foreign demand weakened imports and exports, causing a depreciation in the national currency. (TCMB report, 2008)

An unusual increase occurred in the financial pressure index in January 2014, which was not taken as a crisis date because it did not exceed the threshold point. Preceding this was a period of deterioration that started in May 2013 and continued until December 2013, a period marked by political instabilities considered to have impacted the Turkish economy. A similar increase was experienced in December 2016 is interpreted as the result of the July 15th attempted coup. In this case, Turkey's economic structure shows that it is closely connected with political and social factors. (TCMB report 2013)

There is no study evaluating the signal approach for August 2018, which was analyzed as the last crisis point in the literature. The studies, however, questioned the conducted policies during the August 2018 turbulence. Orhangazi (2019) concluded that the second half of 2018 was a currency crisis, based on the structural crisis of the construction-led growth model in the Turkish economy, dominated foreign capital inflows, and increasing debt rates. Accordingly, the construction-based growing Turkish economy experienced an abundance of capital in the 2000s with the monetary expansion and growth policies in the world. This caused the increase in imports and intermediate goods imports in production. Nevertheless, financial vulnerability was inevitable in the case of capital and foreign exchange outflows. All these factors have made all actors of the economy vulnerable to foreign currency fluctuations. (Orhangazi, 2018:133)

During the second half of 2018, with the specified date chronology, Turkey experienced political, geopolitical crises that led to Turkey's CDS premium soaring and diminished confidence in the economy that seemed to be causing capital outflows. The Central Bank 2018 report also recognized a high inflation rate, sudden increases, fluctuations in exchange rates, and economic slowdown (CBRT, 2018). According to the report, a monetary tightening move was made in May to prevent unnatural price fluctuations and inflation expectations observed in the markets. In June, the policy rate, which increased from 16.5% to 17.5%, rose to 24% due to the

rapid depreciation in TL in August. Reserve Option Mechanism (ROM) upper limit had been pulled down. At the end of 2018, the consumer price index was 20.3%, well above the target. Related to the depreciation of TL, the producer price index was reported as 33.64%. (CBRT, 2018: 17-20)

4.2. KLR SIGNAL APPLICATION ON TURKISH ECONOMY

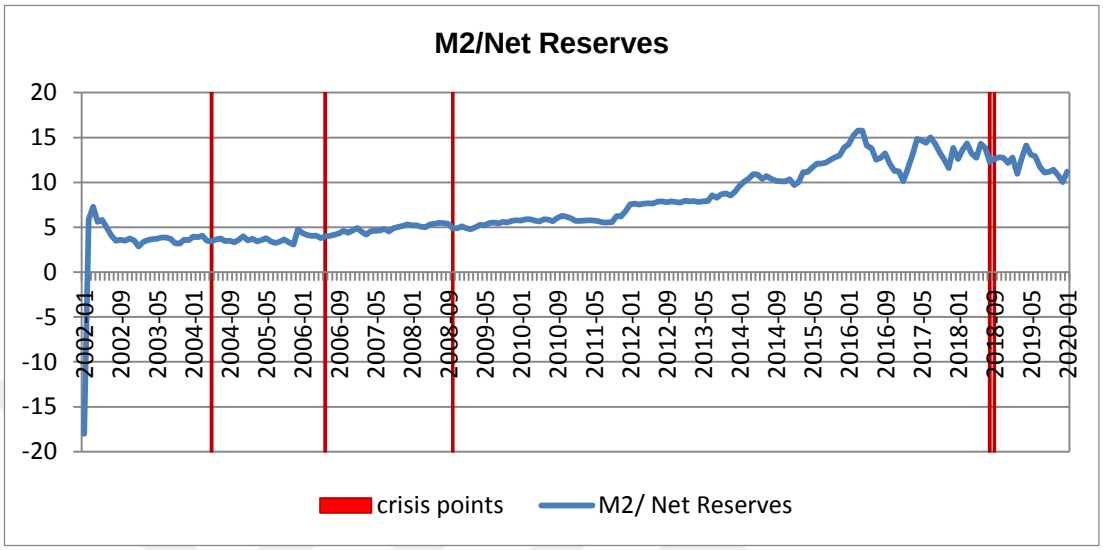
The prediction performance of 13 different indicators is measured using the Turkish economy data between 2002 and 2018. These indicators are respectively M2 / Net Reserves, Real Effective Exchange Rate, BIST100 Index (change, %), Current Account / Foreign Exchange Reserves, Republican Gold (change %), Unemployment Rate, Short Term External Debt Stock / Foreign Exchange Reserves, Export / Import, Domestic Loan Expansion (change %), Foreign Exchange Deposits (change %), Producer Price Index (change %), Industrial Production Index (change %), Domestic Debt Position (change %). All data, except the industrial production index, are obtained from the Electronic Data Delivery System (EDDS) of the Central Bank of the Republic of Turkey (CBRT). The industrial production index is gathered from the IMF due to data availability. We employ the KLR signal approach to measure the predictive performance of macroeconomic indicators for any crisis.

4.2.1. M2 / Net Reserves

In the event of any speculative attack on the national currency or a sense of insecurity caused by various reasons, economic actors may turn to more reliable currencies to maintain the value of money. This trend increases the demand for foreign currencies and affects the price balance, depending on the economy's foreign dependency. At the same time, it also triggers an increase in inflation. These factors combined indirectly, by causing the capital outflow, will end up as an environment open to a financial crisis. In this context, the Central Bank will tend to take a series of actions to ensure the national currency’s stability, which is its primary goal. The Central Bank may sell foreign reserves to the market, which may cause a decrease in Central Bank reserves; however, it could maintain the national currency’s value. If monetary expansion is added to this situation, severe financial and economic consequences are inevitable.

Figure 2 gives a breakdown of the M2 / Net Reserves position for the Turkish Economy. After the 2001 banking crisis, net reserves are leveled at negative values

Figure 2: M2/Net Reserves Level



Using the KLR signal approach, the M2 / Net Reserve indicator is analyzed, which shows data for a 96-month crisis window after January 2002 in 4 different crisis dates, determined according to the financial pressure index in the 201 months.

The M2 / Net Reserve indicator's success rate is shown in detail in the signal-crisis matrix created below. Accordingly, a 13% threshold value is determined, and it is observed that the indicator has a positive trend before the crisis.

Table 6: M2/Net Reserves Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	17.00 **A**	9.00 **B**	0.65 **A/(A+B)**
No Signal	79.00 **C**	96.00 **D**	0.55 **D/(C+D)**
probability	0.17 **A/(A+C)**	0.08 **B/(B+D)**	0.56 **A+D/(A+B+C+D)**

The M2 / Net reserve indicator exceeds the threshold value and gives 26 crisis signals, of which 17 are in the 24 months before the crisis; 9 are recorded as false

signals outside the crisis window. If there is a crisis signal, a 65% probability is that a crisis occurs within 24 months. Table 6 shows that the indicator has a 56% probability of a correct signal rate. The error signal ratio of the indicator is analyzed as 48%

The analysis made with the threshold value created with the standard deviation of 1.5 is shown in Table 7. Accordingly, the indicator gives 35 signals in 201 periods, 19 of them are in the pre-crisis period of 24 months, and 16 are recorded as signals outside the crisis window. The probability of giving the correct signal is analyzed as 54%, and the error signal rate is 77%.

Table 7: M2/Net Reserves Signal Table (1.5 St. Deviation is Threshold Value)

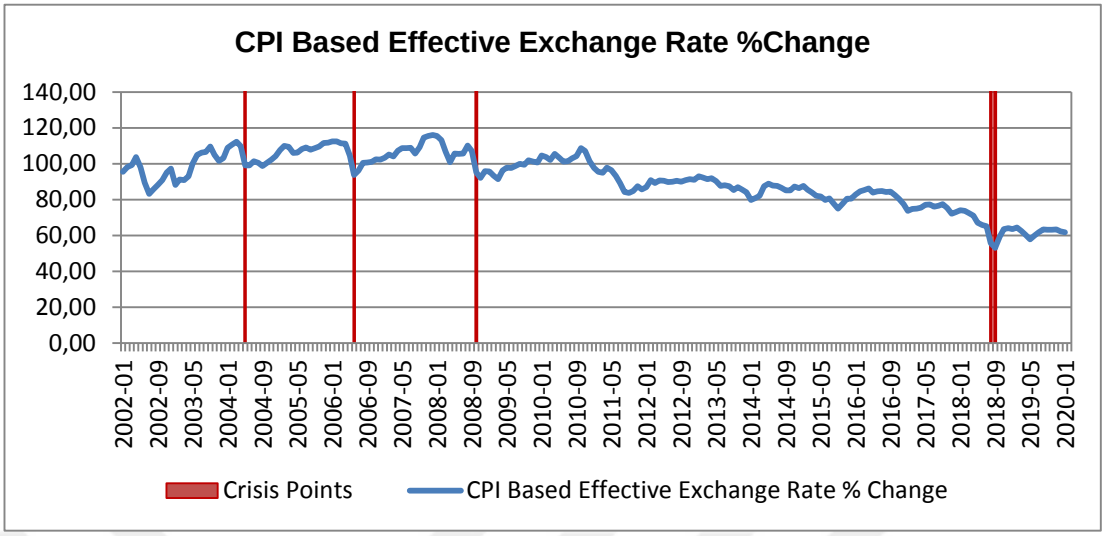
	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	19.00 **A**	16.00 **B**	0.54 **A/(A+B)**
No signal	77.00 **C**	89.00 **D**	0.54 **D/(C+D)**
Probability	0.20 **A/(A+C)**	0.15 **B/(B+D)**	0.54 **A+D/(A+B+C+D)**

4.2.2. Real Effective Exchange Rate

The nominal effective exchange rate refers to the average of the currency basket created for a particular purpose, obtained using a suitable weighting method. The real effective exchange rate, on the other hand, is the settlement of the relative price effects by various methods. In this thesis, according to the basket of developing countries, the real effective exchange rate is selected based on the CPI, and the price effects are adjusted. This indicator reveals the appreciation or depreciation experienced in the national currency.

The direction for the threshold chosen for the values signaled by the indicator is negative. The negative pattern demonstrates negative divergence against emerging market currencies, which means that the Turkish lira depreciation is against the norm.

Figure 3: CPI Based Effective Exchange Rate Level



As a result of the 201-month analysis, the threshold value of the indicator is determined as 11%. A signal-crisis matrix is created in which the 201-month analysis of the indicator is evaluated, reported in Table 8.

Table 8: CPI Based Effective Exchange Rate Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	19.00 **A**	3.00 **B**	0.86 **A/(A+B)**
No Signal	77.00 **C**	102.00 **D**	0.57 **D/(C+D)**
Probability	0.20 **A/(A+C)**	0.03 **B/(B+D)**	0.60 **A+D/(A+B+C+D)**

In 201 months, a total of 21 crisis signals is recorded, which exceeds the 11% threshold value, 19 of which are observed in the 24 months before the crisis, and three as error signals. In other words, if there is a crisis signal, a crisis occurs within 24 months with a probability of 86%. In the second line of the matrix, during the 201-month analysis process, 179 months of no crisis signal are observed; in 102 of these, there is no crisis for 24 months. In other words, if there is no crisis signal, there is a 57% probability no crisis occurs within 24 months. The probability of the correct signal rate is 60%. The error signal ratio of the indicator is analyzed as 14%. According to

the KLR signal approach, it is a significant indicator because the error signal rate is less than one.

Based on the standard deviation method, it has been observed that the indicator gives only three signals in the 201 months, all of which have been observed to occur within the crisis window. Accordingly, when there is a crisis signal, the probability of a crisis is 100%. In the second line of the matrix, when the analysis is evaluated, it is observed that there is no crisis signal for 198 months, and there is no crisis in 105 months. Therefore, if there is no signal, there is a 53% probability there will be no crisis. Error signal rate is zero (0)

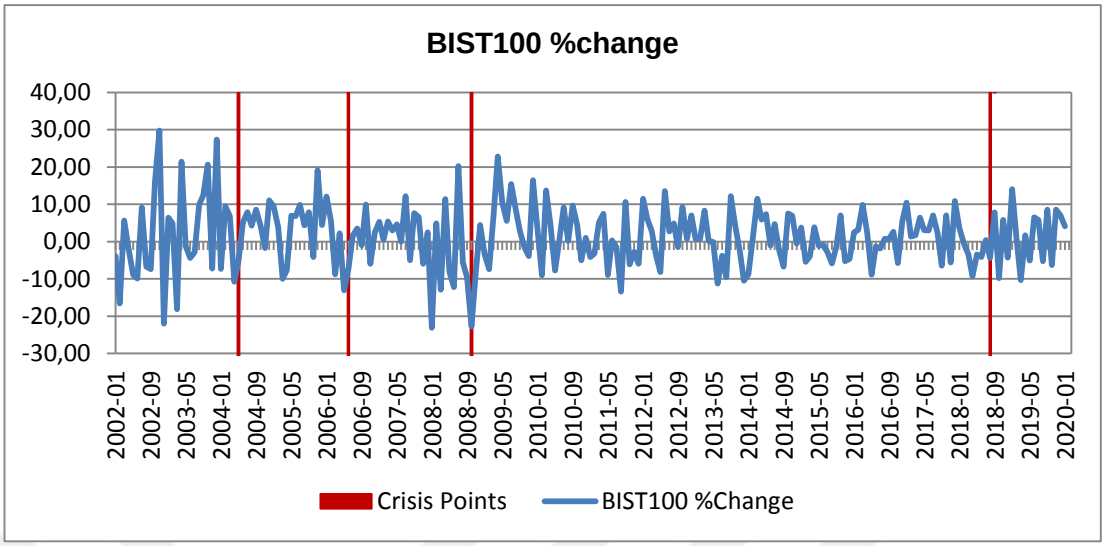
Table 9: CPI Based Effective Exchange Rate Signal Table (1.5 St. Deviation is Threshold Value)

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	3.00 **A**	- **B**	1 **A/(A+B)**
No Signal	93.00 **C**	105.00 **D**	0.53 **D/(C+D)**
probability	0.03 **A/(A+C)**	- **B/(B+D)**	0.54 **A+D/(A+B+C+D)**

4.2.3. BIST100 Index

Stock markets are primarily connected to many significant elements such as politics, banking, expectations, economic management, and foreign funds. Therefore, stock markets are one of the leading indicators of economies. Depending on the observed country's eco-political structure, the stock exchanges may give positive or negative signs before the crisis. In Turkey, in particular, deteriorations are observed in the BIST100 index in pre-crisis periods.

Figure 4: BIST100 Percentage Change



An analysis is made with the percentage change of the monthly closing values of the 100 determinant companies traded on the Istanbul Stock Exchange. For the 201 months, the value of 8% is chosen as the threshold value since it gives the least error signal rate. In Table 10, the indicator signaled 16 times, ten times correctly, and six times incorrect. In this case, the probability of a crisis is 62% when there is a signal. The probability of a correct signal is 54%. The error signal rate of the indicator is analyzed as 54%. Thus, the error signal ratio is less than one indicates that it is a successful indicator.

Table 10: BIST100 percentage Change Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	10.00 **A**	6.00 **B**	0.62 **A/(A+B)**
No Signal	86.00 **C**	99.00 **D**	0.54 **D/(C+D)**
probability	0.10 **A/(A+C)**	0.05 **B/(B+D)**	0.54 **A+D/(A+B+C+D)**

Using the standard deviation method, the indicator records ten crisis signals in 201 months; 6 of them were in the crisis window, and four crisis signals are recorded as false signals. In other words, when there is a signal, the probability of a crisis is 60%. The second line of the matrix shows that the indicator does not give a signal for

191 periods. In Table 11, if the threshold value is 1.5 standard deviations, the error signal rate is 61%, while the probability of giving the correct signal is 53%. The error signal ratio is less than one. Thus, in terms of values, this shows that the indicator is successful.

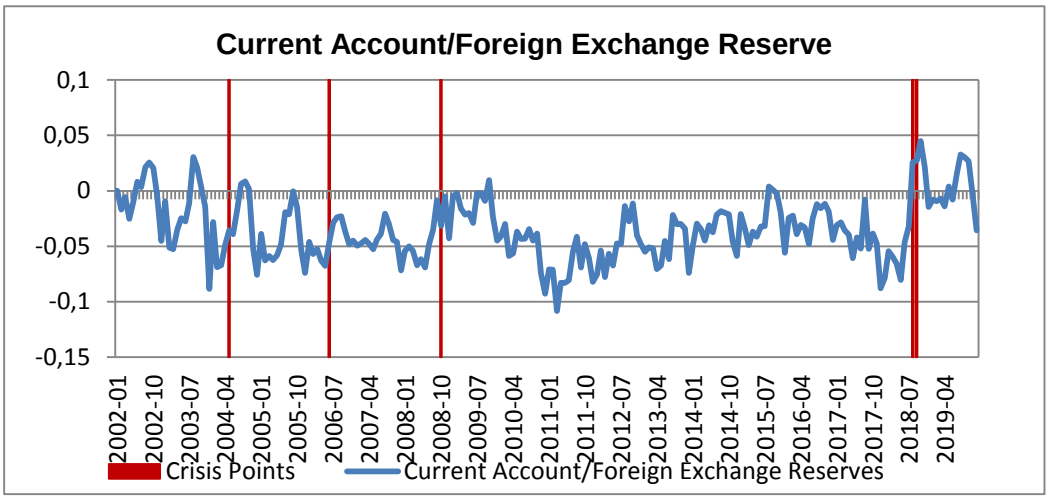
Table 11: BIST100 Percentage Change Signal Table (1.5 St. Deviation is Threshold Value)

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	6.00 **A**	4.00 **B**	0.60 **A/(A+B)**
No Signal	90.00 **C**	101.00 **D**	0.53 **D/(C+D)**
probability	0.06 **A/(A+C)**	0.04 **B/(B+D)**	0.53 **A+D/(A+B+C+D)**

4.2.4. Current Account / Foreign Exchange Reserves

The current account is a significant macroeconomic indicator that can provide comprehensive information about a country's economy; it also has a strong linkage with the key macroeconomic indicators such as national income, growth, employment rate, and inflation. The Turkish economy has had a chronic current account deficit for many years, which means that the consumption of goods and services is more than production. This situation can be interpreted either positively or negatively with its evaluation with other macroeconomic indicators. In cases in which this deficit is not financed by investments and funds, as an act of balancing the reserves, it will lead to a decrease in reserves and increase the fragility of the country's economy in international markets, exposing the country to speculation risks.

Figure 5: Current Account / Foreign Exchange Reserves Level



As a result of the analyzes made with monthly data since January 2002, 18% value is determined as a threshold for the indicator. It is observed that the indicator gives a negative signal in the pre-crisis periods.

Table 12 shows that during the 201 months, 36 crisis signals are given, 18 of them are recorded as error signals, and the crisis occurred in the 24 months after 18 other crisis signals. Therefore, the probability of a crisis is 50% within 24 months following the month when the crisis signal occurred. In the second line, the indicator does not signal a total 165 months period; however, after 78 of them, crises are recorded within 24 months. In other words, if there is no signal, there is a 53% probability a crisis will not occur. While the error signal rate of the indicator is 91%, the probability of the correct signal rate is 52%. As the error signal ratio is less than one, this is a significant indicator.

Table 12: Current Account / Foreign Exchange Reserves Level Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	18.00 **A**	18.00 **B**	0.50 **A/(A+B)**
No Signal	78.00 **C**	87.00 **D**	0.53 **D/(C+D)**
probability	0.19 **A/(A+C)**	0.17 **B/(B+D)**	0.52 **A+D/(A+B+C+D)**

Based on the 1.5 standard deviations as the threshold value, it is recorded that ten crisis signals were received in the 201 months, four of them within the 24-month crisis window, 6 of them are observed as error signals. The matrix created based on these numbers is in Table 13. Accordingly, the probability of a crisis is 40% when there is a signal. Since the error signal rate is greater than one as 137%, according to this method, it has been noted that it is an unsuccessful indicator.

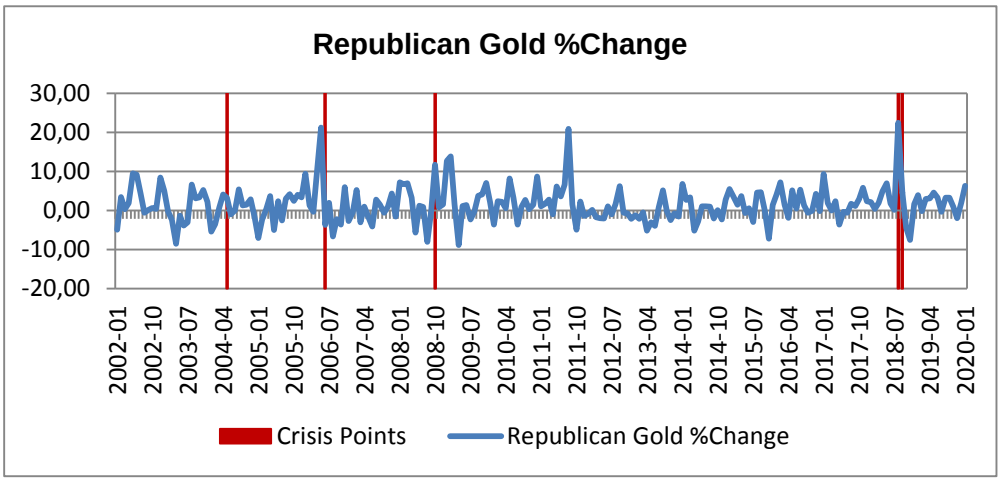
Table 13: Current Account / Foreign Exchange Reserves Level Signal Table (1.5 St. Deviation is Threshold Value)

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	4.00 **A**	6.00 **B**	0.40 **A/(A+B)**
No Signal	92.00 **C**	99.00 **D**	0.52 **D/(C+D)**
probability	0.04 **A/(A+C)**	0.06 **B/(B+D)**	0.51 **A+D/(A+B+C+D)**

4.2.5. Republican Gold Percentage Change

Gold is a precious metal that has preserved its value throughout history and has been used as the reserve element by central banks for many years. In this context, speculation and panic in the economy may push investors to move from the national currency to gold to maintain the value of savings. Particularly in the Turkish economy, demand for gold by economic individuals has traditionally been the preferred way to maintain their savings value. For this reason, in our study, the prices of the republican gold are examined.

Figure 6: *Republican Gold Percentage Change*



In the 201 months, the signal performance of the indicator for the crisis is tested with the monthly percentage change of the republican gold pricing. As the threshold value, the value of 11%, which is the lowest value of the error signal rate, is determined. It is observed that the indicator has a positive tendency in the pre-crisis periods. Matrix table 14 prepared with the analysis shows 22 crisis signals are recorded, 12 of which are recorded in the 24-month crisis window, 10 of which are recorded as error signals. When there is a signal for the indicator of the republican gold, it can be estimated that there is a 55% probability of a crisis within 24 months. In the second line of the matrix, it is observed that no signal is received for 179 months, and 95 of these months without signal are outside of the 24-month crisis window. In other words, in the absence of a signal, there is a 53% likely there will be no crisis. The probability of the correct signal is 53%, and the error signal rate is 76%, so, as the value is less than one, denoting the indicator is successful.

Table 14: Republican Gold Percentage Change Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	12.00 **A**	10.00 **B**	0.55 **A/(A+B)**
No Signal	84.00 **C**	95.00 **D**	0.53 **D/(C+D)**
probability	0.12 **A/(A+C)**	0.09 **B/(B+D)**	0.53 **A+D/(A+B+C+D)**

Using the standard deviation method, during the 201 months, 14 crisis signals are recorded; 7 of these take place within the 24-month crisis window, seven of them are recorded as false signals. In this case, if there is a crisis signal, the probability of a crisis is 50%. As seen in the second line of the matrix, there is no signal in 187 months; 89 months occurred outside the crisis window. Thus, there is a 52% likely there will be no crisis in the absence of a crisis signal. According to this method, the error signal ratio of the indicator is 91%, the probability of giving the correct signal is 52%. The indicator may be considered successful.

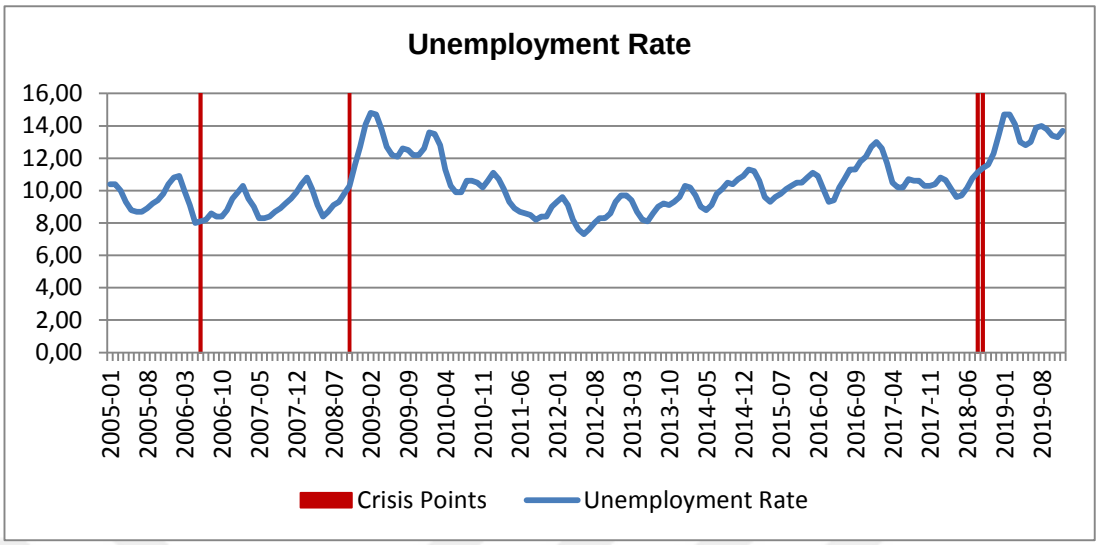
Table 15: Republican Gold Percentage Change Signal Table (1.5 St. Deviation is Threshold Value)

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	7.00 **A**	7.00 **B**	0.50 **A/(A+B)**
No Signal	89.00 **C**	98.00 **D**	0.52 **D/(C+D)**
probability	0.07 **A/(A+C)**	0.07 **B/(B+D)**	0.52 **A+D/(A+B+C+D)**

4.2.6. Unemployment Rate

For a healthy economy, a low unemployment rate is desirable. Its direct connection with economic growth shows that the unemployment rate can provide leading information about its economy and crisis periods. Consequently, in crisis periods or pre-crisis periods, depending on the capacity utilization rate, layoffs are expected to increase. It can be envisaged that the economy may shrink, and the national economy may end up in a recession. Therefore, governments aim to keep the unemployment rate as low as possible and to implement sustainable policies accordingly.

Figure 7: Unemployment Rate Level



Monthly changes of the unemployment rate percentage level value are analyzed as of January 2005 within the data. The lowest value of the error signal ratio, 17%, is accepted as the threshold value.

The results matrix created with the 168-month analysis is shown in Table 16. In total, 28 crisis signals are recorded. While 20 of them are false signals, 8 of them occur within the 24-month crisis window and indicate a crisis might occur. In this context, when there is a signal, it is estimated there is a 29% likelihood that a crisis will occur. There is no signal recorded in 137 months; 57 are in the 24-month crisis window, while 80 months are out of the crisis window. So, in the absence of a signal, the probability of a crisis is analyzed as 58%

Table 16: Unemployment Rate Level Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	8.00 **A**	20.00 **B**	0.29 **A/(A+B)**
No Signal	57.00 **C**	80.00 **D**	0.58 **D/(C+D)**
probability	0.12 **A/(A+C)**	0.20 **B/(B+D)**	0.53 **A+D/(A+B+C+D)**

Although the unemployment rate indicator has a 53% probability of signaling correctly, the error signal rate is higher than one at 162%, showing that the indicator is

unsuccessful. As reported in Figure 7, it is observed that the pattern of rising unemployment came after the crisis rather than before, so it is not a good performing leading indicator. Notably, it is visible in October 2008 and August 2018, which are defined as crisis points.

Based on the standard deviation threshold, during the 165 months, in total, 11 crisis signals were received, 9 of them were error signals and occur outside the 24-month crisis windows, and 2 of them are recorded in the crisis window periods. According to the analysis results, the probability of a crisis is 18% when the crisis signal is received. No signal is recorded for 154 months, and 91 are recorded outside of the crisis windows. In other words, if the crisis signal is not received, there is a 59% likely a crisis will not occur. Although the correct signal rate is 56%, the error signal rate is 292%, much higher than 1. Thus, the indicator is considered unsuccessful.

Table 17: Unemployment Rate Level Signal Table (1.5 St. Deviation is Threshold Value)

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	2.00 **A**	9.00 **B**	0.18 **A/(A+B)**
No Signal	63.00 **C**	91.00 **D**	0.59 **D/(C+D)**
probability	0.03 **A/(A+C)**	0.09 **B/(B+D)**	0.56 **A+D/(A+B+C+D)**

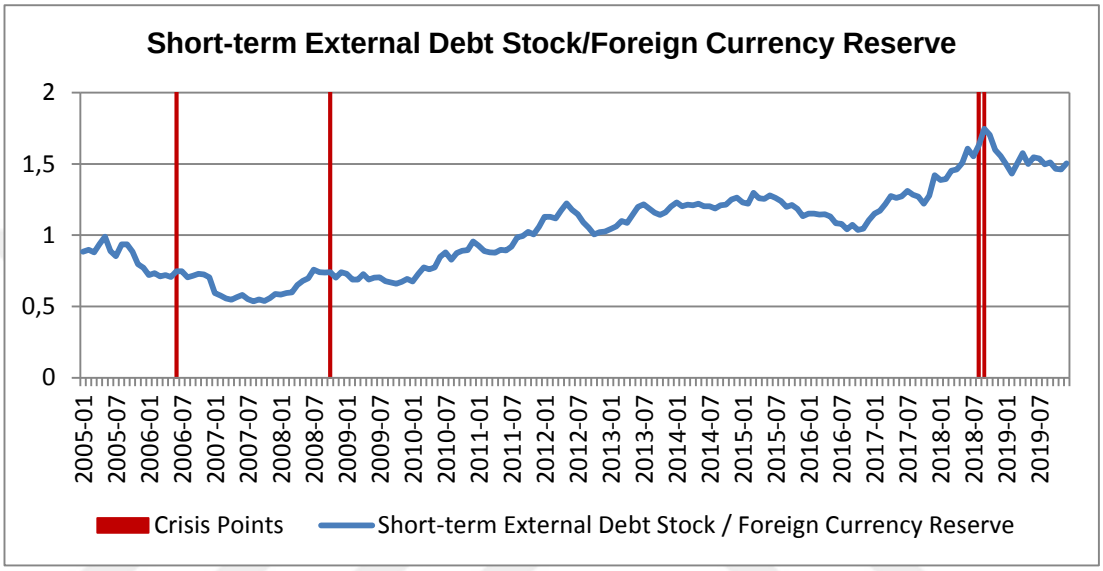
4.2.7. Short Term External Debt Stock / Foreign Exchange Reserves

Short-term external debt is the liability lent by the units established in the foreign economies and planned to make principal and/or interest payments within one year from the date of use. With developing technology and globalization, the rapid movement of capital and policies aiming to grow globally caused the cost of debt to be cheaper. This resulted in an increase of short/long term debts after 2002 for Turkey as an emerging economy.

Long-term debt is preferred for investments and healthy growth with its payment schedule and relatively acceptable interest rates. However, it may not always be possible to find capital under favorable terms for countries due to high CDS premiums, insufficient credit registrations for private affiliates, or political reasons. In

this context, short-term debt is generally an undesirable form of borrowing, given the relatively high interest rates charged and the need to re-pay in the short term. Short-term debts are considered as a palliative solution to shocks, immediate but not advantageous. Therefore, it is considered that augmentation in short-term external debts is not compatible with the principle of sustainability.

Figure 8: Short-Term External Debt Stock / Foreign Currency Reserve Level



In the 165 months in which we examined the performance of the ratio of short-term external debts to foreign exchange reserves according to the KLR signal approach, the threshold value is determined to be 11%, where the error signal rate is the least. Table 18 shows the result of the analysis. A total of 18 crisis signals are received, 4 of them are false signals, and 14 are recorded within the 24-month crisis window. Thus, it is estimated that a crisis will occur within 24 months with a probability of 78% when the crisis signal is received. At the bottom line of the matrix, a crisis signal is not received for 147 months; 51 of them are recorded as false signals since they are in the crisis window. In this regard, if there is no crisis signal, there is a 65% likelihood that a crisis will not occur. While the probability of the indicator to the correct signal is 67%, the error signal rate was analyzed as 18% less than one, indicating this indicator is successful.

Table 18: Short-Term External Debt Stock / Foreign Currency Reserve Level Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	14.00 **A**	4.00 **B**	0.78 **A/(A+B)**
No Signal	51.00 **C**	96.00 **D**	0.65 **D/(C+D)**
probability	0.22 **A/(A+C)**	0.04 **B/(B+D)**	0.67 **A+D/(A+B+C+D)**

Using the threshold value of 1.5 standard deviations for short-term external debts to the foreign exchange reserves indicator, during the 165 months, five crises signal are received; 2 of them are recorded as false signals outside of the 24-month crisis window, and 3 of them are recorded as correct signals. In this context, the probability of a crisis is 60% within 24 months after the crisis signal is recorded. No signal is received in the remaining 160 months, 98 of which occur outside of the crisis window. When no crisis signal is received, there is a 61% likely there will be no crisis. It is seen that the probability of a correct signal is 61%, and the error signal ratio is 43%. Therefore, the indicator is successful.

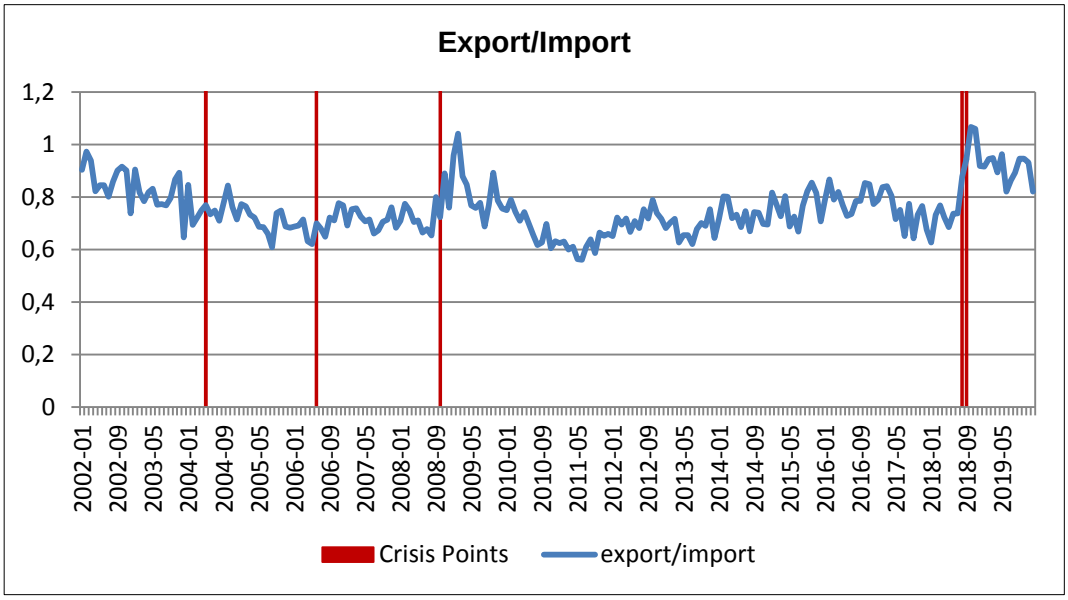
Table 19: Short-Term External Debt Stock / Foreign Currency Reserve Level Signal Table (1.5 St. Deviation is Threshold Value)

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	3.00 **A**	2.00 **B**	0.60 **A/(A+B)**
No Signal	62.00 **C**	98.00 **D**	0.61 **D/(C+D)**
probability	0.05 **A/(A+C)**	0.02 **B/(B+D)**	0.61 **A+D/(A+B+C+D)**

4.2.8. Export / Import

Export and import are macroeconomic indicators that contain information about national economies. As import-based economies cannot sustain their requirements without foreign elements, the national economy's financial vulnerability increases. In the case of changing economic conditions or shocks, severe financial crises may occur. The Netherlands discovered natural gas reserves in the 1960s. With the sudden enrichment, The Dutch Guilder over-appreciated against other national currencies. Production in many sectors decreased, GDP growth stopped, and The Netherlands became an import-based economy. In this short period, a reduction in industries and increases in imports caused financial fragility. This crisis became known in the literature as the Dutch Disease and demonstrated the necessity of a balanced trade and economic policy. Today, Venezuela experiences the Dutch disease conditions with its oil-based economy; the national economy has been struggling with hyperinflation since 2014, leading to problems in providing essential supplies such as electricity, water, and food. Turkey has followed a stable trend in overall imports and exports. In the economy, where the import amount is one step ahead. Accordingly, negative changes in the ratio of exports to imports are considered as signals for the crisis.

Figure 9: Export / Import Level



For the indicator, 201 months of exports to imports data are used in the analysis, according to the KLR signal approach. The 20% ratio of the error signal rate, which received the minimum value, is determined as the threshold value. In the period of 201 months, 40 crisis signals are received, and only 13 of them in the 24-month crisis window. Twenty-seven of them are recorded as error signals which occur out of the crisis window. In other words, if the crisis signal is recorded, the probability of a crisis within 24 months is 32%. In the bottom line of the matrix, it is observed that no signal is recorded for 161 months, and 78 of them were in periods out of the crisis window. It is estimated that there will be a 48% probability of no crisis when there is no signal recorded.

Although the indicator has a 45% likelihood of being correct signaling, the error signal rate is observed as 189%. The indicator is considered unsuccessful as the error signal rate value is greater than one. Additionally, during the crisis periods, February 2009 and November 2018, as determined according to the financial pressure index, imports decreased significantly compared to previous months, and the ratio of exports to imports peaked. The reason for this is considered as the decreasing tendency to spend as a protective instinct after the crisis.

Table 20: Export / Import Level Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	13.00 **A**	27.00 **B**	0.32 **A/(A+B)**
No Signal	83.00 **C**	78.00 **D**	0.48 **D/(C+D)**
probability	0.13 **A/(A+C)**	0.26 **B/(B+D)**	0.45 **A+D/(A+B+C+D)**

Using 1.5 standard deviation value as a threshold for the indicator of the ratio of export to import on a monthly basis, only three signals are received in the 201 months; all of them are recorded as error signals outside the 24-month crisis window. Thus, error signal rate mathematically undefinable so, the indicator has been evaluated as unsuccessful.

Table 21: Export / Import Level Signal Table (1.5 St. Deviation is Threshold Value)

	Crisis (within 24 months)	No Crisis within 24 months	Probability
Signal	- **A**	3.00 **B**	0 **A/(A+B)**
No Signal	96.00 **C**	102.00 **D**	0.51 **D/(C+D)**
probability	0 **A/(A+C)**	0.03 **B/(B+D)**	0.51 **A+D/(A+B+C+D)**

4.2.9. Domestic Loan Expansion Percentage Change

Economies have their internal dynamics according to their particular characteristics; the goal is to balance these dynamics. In this regard, excessive credit expansion may increase financial vulnerability. However, proper and balanced credit expansion can be explained by healthy growth. As a result of monetary policies that aim at globalization and growth, borrowing costs have decreased, and it has become relatively easy to take up a loan. While this has a positive effect on growth, excessive credit growth can cause a bubble, as experienced in the 2008 subprime crisis. Credit expansion in the Turkish economy has been drawing an increase since 2002, as shown in Figure 10.

Figure 10: Domestic Loan Expansion Level

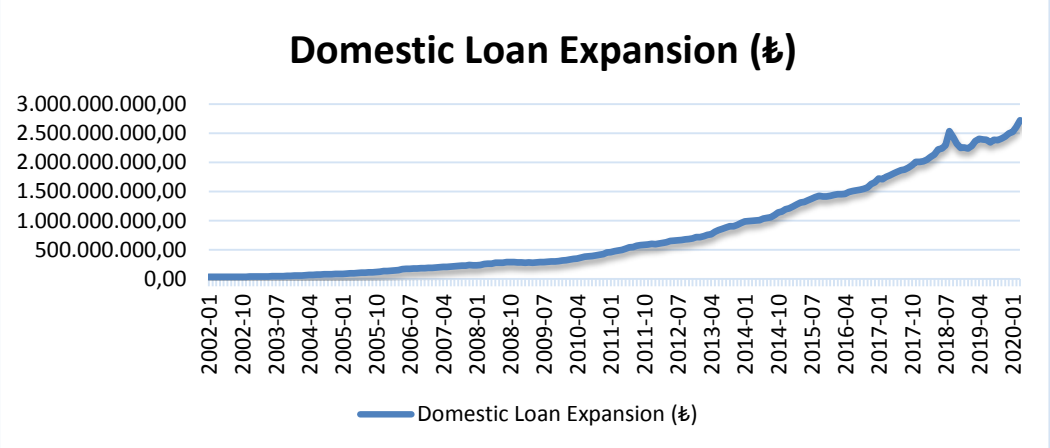
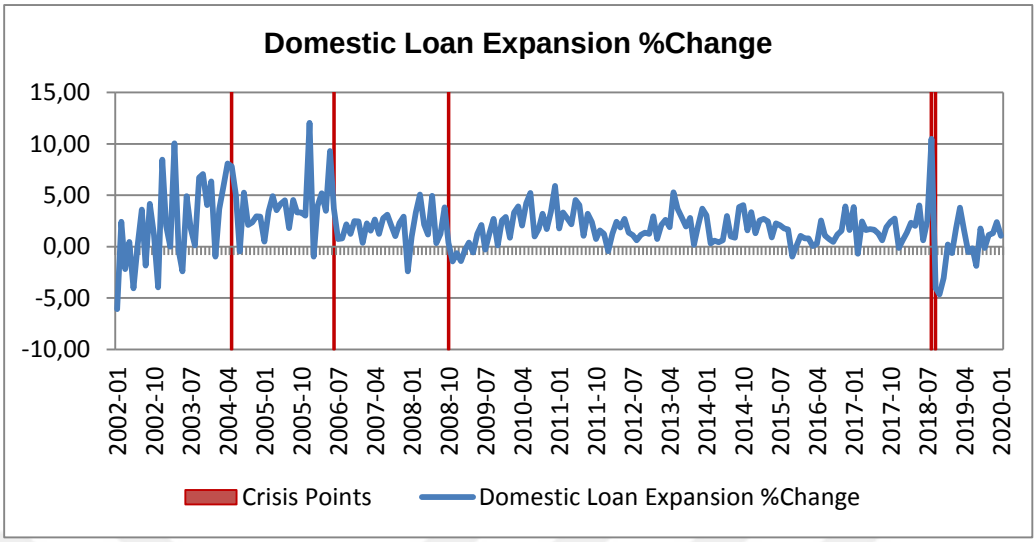


Figure 11: Domestic Loan Expansion Percentage Change



According to the analysis made for the indicator, the lowest 12% value of the error signal rate is determined as the threshold value. In the 201 months, 24 crisis signals are recorded, while 18 signals are received in the 24-month crisis window, six false signals are observed out of the crisis window. In this context, if there is a crisis signal, there is a 75% likelihood a crisis will occur. As shown in the second line of the matrix, no crisis signal is received in 177 periods, 99 of which occur outside the crisis window, and 78 of them occur within the crisis window. Thus, if there is no crisis signal, there is a 56% probability there will be no crisis within 24 months.

The performance of the percentage change of domestic loan expansion, a leading indicator, is analyzed based on the KLR method. As a result, the probability of a correct signal rate is 58%, the error signal rate is observed as 30%; thus, the indicator is successful.

Table 22: Domestic Loan Expansion Percentage Change Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	18.00 **A**	6.00 **B**	0.75 **A/(A+B)**
No Signal	78.00 **C**	99.00 **D**	0.56 **D/(C+D)**
probability	0.18 **A/(A+C)**	0.06 **B/(B+D)**	0.58 **A+D/(A+B+C+D)**

In the analysis made by accepting the threshold value of 1.5 standard deviations for the indicator, we evaluate the percentage change of the domestic loan expansion monthly; ten signals are received in the 201 months, 9 of which occur within the 24-month crisis window. In this case, while the error signal rate of the indicator is 10%, the correct signal rate probability is 56%.

Table 23: Domestic Loan Expansion Percentage Change Signal Table (1.5 St. Deviation is Threshold Value)

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	9.00 **A**	1.00 **B**	0.90 **A/(A+B)**
No Signal	87.00 **C**	104.00 **D**	0.54 **D/(C+D)**
probability	0.09 **A/(A+C)**	0.01 **B/(B+D)**	0.56 **A+D/(A+B+C+D)**

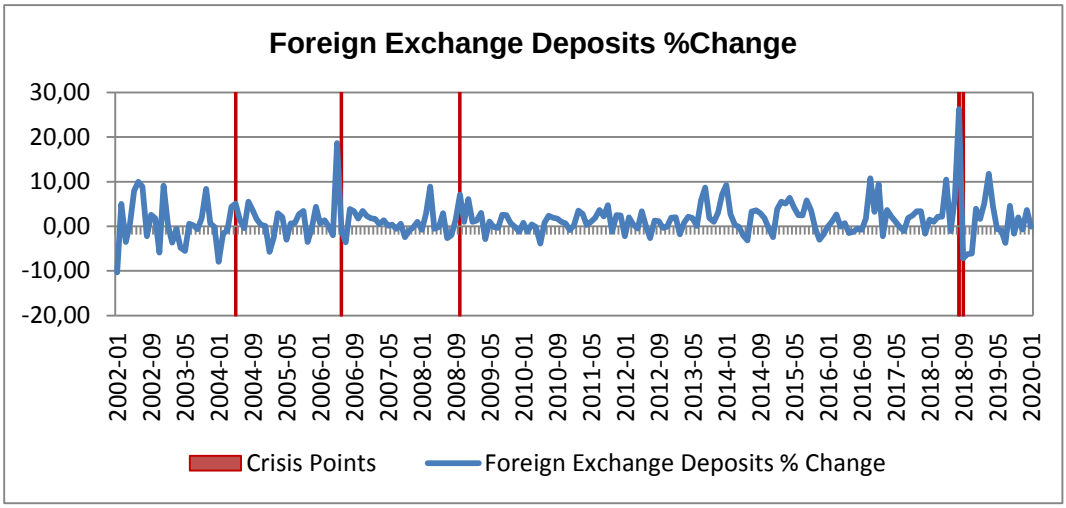
4.2.10. Foreign Exchange Deposits Percentage Change

The decline of trust for the national exchange, before and during the crisis will lead economic individuals to relatively strong and reliable currencies. Dollarization, the substitution of foreign money holdings for domestic money, is common in many developing countries. (Agénor and Khan, 1996:101)

The Asian crisis, which started in Thailand and affected south Asian economies, affected Russia and Brazil. It was observed that the demand for foreign currency during the crisis was significantly high. Commercial bank assets and liabilities in Cambodia, for example, are almost all in foreign currencies, and over 70% of all transactions are in dollars. (Okonjo-Iweala et al., 1999:49)

Foreign exchange deposit data simply allow us to monitor the demands of individuals and legal entities for foreign currency. This situation exacerbates financial fragility for emerging economies.

Figure 12: Foreign Exchange Deposits Percentage Change



Monthly percentage changes of total foreign currency deposit accounts' performance as a leading indicator have been evaluated by the KLR signal approach. The 8% value with the lowest error signal ratio was accepted as the threshold value, and the indicator was observed to be positive in the pre-crisis periods. In the 201 months, 16 crisis signals have been received, and 11 of them were within the crisis window, while 5 were out of the 24-month crisis window, so a false signal. In other words, when there is a crisis signal, the probability of a crisis within 24 months is 69%. Besides, a total of 185 months without crisis signals were observed; 85 of them were recorded in the crisis window. In this context, if there is no crisis signal, there is a 54% likely there will be no crisis within 24 months.

According to the analysis, the correct signal rate is 55%, and the error signal rate is 41%. Since it is less than one (1), the indicator is accepted as successful.

Table 24: Foreign Exchange Deposits Percentage Change Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	11.00 **A**	5.00 **B**	0.69 **A/(A+B)**
No Signal	85.00 **C**	100.00 **D**	0.54 **D/(C+D)**
probability	0.11 **A/(A+C)**	0.05 **B/(B+D)**	0.55 **A+D/(A+B+C+D)**

Employing the threshold value as 1.5 standard deviations, fifteen crisis signals are recorded in 201 months, 10 of them are within the crisis window, and five are recorded as false signals out of the crisis window. If there is a crisis signal, the probability of a crisis is analyzed as 67%. If there is no crisis signal, there is a 53% likelihood a crisis will not occur. As a result of the analysis of the indicator, it is observed that the probability of the correct signal is 55%, and the error signal rate is 45%.

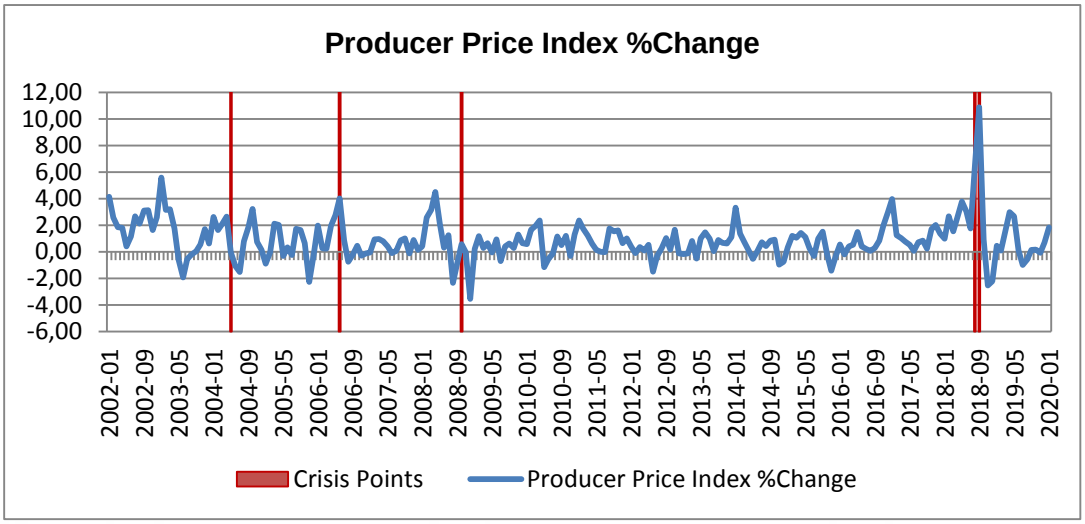
Table 25: Foreign Exchange Deposits Percentage Change Signal Table (1.5 St. Deviation is Threshold Value)

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	10.00 **A**	5.00 **B**	0.67 **A/(A+B)**
No Signal	86.00 **C**	100.00 **D**	0.53 **D/(C+D)**
probability	0.10 **A/(A+C)**	0.05 **B/(B+D)**	0.55 **A+D/(A+B+C+D)**

4.2.11. Producer Price Index Percentage Change

The indicator measures pricing information about the goods and services produced in the economy over a certain period. Since producer prices react to economic activities before consumer prices, it is considered a good leading indicator. The tight connection of producer prices with inflation and exchange rates reinforces the expectation that it may be a good leading indicator for a possible crisis.

Figure 13: Producer Price Index Percentage Change



In the analysis of the indicator with the KLR method, the minimum error signal rate of 12% is determined as the threshold value. It is observed that there is a positive increase tendency in pre-crisis periods. Table 26 shows the results for the producer price index. Accordingly, 24 crisis signals have been recorded in total, and 19 of them occur in a 24-month crisis window, while five were recorded as error signals. Therefore, there is a 79% chance a crisis will occur within 24 months. The second line of the matrix shows no crisis signal for 177 months, and 100 of these months without signal were outside the 24-month crisis window. In other words, in the absence of a crisis signal, there is a 56% likely there will be no crisis within 24 months. The indicator gives a 59% probability of a correct signal rate and the error signal rate of 24%; thus, the indicator is considered successful.

Table 26: Producer Price Index Percentage Change Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	19.00 **A**	5.00 **B**	0.79 **A/(A+B)**
No Signal	77.00 **C**	100.00 **D**	0.56 **D/(C+D)**
probability	0.20 **A/(A+C)**	0.05 **B/(B+D)**	0.59 **A+D/(A+B+C+D)**

Using the standard deviation method, seventeen crisis signals were recorded in 201 months; 12 of them were in the 24 months crisis window, five crisis signals were recorded as false signals. When there is a signal, there is a 71% probability there will be a crisis. In the second line of the matrix, it is seen that there no signal has been recorded for 184 periods, 100 of them outside of the crisis period, so, if there is not a crisis signal, there is a 54% probability there will be no crisis within 24 months. Moreover, since the error signal rate is 38%, the probability of a correct signal rate is 56%. The fact that the error signal rate is less than one in numerical values indicates that the indicator is successful.

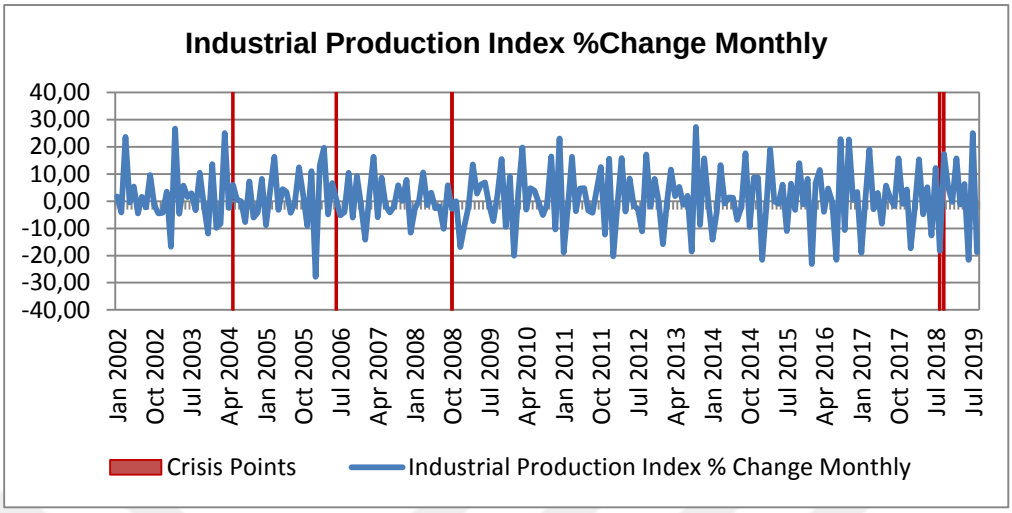
Table 27: Producer Price Index Percentage Change Signal Table (1.5 St. Deviation is Threshold Value)

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	12.00 **A**	5.00 **B**	0.71 **A/(A+B)**
No Signal	84.00 **C**	100.00 **D**	0.54 **D/(C+D)**
probability	0.12 **A/(A+C)**	0.05 **B/(B+D)**	0.56 **A+D/(A+B+C+D)**

4.2.12. Industrial Production Index Percentage Change

Industrial production is a macroeconomic indicator that contains substantial information about national economies due to its direct connection with GDP and employment; it also supports many sectors, including the service sector. Although the importance of the industrial production index as an indicator differs according to the dependency of the economic activities, it is the sole element that forms the core of the national economy for all major economies. It was observed that the indicator has a negative tendency in crises or pre-crisis periods for the Turkish economy. The decline in industrial production leads to a decrease in exports, a decrease in employment, an increase in unemployment and a disruption in the balance of payments in the long run.

Figure 14: Industrial Production Percentage Change



In the analysis made with the KLR method, a 201-month data set is used. The minimum value of 20% of the error signal rate is accepted as the threshold value. The matrix table created as a result of the analysis is shown in Table 28. Accordingly, a total of 40 crisis signals have been received, and 19 of them have been recorded within the 24-month crisis window, and 21 as false signals. In other words, if a crisis signal is received, it is estimated there is a 47% probability a crisis will occur within 24 months. In 161 months, there was no signal; 84 months were out of the crisis window. So, there is a 52% probability there will be no crisis within 24 months in the absence of a crisis signal. Although the indicator has a 51% probability of the correct signal rate, the error signal rate is greater than one as a value of 101%. Thus the indicator has poor performance as a leading indicator according to the KLR method.

Table 28: Industrial Production Percentage Change Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	19.00 **A**	21.00 **B**	0.47 **A/(A+B)**
No Signal	77.00 **C**	84.00 **D**	0.52 **D/(C+D)**
probability	0.20 **A/(A+C)**	0.20 **B/(B+D)**	0.51 **A+D/(A+B+C+D)**

Based on the standard deviation method, it is observed that there are 18 crisis signals in the 201 months of the indicator; 4 of them are in the crisis window, 14 of them are error signals. Accordingly, when there is a crisis signal, there is a 22% probability there will be a crisis within 24 months. In the second line of the matrix, it was observed that there was no crisis signal for 183 months and 91 of them out of the crisis window. If there is no crisis signal, there is a 50% probability there will be no crisis. The indicator has a 47% probability of a correct signal rate, yet as the error signal rate analyzed at 320% is more than one, the indicator is considered as a poorly performing indicator for crisis estimation for the Turkish Economy.

Table 29: Industrial Production Percentage Change Signal Table (1.5 St. Deviation is Threshold Value)

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	4.00 **A**	14.00 **B**	0.22 **A/(A+B)**
No Signal	92.00 **C**	91.00 **D**	0.50 **D/(C+D)**
probability	0.04 **A/(A+C)**	0.13 **B/(B+D)**	0.47 **A+D/(A+B+C+D)**

4.2.13. Domestic Debt Position Percentage Change

Short and long-term borrowings with government securities or similar derivative instruments form the domestic debt position. Real and legal entities realize internal borrowing, and it is carried out by public institutions and organizations, commercial banks, or a central bank. The excess or scarcity of domestic debt stock varies depending on its economic structure, global conjuncture, and country policies. While the increase in domestic debt is sometimes interpreted as positive support for growth, it sometimes negatively affects the economy by causing speculation, such as financing a budget deficit. One way to see this distinction is to evaluate the ratio of domestic debt to gross domestic product. Turkey's domestic debt position has increased continuously since 2002. While the total domestic debt was

around 128 billion TL in January 2002, this figure increased by almost six times by January 2020 and reached 762 billion TL, illustrated in Figure 15.

Figure 15: Domestic Debt Position Level

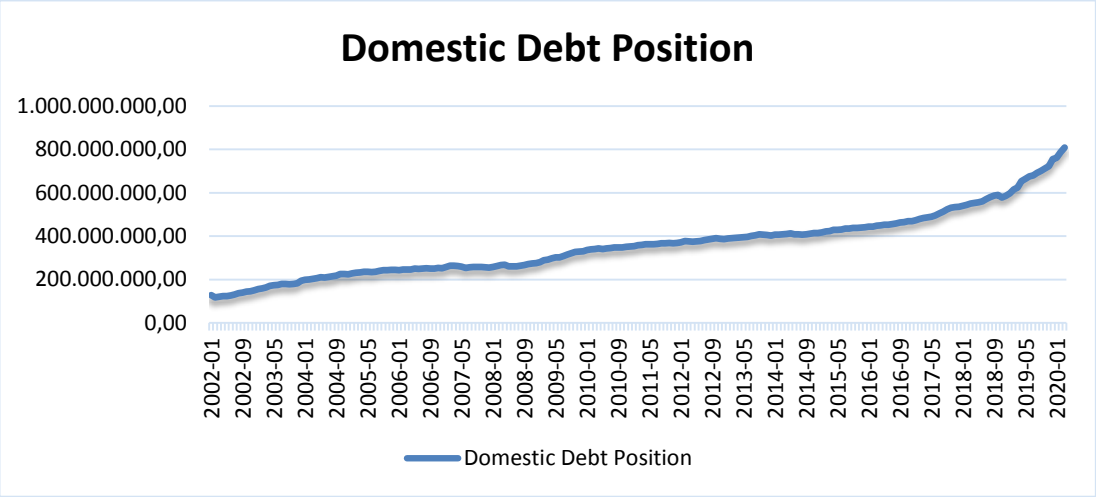
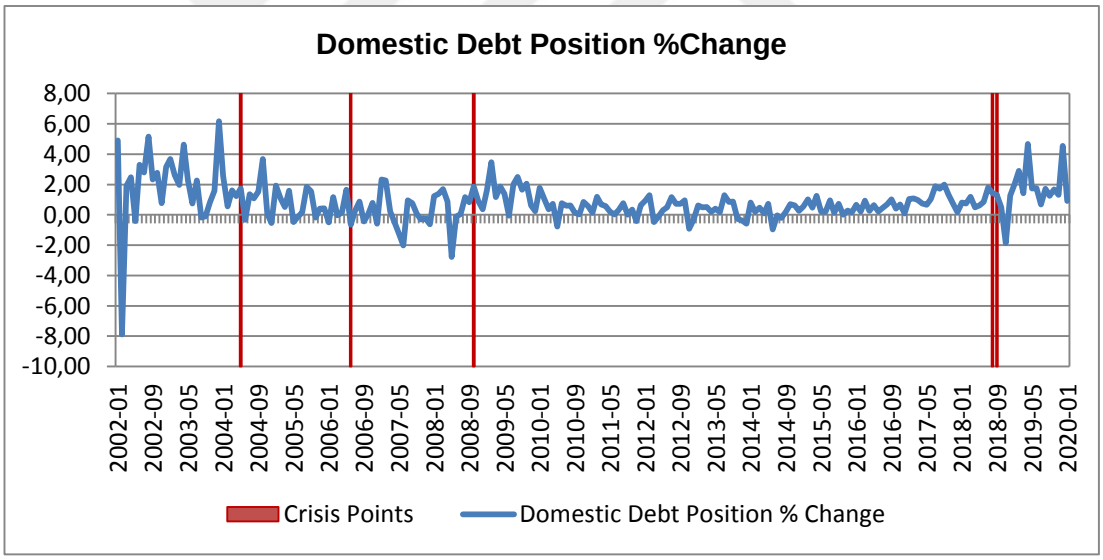


Figure 16: Domestic Debt Position Percentage Change



In this analysis, the domestic debt position's percentage changes are analyzed every month, and sudden shock increases are observed except the trend. Consequently, the contribution of the indicator to the leading signal performance is examined. It has been observed that the indicator has an uptrend during a crisis or pre-crisis period. For the indicator analyzed with the KLR method, the 10% value with the lowest error signal rate is accepted as the threshold value. A 201-month data set is used, a total of 20 crisis signals are recorded, 16 of them occur within the 24-month crisis window, and four are outside the crisis window as an error signal. Therefore,

when there is a crisis signal, there is an 80% probability there will be a crisis within 24 months. No crisis signal was received for 181 months; 101 of these occurred out of the crisis window. Thus, if there is no signal for a crisis, a 56% probability a crisis will not occur within 24 months. While the error signal rate of the indicator is 22%, the probability of a correct signal is 58%. Since the error signal rate is less than, it indicates a successful performance.

Table 30: Domestic Debt Position Percentage Change Signal Table

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	16.00 **A**	4.00 **B**	0.80 **A/(A+B)**
No Signal	80.00 **C**	101.00 **D**	0.56 **D/(C+D)**
probability	0.17 **A/(A+C)**	0.04 **B/(B+D)**	0.58 **A+D/(A+B+C+D)**

According to the standard deviation method, during the 201 months, 11 crisis signals were received and 2 of them were recorded as false signals outside of the 24-month crisis window and 9 of them were recorded as correct signals. In this context, if there is a signal, the probability of a crisis is 82% within 24 months. There is no signal for 190 months, 103 of which occurred outside the crisis window. So, if there is no crisis signal, there is a 54% probability there will be no crisis. As a result of the analysis, it is seen that the probability of a correct signal is 56% and the error signal ratio is 20%. Therefore, the indicator is successful.

Table 31: Domestic Debt Position Percentage Change Signal Table (1.5 St. Deviation is Threshold Value)

	Crisis (within 24 months)	**No Crisis within 24 months**	**Probability**
Signal	9.00 **A**	2.00 **B**	0.82 **A/(A+B)**
No Signal	87.00 **C**	103.00 **D**	0.54 **D/(C+D)**
probability	0.09 **A/(A+C)**	0.02 **B/(B+D)**	0.56 **A+D/(A+B+C+D)**

The summary of the empirical results is reported in Tables 32 and 33. Accordingly, the “CPI-based real effective exchange rate” is defined as the most successful indicator by both methods, giving signals before the 2018 currency crisis based on both methods; the indicator’s error signal ratio (ESR) of the indicator is below (1). Negative divergences in the basket of developing countries for the real effective exchange rate imply the depreciation of the Turkish Lira and implicitly increased Turkish Lira (₺) liabilities in foreign currency. Given that increased liabilities put negative pressure on the private sector and mean price increases and inflation for the energy-dependent Turkish economy for the long term. The indicator is significant for decision-makers.

The second most successful indicator in the KLR method's analysis is "short-term external debts/foreign exchange reserves", giving signals before the 2018 currency crisis where Turkey's geopolitical, economic risks arose. Emerging economies are heavily dependent on capital. The existence of capital in a developing country depends on the risk perception in that country. In times of crisis risk, when risk perception increases in that economy, only the short-term capital flows to the country's economy with higher interest rates. In this context, the success of the indicator supports the theory.

According to the 1.5 standard deviation threshold value, the second-best leading indicator is “Domestic Loan Expansion Change”. The indicator gave the most signals before the 2004 crisis. Some signals were recorded before the 2006 and 2018 crises; however, it does not signal the 2008 crisis, indicating that the indicator might be unresponsive to external dynamics. The domestic loan position, which shows a continuous increase in the Turkish economy's level basis since 2002, would be more accurate to interpret that this expansion depends on growth policies since the Turkish economy is an emerging market. However, analyzing this indicator with the KLR, the indicator signaled before and during all crisis periods. It is the fifth most successful indicator according to the KLR method. Figure 11 illustrates that it gave significant shock signals before the 2006 and 2018 crises.

The third most successful indicator in both analyses is defined as "domestic debt position change". It is observed that the most signal was given before the 2004 crisis in both methods. There has been a stable increase for the indicator since 2002 in terms of level, and upward breaks were observed after the 2008 and 2018 crises. Moreover, there is an increase in the debt position for growth purposes or post-crisis budget improvements, as shown in Figure 15.

The three worst indicators in both analyzes are industrial production change (IPI)., unemployment rate and export/import with an error signal rate above (1) one. The indicators' failure is that they are not a *harbinger* of a crisis but rather a consequence of a crisis.

Overall, the KLR signal approach and its variation, the 1.5 standard deviation threshold method, produce very similar results. However, empirical results should cautiously be taken: While the KLR method can be applied to the cyclical economy where facts change through time, the 1.5 standard deviation method is more mechanical and uniform since it uses the same threshold value. With the KLR method, it is possible to anticipate much earlier and apply precautions before the crisis with a higher leading signal frequency and stimulation, based on the percentile method's threshold value. The same does not apply for the 1.5 st deviation method because the crisis signal frequency is shallow. This situation may cause the crisis signals to be perceived as usual, and it may cause the loss of sufficient time to take action in advance.

Table 32: Summary of the Performances of Indicators by KLR Method (%)

Variable Name	Probability of signaling in the event of a crisis	Probability of signaling in the absence of a crisis	Error signal rate	Probability of crisis when there is a signal	Probability of not having a crisis when there is no signal	Probability of crisis when there is a signal-probability of crisis	Probability of correct signal	Threshold Value
Probability Formulation	A/(A+C)	B/(B+D)	[B/(B+D)] /[A/(A+C)]	A/(A+B)	D/(C+D)	[A/(A+B)]-[(A+D)/(A+B+C+D)]	(A+D)/(A+B+C+D)	Defined by percentile method
CPI Based Real Effective Exchange Rate (Developing Countries)	19.79	2.86	**14.44**	86.36	56.98	38.60	60.20	11
short term external debt stock/ foreign exchange reserve	21.54	4.00	**18.57**	77.78	65.31	38.38	66.67	11
domestic debt stock percentage change	16.67	3.81	**22.86**	80.00	55.80	32.24	58.21	10
(PPI)Producer Price Index Percentage change	19.79	4.76	**24.06**	79.17	56.50	31.41	59.20	12
Domestic Loan Stock Percentage Change	18.75	5.71	**30.48**	75.00	55.93	27.24	58.21	12

Variable Name	Probability of signaling in the event of a crisis	Probability of signaling in the absence of a crisis	Error signal rate	Probability of crisis when there is a signal	Probability of not having a crisis when there is no signal	Probability of crisis when there is a signal-probability of crisis	Probability of correct signal	Threshold Value
Foreign Exchange Deposit Account Rate Percentage Change	11.46	4.76	**41.56**	68.75	54.05	20.99	55.22	8
M2/Net Reserve	17.71	8.57	**48.40**	65.38	54.86	17.62	56.22	13
BIST100 percentage change	10.42	5.71	**54.86**	62.50	53.51	14.74	54.23	8
Republican Gold Price Percentage change	12.50	9.52	**76.19**	54.55	53.07	6.78	53.23	11
Current Account/Foreign Exchange Reserve	18.75	17.14	**91.43**	50.00	52.73	2.24	52.24	18
(IPI)Industrial Production Index percentage change	19.79	20.00	**101.05**	47.50	52.17	-0.26	51.24	20
Unemployment Rate	12.31	20.00	**162.50**	28.57	58.39	-10.82	53.33	17
Export/Import	13.54	25.71	**189.89**	32.50	48.45	-15.26	45.27	20

Table 33: Summary of the Performances of Indicators by 1.5 Standard Deviation (%)

Variable Name	Probability of signaling in the event of a crisis	Probability of signaling in the absence of a crisis	Error signal rate	Probability of crisis when there is a signal	Probability of not having a crisis when there is no signal	Probability of crisis when there is a signal-probability of crisis	Probability of correct signal	Threshold Value
Probability Formulation	A/(A+C)	B/(B+D)	[B/(B+D)] /[A/(A+C)]	A/(A+B)	D/(C+D)	[A/(A+B)]-[(A+D)/(A+B+C+D)]	(A+D)/(A+B+C+D)	1.5 Std. Deviation
CPI Based Real Effective Exchange Rate (Developing Countries)	3.13	0.00	0.00	100.00	53.03	52.24	53.73	1.5 Std. Deviation
Domestic Loan Stock Percentage Change	9.38	0.95	10.16	90.00	54.45	42.24	56.22	1.5 Std. Deviation
domestic debt stock percentage change	9.38	1.90	20.32	81.82	54.21	34.06	55.72	1.5 Std. Deviation
(PPI)Producer Price Index Percentage change	12.50	4.76	38.10	70.59	54.35	22.83	55.72	1.5 Std. Deviation
short term external debt stock/ foreign exchange reserve	4.62	2.00	43.33	60.00	61.25	20.61	61.21	1.5 Std. Deviation
Foreign Exchange Deposit Account Rate Percentage Change	10.42	4.76	45.71	66.67	53.76	18.91	54.73	1.5 Std. Deviation

Variable Name	Probability of signaling in the event of a crisis	Probability of signaling in the absence of a crisis	Error signal rate	Probability of crisis when there is a signal	Probability of not having a crisis when there is no signal	Probability of crisis when there is a signal-probability of crisis	Probability of correct signal	Threshold Value
BIST100 percentage change	6.25	3.81	60.95	60.00	52.88	12.24	53.23	1.5 Std. Deviation
M2/Net Reserve	19.79	15.24	76.99	54.29	53.61	6.52	53.73	1.5 Std. Deviation
Republican Gold Price Percentage change	7.29	6.67	91.43	50.00	52.41	2.24	52.24	1.5 Std. Deviation
Current Account/Foreign Exchange Reserve	4.17	5.71	137.14	40.00	51.83	-7.76	51.24	1.5 Std. Deviation
Unemployment Rate	3.08	9.00	292.50	18.18	59.09	-21.21	56.36	1.5 Std. Deviation
(IPI)Industrial Production Index percentage change	4.17	13.33	320.00	22.22	49.73	-25.54	47.26	1.5 Std. Deviation
Export/Import	0.00	2.86	-	0.00	51.52	-47.76	50.75	1.5 Std. Deviation

CONCLUSION

In the period up to the 19th century, crises generally occurred due to speculations, wars, or political issues, and their effects remained in the country or in that region. Afterward, with the improvement of financial instruments and the interaction of countries with each other, the destructiveness of the crises increased, and the area of influence expanded. Globalization in the second half of the 20th century, the acceleration of capital movements with advancing technology, especially the proliferation of financial derivative instruments, make crises much more destructive and globally felt.

The history of economic crises dates back centuries. Hundreds of crisis scenarios had been experienced by thousands of different economic actors. Nevertheless, in fact, the explanation is straightforward: the reason for the crises is the deterioration of economic balance. This deterioration is sometimes a bubble created by the ambition to earn more, sometimes war or natural disasters, and sometimes the atmosphere of panic created by the disappearance of the concept of “trust”, a derivative of the mother of the justice mechanism all virtues. Whatever the reason, a crisis reduces the efficiency of the system with devastating socio-economic consequences and costly results such as time, labor, production, and money losses. In this context, the importance of anticipating crises is increasing day by day.

In the study, 13 different indicators were evaluated using the KLR signal approach, developed by Kaminsky, Reinhart, and Lizondo (1997), to determine the indicators that have the highest prediction performance for the Turkish economy ahead of a crisis. At the same time, the performance of the KLR signal approach was compared with another method developed by Kaya, Gülhan, and Güngör (2013) as a derivative of the KLR signal approach. In both methods, four crisis periods were identified using the Financial Pressure Index (FPI) formed by Eichengreen et al. (1996).

An analysis was carried out with a KLR signal approach using data across 201 months between 2002-2018. The findings show the most accurate signal performance indicators within the specified period are as follows: the CPI-based real effective exchange rate (developing countries), short term external debt stock/foreign exchange reserves, domestic debt stock percentage change, producer price index percentage change, domestic loan stock percentage change, foreign exchange deposit account rate percentage change, M2/net reserves, Bist100 percentage

change, Republican Gold price percentage change, and current account /foreign exchange reserves. In addition to these, three indicators were found not to deliver significant performance. These are industrial production index percentage change (IPI), unemployment rate, and export/import. Nevertheless, it would be wrong to deduce that these indicators are not affected by the crisis period. Abnormal reactions were observed in these indicators during periods of crisis, but not the pre-crisis periods.

It was observed that the indicator with the most accurate signal ratio is the CPI-based real effective exchange rate (developing countries). For this indicator, relatively more signals recorded before the 2018 crisis, and the index value showed a downward trend before all four crises. This trend was felt continuously after the 2008 crisis. It is seen that the second most successful indicator is short term external debt /foreign exchange reserves. It is observed that the indicator, whose reliable data available as of 2005, gives more correct signals before the 2018 crisis. The reason why the two leading indicators gave serious warning signals before the 2018 crisis is thought to be due to the political difficulties and unsustainable growth policies after the 2008 crisis, which exposed the Turkish Economy to manipulations. Besides, there has been a continuous depreciation in the Turkish Lira since the 2008 crisis. The third most successful indicator is observed as domestic debt position. This indicator, which shows a continuous and steady increase in the Turkish economy since 2002, gives good prediction signals before the 2004 crisis. However, although it is not considered a predictor signal due to the abnormal increases after the 2008 and 2018 crises, values above the threshold were observed.

The best estimators are the ones that signaled in all pre-crisis periods having an error signal ratio remaining below the value of one (1), which is an acceptable level. These are producer price index percentage change, foreign exchange deposit account rate percentage change, Republican Gold price percentage change, and current account/foreign exchange reserves. Signaling in all pre-crisis periods supports the idea that these indicators may be leading indicators for a crisis in the Turkish economy that may occur in the future.

The analysis shows that financial indicators perform more successfully as an early warning signal than real sector indicators, given their low error signal ratio. This situation supports the idea that crises have a consequence in the real sector, so real sector indicators are too late to deliver a warning.

The second analysis was performed by accepting 1.5 standard deviations as a threshold value for all indicators in the 201 months between 2002-2018, and the early signal performance of the indicators was measured. As a result, the most accurate signal performance indicators within the specified period are CPI based real effective exchange rate (developing countries), domestic loan position percentage change, domestic debt stock percentage change, (PPI) producer price Index percentage change, the short-term external debt stock/foreign exchange reserve, foreign exchange deposit account rate percentage change, BIST100 percentage change, M2/net reserves, and Republican Gold price percentage change. In addition to these, four indicators were evaluated as insignificant because of their high error signal rate. These are current account/foreign exchange reserves, unemployment rate, (IPI) Industrial Production index percentage change, and export/import.

In the second analysis, only producer price index percentage change (PPI) and foreign exchange deposit account rate percentage change indicators were observed as the best predictors by signaling in all pre-crisis periods. Another significant point is that real sector indicators gave insignificant results in this analysis as well, except for (PPI) Producer Price Index Percentage change indicator. The reason is considered to be that the crises precede damage in the real sector.

The most successful signal performance indicator in both analysis methods is the CPI-based real effective exchange rate (developing countries). Remarkably, it was observed that it signaled only in the periods before the 2018 crisis in both analyses.

The KLR signal approach can determine the threshold value that the indicator will give the maximum successful signal potential according to the importance (identity) of the indicator in the researched economy. However, the 1.5 standard deviation method is much more mechanical, and being equal for each indicator may cause significant signals before the crisis to be ignored. This situation gives much more radical statistical results with decreasing signal numbers.

The periods used as a data set in this study are similar to those used in previous studies, such as those by Yıldız (2019) or Alpdogan (2018), and comparable outcomes were noted in identifying crises. In this thesis, however, August and September 2018 were also identified as a crisis period.

The 2018 crisis period, which has just started to take its place in the literature, has been identified as a severe crisis in this research. It was observed that many financial indicators signaled only in this period. The CPI-based real effective

exchange rate (developing countries) indicator signaled that the Turkish economy negatively differentiated from those economies. The second most successful indicator is the short-term external debt stock/foreign exchange reserve, which gave serious signals for 2018. The seventh most successful signal indicator, the M2/Net reserve, gave an intense signal rate for the 2018 crisis period, proving that decreasing reserves and increasing foreign indebtedness cause fragility in economies.

In times of crisis, estimators should not be expected to be valid in all crises with a single model. Criteria such as the development of countries, economic trend, openness, socio-economic and socio-cultural structures may change over time. Accordingly, the leading indicators of the country under investigation may change. In this context, a defined timeframe should cover the characteristics of the period. However, problems or trends that have become chronic in economies may be exceptions.

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