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RESEARCH PAPER

Turkish Economy Currency Crisis and Depression: Different Start, Different Result

Turgut Yokuş[*,a], **Ahmet Ay**[a]

a. Department of Economics, Faculty of Economic and Administrative Sciences, University of Selçuk, Konya, Turkey.
* Corresponding author

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Abstract

It is generally accepted in the literature that the currency crisis has negative macroeconomic consequences, such as bankruptcies, unemployment, and recession in economies. The economic consequences of different currency crisis severity will also be different. To reveal these differences, in our study, the severe currency crisis that puts the economies into recession is defined as the "Currency Depression". It is extremely important that cases of currency crisis/depression can be predicted before they arise, and allow the economic authorities enough time to implement recovery policies to prevent or at least soften the negative effects of the case. In reference to this importance, Cases of currency crisis/depression occurring in the Turkish economy during 1992:1-2020:12 were created by the early warning system signal approach and analyzed in comparison with the 20 set of indicators. The analysis concluded that these two cases had different initial conditions based on the indicators and their efficacy. The macroeconomic consequences of the currency crisis and currency depression are comparable; four-quarter observation period averages respectively, growth, (1.7%, -3.52%) unemployment (employment/employable population: down 2.1 and 2.85 points), inflation (7.37%, 13.38%), interest (43.89%, 63.04%) and real public domestic debt stock change, (11.54%, 20.7%). Thus, the judgment was reached that these two cases had different initial conditions and different outcomes.

Keywords: Currency Crises, Early Warning System, Signal Approach.
JEL Classification: E44, E60, F31, F37,G21.

1. Introduction

The collapse of socialist market economies in the 1990s and their transition to free market economies accelerated both international trade and, accordingly, financial globalization. The increase in the intensity and speed of the international flows of

capital has made the conversion rate of currencies to each other extremely critical. Depending on this new economic period, the European Monetary System (EMS) 1992, Mexico 1994-1995, Asia 1997, Russia 1998, Turkey 2001, and Argentina 2002 crises resulted in major collapses in the currencies of countries (Glick and Hutchison, 2013; Li, 2017). As a result of processes such as the transition of the Eastern bloc countries from the socialist market economy to the free market economy and the transition of the EU countries to the Euro in 2002, a relatively quiet period was experienced in the world economy. The end of this calm period was a crisis known as the "2008 Global Financial Crisis" (GFC), which was unlike any crisis in the world before. This crisis, which started in the USA and spread all over the world, collapsed the financial systems of the economies and also caused major collapses in the currencies of the economies (Rose and Spiegel, 2012).

Economic crisis can be defined as the process of exceeding the price or amount of goods, services, production factors, or currencies in the supply and demand cycle in the market at a greater rate than an acceptable change (Kibritçioğlu, 2001). Crises occurring in the economy are classified into two main parts: real sector crises and financial crises. Currency crisis is called money/exchange/currency crisis, which is in the financial crisis category, and some authors distinguish it as a sudden stop/balance of payments crisis (Claessens and Köse, 2013; Reinhart and Rogoff, 2009). However, both arise as a result of the supply and demand imbalance of the foreign exchange (FX) market.

Although different names and definitions have been made for currency crises in the literature, crisis models have been developed and tried to explain them. The first-generation currency crisis models, which are accepted as the beginning of these models, emerged as a collision of the authority's efforts to create money, despite the current account deficit (CAD) in the fixed exchange rate system. In the second-generation models, the EMS crisis in 1992-1993 was tried to be explained with the first-generation crisis model, but it was seen that the first-generation models were insufficient to explain this crisis. Therefore, speculative attacks and self-fulfilling processes have been added to the first-generation models, deepening the crises by entering the cyclical process. In the following periods, the Asian 1997 Crisis emerged due to moral hazard despite the good economic foundations in the economies. Thus, the existence of different economic starting conditions from the second-generation crises revealed the necessity of constructing third generation models (Krugman, 2014). When the GFC emerged in 2008, it was seen that there was a crisis different from all these crisis models, and it could not be fully explained by any of the previous crisis models. As a result of this inadequacy,

"Fourth Generation Currency Crises" have started to be encountered in the literature, albeit a little. The purpose of crisis generation models is to develop an Early Warning System (EWS) that will predict the crisis with indicator changes in the pre-crisis period.

The purpose of the EWS is to provide a warning before the crisis occurs and to give economic officials sufficient time to implement bailout policies to prevent or at least soften the negative effects of the crisis. However, the emergence of each crisis with new facts has revealed the necessity of updating the EWS for each crisis. The methods used in EWS construction are classified into two groups as traditional models and other models. Conventional models are the signal approach model (Kaminsky et al., 1997; Kaminsky and Reinhart, 1999) and dependent variable probit/logit models (Eichengreen et al., 1996; Frankel and Rose, 1996). Other models are Markov switching models (Cerra and Saxena, 2002; Martinez, 2002; Abiad, 2003), artificial neural networks (ANN), and machine learning-based analyzes such as genetic algorithms (Nag and Mitra, 1999; Apoteker and Barthelemy, 2000) and binary recursive tree (Ghosh and Ghosh, 2003; Frankel and Wei, 2004).

The reason for the effort to predict a currency crisis with so many different methods and models is that currency crises have negative macroeconomic consequences, such as bankruptcies, unemployment, and growth declines. Nakatani (2019) statistically analyzed the effects of the currency crisis on the growth of 49 countries in the emerging market and developing country group of the 1980-2011 period. According to the analysis, it was concluded that the currency crises caused an average of 4% to 8% loss in the growth of countries. In another study, it was found that currency crises triggered financial and real sector crises and had a significant negative effect on macroeconomic variables such as consumption, investment, and production (Claessens and Köse, 2013).

For this reason, in our study, the severe currency crisis dragging the real economy into a technical recession is defined as the "Currency Depression". The purpose of this definition is to identify the conditions that give rise to different severe currency crises and to analyze the macroeconomic consequences of these crises. In some studies, it has been determined that these two different currency crises have different effects on growth by defining a currency crisis and a severe currency crisis (Claessens and Köse, 2013; Nakatani, 2019). However, the economic conditions that led to different severe currency crises were not analyzed. In our study, the economic conditions that led to the currency crisis and currency depression, and their economic consequences, were analyzed comparatively.

In the study, firstly, the currency crisis and currency depression were defined, and the cases in the analysis period were determined. In addition, in this section, indicators specific to the Turkish economy that can be used in the signal approach are grouped and determined. Secondly, the signal approach was applied for the currency crisis and the currency depression EWS model, and the effectiveness of the indicators for predicting the cases was analyzed. In addition, this section covered the comparisons of the macroeconomic results of these two cases. The last section presented the differences in the initial conditions and economic consequences of the currency crisis and currency depression cases in the Turkish economy.

2. Signal Approach

Eichengreen et al. (1996) and Frankel and Rose (1996) examined the graphical changes of indicators in tranquil periods (crisis windows) to predict currency crises. The signal approach makes a graphical comparison of the performance of indicators during crisis periods with their performance during tranquil periods. Kaminsky et al. (1997) named this methodology the signal approach and brought it to the literature. This approach consists of three stages. In the first stage, exceeding 3 standard deviations (SD) from the Exchange Market Pressure Index (EMPI) average, which is formed with nominal exchange rates (NCR) and international reserves (R), is defined as a currency crisis, and the crises that occurred in the examined period are determined. In the second stage, indicators that are expected to play a role in the crisis, such as inflation, external debt, and current account deficit, are determined, and the changes in the graphics of the determined indicators are visually examined. Then, it is determined whether the indicators showed extraordinary behavior before the crisis. In the third stage, a threshold value is determined for each indicator by minimizing the probability of not signaling in a crisis (type I error) and the probability of signaling against a non-existent crisis (type II error). If the indicator exceeds a predetermined threshold, then it receives the value “1” as a crisis signal; otherwise, the value “0” is assigned. Depending on the threshold value of each indicator, a spreadsheet as in Table 1 is obtained.

A: represents the number of observations (signals) in which the model indicates a crisis actually occurring; B: corresponds to the number of observations for which the model indicates an unrealized crisis; C: the number of observations where the model does not indicate a crisis actually occurring; and D: the number of observations where the model did not indicate an unrealized crisis.

Table 1. Indicator Signal Performance Matrix

	Crisis (within 24 months)	**No crisis (within 24 months)**
Signal was issued	A	B (Type I Errors)
No signal was issued.	C (Type II Errors)	D

Source: Kaminsky et al. (1997).

Although the signaling window, in which the signals are monitored, varies according to the structure of the indicators, the 24, 18, and 12-month periods before the crisis are used. The threshold value that will take the value of "1" or "0" in the signaling window period allows the indicators to signal in a way that covers the number range of 10%-25% (out of 75%-90%) of the data. While determining the number of signals for each of these indicators, it is aimed to minimize the noise-to-signal ratios (NSR) given in equation (1) (Reinhart et al., 2000; Kaminsky et al., 1997).

$$NSR = \frac{B}{(B+D)} \Big/ \frac{A}{(A+C)} \quad (1)$$

The smaller the NSR, the better the indicator signals for the right crisis. If the NSR is greater than or equal to "1", the crisis signal effectiveness of the indicator is not available. According to the NSR, false signals and signals that are not given during the crisis are handled with equal weights. The main advantage of the signal approach is that the method does not impose any parametric structure on the data, and the method provides more accessible and informative data than coefficient estimation tables (Frankel and Rose, 1996).

3. Literature Review

The method proposed by Kaminsky et al. (1997) and named as "KLR" in the literature has been applied to many countries. In the implementations of the KLR approach, changes such as the structure of the EMPI equation, the crisis threshold value, the analysis period, the indicators used, the signaling window, the optimum signal numbers of the indicators, the applied country/countries, and finally the indicators that are effective as a result of the analysis reveal the differences of the studies. In the literature reviewed, except for Heun and Schlink (2004), the EWS model for currency crisis has been proposed by applying the signal approach for Turkey or country groups including Turkey. Effective indicators and identified crisis periods are given in Table 2.

Table 2. Literature Review

NSR≤0.5 Indicators	Reference
Exports	Kaminsk et al. (1997,1998); Berg and Pattillo (1999); Brüggemann and Linne (2002); Heun and Schlink (2004); Kesbic et al. (2016)
Import, Import/GDP	Sevim (2012), Kesbic et al. (2016)
Current Account (CA)/Reserve (R), CA Foreign Trade Balance/GDP	Kaya (2006); Sevim (2012); Avcı and Altay (2013); Cicioğlu and Yıldız (2018);
Export/Import	Sevim (2012)
Terms of Trade	Sevim (2012); Avcı and Altay (2013)
Real Exchange Rate (RER)	Kaminsk et al. (1997; 1998); Edison (2003); Berg and Pattillo (1999); Brüggemann and Linne (2002); Heun and Schlink (2004); Kaya (2006); Avcı and Altay (2013); Kesbic et al. (2016)
GDP, TIPI, Output	Kaminsk et al. (1998); Altıntaş and Öz (2007); Avcı and Altay (2013); Kesbic et al. (2016); Cicioğlu and Yıldız (2018)
Stock Price	Kaminsk et al. (1997; 1998); Öz and Taban (2007); Sevim (2012); Avcı and Altay (2013)
M2/R, M2	Kaminsk et al. (1997; 1998); Edison (2003); Berg and Pattillo (1999); Heun and Schlink (2004); Sevim (2012),
Real Interest Differences, World Interest Rate, Lending/Deposit Rate	Kaminsk et al. (1998); Brüggemann and Linne (2002); Sevim (2012); Avcı and Altay (2013)
Foreign Currency Deposits (FCD)/M2, (M2+FCD)/GDP	Kaya (2006); Sevim (2012)
Foreign Debt, Short-Term External Debt (STED)/R	Kaminsk et al. (1998); Edison (2003); Kaya (2006); Sevim (2012)
Capital Outflow	Altıntaş and Öz (2007)
Real Domestic Debt	Sevim (2012)
Budget Deficit/GDP	Brüggemann and Linne (2002); Kaya (2006); Sevim (2012); Cicioğlu and Yıldız (2018)
Currency Crises in the Turkish Economy After 1992:01	
1994	Kaminsk et al. (1997; 1998); Edison (2003); Berg and Pattillo (1999); Kaya (2006); Altıntaş and Öz (2007); Sevim (2012); Avcı and Altay (2013)
1997	Edison (2003)
2001	Brüggemann and Linne (2002); Kaya (2006); Öz and Taban (2007); Altıntaş and Öz (2007); Sevim (2012); Avcı and Altay (2013); Cicioğlu and Yıldız (2018)
2006	Kesbic et al. (2016); Cicioğlu and Yıldız (2018)
2008	Cicioğlu and Yıldız (2018)
2011 and 2013	Kesbic et al. (2016)

The EMPI equation is established with the NCR and R variables, and the index is 3 SD from the mean (Kaminsky et al., 1997; 1998; Berg and Pattillo, 1999; Heun and Schlink, 2004). Edison (2003), using the same variables over the index

mean of 2.5 SD defines a currency crisis. The same studies took the 24-month period as the signaling window. In signal approach studies applied only to the Turkish economy, the interest parameter was added to the EMPI equation of the KLR, and 1.5 SD from the index mean (Kaya, 2006; Avcı and Altay, 2013; Kesbic et al., 2016; Cicioğlu and Yıldız, 2018), Öz and Taban (2007) and Altıntaş and Öz (2007) 1.43 SD, and Sevim (2012) 3 SD overshoot defined as a currency crisis. The signaling window was used as 12 months in the study of Sevim (2012) and 24 months in other studies. A different definition of currency crisis is in the study of Brüggemann and Linne (2002) that applies a signal approach for Central and Eastern European countries, including Turkey. Currency crisis is defined as a minimum 20% decrease of the local currency against USD in a 10-day foreign exchange trading day, and the signal observation period is taken as 18 months. In the studies examined, the threshold value that minimizes the NSR of the data in the range of 5%-35% (such as 10%-20%, 10%-25%) of the optimal signal number of the data period was taken.

When the effective indicators are examined in Table 2, for the currency crisis in the Turkish economy; Effective signals are received from indicators such as the real exchange rate (RER) deviating from its trend, the increase in the current account deficit, the public's budget deficits, the inconsistent money supply and interest policies, the increase in foreign exchange orientation, growth losses and decreases in stock price. In other words, it has been seen that the effective Turkish currency crisis indicators determined in the literature are compatible with the first- and second-generation crisis models.

In Table 2, it is seen that there are 7 different crisis periods, and the 1994 and 2001 crises were identified in all studies covered by the analysis period. However, due to the differences in the definition of EMPI and the data analysis period, an important crisis such as the 2008 GFC could not be detected in some studies. Our signal approach study has contributed to the existing literature as it includes innovations such as the definition of currency crisis specific to the Turkish economy, the optimization method of the signal threshold value, the width of the analysis period, the scope and property of the indicators. The most important of these contributions is that which is not encountered in the current literature; It is a comparative analysis of the initial conditions and macroeconomic consequences of currency crisis and currency depression cases.

3. Methods and Materials

In the first stage of the signal approach; currency cases (currency crisis and currency depressions) were determined by using EMPI and quarterly growth figures for the 1992-2020 monthly period for the Turkish economy. In the second step; The economic indicator set, which is likely to signal by showing abnormal changes in the period before the currency cases, has been determined. In the third stage, for the signal tracking of this indicator set, it includes the procedures for how long an observation period will be followed before the case and which rate of change should be taken as a crisis signal for the indicators. In the fourth step, the effectiveness of the indicator set against currency cases is analyzed and analyzes are made regarding the cases prediction effectiveness of the indicator set. In the last stage, the Weighted Composite Index (I) was prepared for both the currency crisis and the currency depressions with the indicator set that was evaluated as effective. The estimation efficiency of this index on Turkey's currency cases has been examined.

4.1 Turkish Economy 1992 January-2020 December Currency Cases

Yokus and Ay (2020) proposed Turkey-specific EMPI by forming it in Equation (2). The equation consists of the nominal exchange rate (e), the change in the reserve (R*) to which the Net Error Omission (NHN) item is added and the Turkey-USA interest difference $(i - i^f)$ parameters. In this context, the EMPI value and case threshold values during the analysis period are given in Figure 1.

$$\mathrm{EMPI} = \frac{\Delta\%\mathrm{e}}{\sigma_{\mathrm{e}}} - \frac{\Delta\%\mathrm{R}^*}{\sigma_{\mathrm{R}^*}} + \frac{\Delta\%\left(\mathrm{i} - \mathrm{i}^{\mathrm{f}}\right)}{\sigma_{(\mathrm{i}-\mathrm{i}^{\mathrm{f}})}} \tag{2}$$

$$\mathrm{Y_t} = \begin{cases} 1, \mathrm{EMPI_t} > \mu_{\mathrm{EMPI}} + 1.5\sigma_{\mathrm{EMPI}} \\ 0, \mathrm{EMPI_t} \leq \mu_{\mathrm{EMPI}} + 1.5\sigma_{\mathrm{EMPI}} \end{cases} \tag{3}$$

For the 348-month data period, 21 cases of currency crisis were identified that exceeded 1.5 SD (3.55) of the EMPI average according to Equation (2,3). EMPI had the highest value of 15.85 in April 1994, and the lowest value of the analysis period with -5.46 in January 2001. The fluctuation of EMPI in this wide range shows the necessity of a new definition for the difference in the severity of the crisis, which is not included in the definitions of currency crisis.

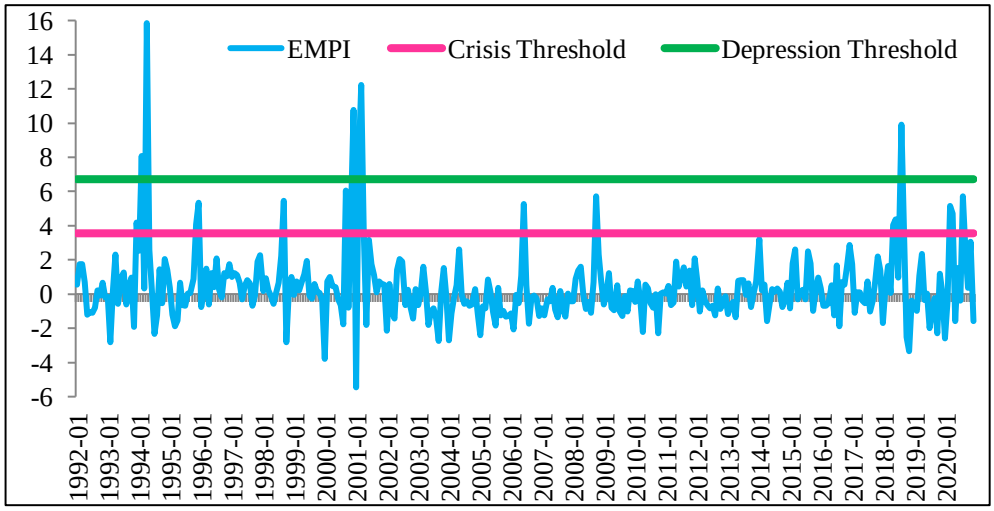

Figure 1. Turkish Economy 1992 January-2020 December Currency Cases
Source: Research finding.

Mazure and Mielcová (2013) state that different definitions of recession are used, but as a technical definition, it is more specific and effective to define GDP as two consecutive negative growth periods from quarter to quarter. Breuer and McDermott (2013) define the Economic Depression as the entry of the economy into a long-term and severe recession period. One of the technical definitions is a 20% decrease in per capita GDP cumulatively, and this decrease period lasts for at least 4 years. As a result of all these definitions and justifications, a new term, "Currency Depression", has been proposed in the literature. The technical recession in the economies by the severe currency crisis affecting the real sector is defined as the "Currency Depression". Technically, it is when the EMPI is exceeded by more than 3 SDs from the mean and the economy enters a technical recession within the quarter or within the first 2 quarters following that period.

$$Y_t = \begin{cases} 1, & EMPI_t > \mu_{EMPI} + 3\sigma_{EMPI} \wedge technical\ recession, \\ 0, & all\ other\ cases \end{cases} \quad (4)$$

There is a currency depression "1", in other cases, that is, the months when there is no currency depression are classified in the "0" category. The currency depression is expressed mathematically by Equation (2,4), and the EMPI values and the depression threshold are given in Figure 1. The periods of currency crisis and currency depressionare given in Table 3.

The crisis months that take place within six months, starting from the first month of the crisis, are defined as the crisis of the same period (Eichengreen et al., 1996). For this reason, in the study, the cases of currency crisis in 8 periods and currency depression in 3 periods were taken.

Table 3.Turkey 1992 January-2020 December Currency Crisis and Depression

Date	EMPI	Case	Quarterly GDP Change (%)
1993-12	4.17	Crisis	93Q4 (8.4), 94Q1 (5.2)
1994-02	8.08	Depression	94Q2 (-10.7), 94Q3 (-7.8),
1994-04	15.85	Depression	94Q4 (-5.5)
1995-11	4.06	Crisis	95Q3 (9), 95Q4 (6.6)
1995-12	5.36	Crisis	
1998-09	5.45	Crisis	98Q3 (2.7), 98Q4 (0.6)
2000-09	6.05	Crisis	2000Q3 (8.1)
2000-11	4.79	Crisis	2000Q4 (7), 2001Q1 (2.4)
2000-12	10.78	Depression	2001Q2 (-7.2), 2001Q3 (-7.3), 2001Q4 (-10)
2001-02	7.85	Depression	
2001-03	12.24	Depression	
2001-04	3.56	Crisis	
2006-06	5.27	Crisis	2006Q2 (9.2), 2006Q3 (6.9)
2008-10	5.71	Crisis	2008Q3 (0)
2018-05	4.03	Crisis	2018Q2 (5.5)
2018-06	4.35	Crisis	2018Q3(2.3)
2018-08	9.92	Depression	2018Q4 (-2.6),2019Q1 (-2.4)
2018-09	3.70	Crisis	
2020-03	5.15	Crisis	2021Q1 (%4.6)
2020-04	4.69	Crisis	2021Q2 (%-8.7)
2020-08	5.71	Crisis	2021Q3 (%5.4), 2021Q4 (%5)

Source: Research finding and https://evds2.tcmb.gov.tr/.

4.2 Turkish Economy Currency Crisis Determinants

Crises arise when one or more economic imbalances in the economic process turn into a speculative attack, a self-fulfilling process formed by contagion and herd psychology. Economic imbalances occur as a result of factors such as a wrong monetary-fiscal policy, a wrong financial application and regulations, asset price bubbles. In addition, human beings tend to use every aspect that they see for their own benefit, which will create an imbalance in the economy. In other words, moral hazard phenomenon is the biggest problem of the economy today and in the future as it was yesterday. As a result of the combination of the level of economic imbalances and the size of the speculative attack, a currency crisis occurs. Economists have tried to explain the formation processes of currency crises with crisis generation models. However, for each new unexplained crisis, additions and updates to the indicator sets have created new generation crisis models. These additions and updates are aimed at observing the economic imbalances that may occur with different phenomena and determining the potential of speculative attack. In the study, while choosing an indicator set that will determine the

existence and degree of an unbalanced structure in the FX market, it has also been tried to select indicators that can determine the effect size of the speculative attack. The illustration regarding the grouping and selection of indicators is given in Figure 2.

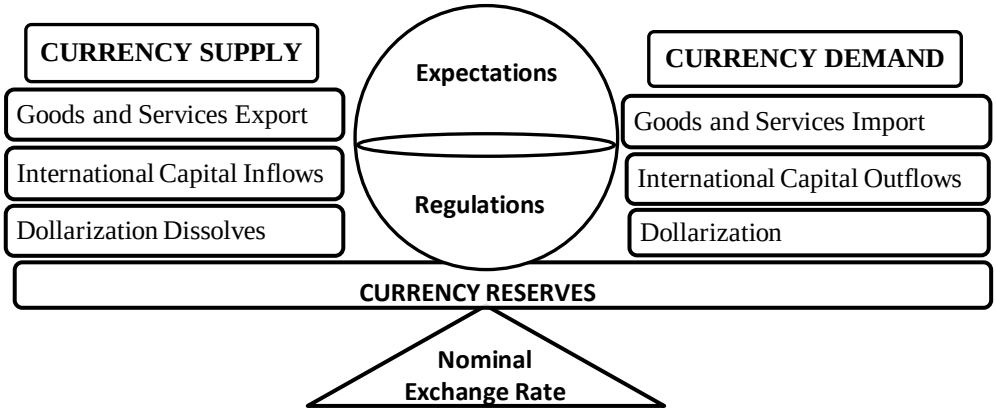

Figure 2. FX Market Supply and Demand Factors
Source: Research finding.

Foreign exchange market indicators direct the expectations of exchange rate market actors, and these expectations affect these indicators, resulting in a cyclical interaction process. In this context, 20 indicators are given in Table 4 by classifying the currency crisis indicators in three groups as Goods and Services Trade (GST), International Capital Flows (IFC) and Dollarization.

4.3 The Optimum Number of Signals

Within the scope of the study, a total of 20 leading indicators were selected, 8 in the GST group, 7 in the ICF group and 5 in the dollarization group. The ideal indicator is expected to receive the maximum number of signals during the 12-month signalling window when there is a crisis, while it is expected to give the least number of signals when there is no crisis. The optimum number of signals (OSN) was calculated based on a signal number (80-30) that minimizes the NSR and covers 10% to 25% of the data during the 12-month signalling window. The sign and OSNs of the indicators selected for the signal approach are given in Table5.

Table 4. FX Supply and Demand Indicators by Groups

Indicators	Description	Reference
Goods and Services Trade Indicator Group		
Current Account to Reserves (CA/R)	(R+CA)/R	CBRT
Export/Import (E/I)	Export/Import	
Real Effective Exchange Rate Deviation from Trend (RER)	[1991 December TL/USD (t. Period Turkey CPI/ICF CPI)-t. Term TL/USD]/t.Term TL/USD	IM,F:IFS,CBRT
Energy Cost Index (ECI)	t. Period Index/Past 12 Month Average Index	WB
World Export (WE)		IMF
Turkey Industrial Production Index (TIPI)		IMF:IFS
Totaly OECD Industrial Production Index (WIPI)		OECD
CBOE Volatility Index (VIX)		CBRT
OECD Turkey Composite Leading Indicator (TCLI)	Monthly Index Value	FRED
International Capital Flows Indicator Group		
Real Change in FED Assets (RFEDA)	t. Period FEDA/ ICF CPI	FED, FRED
Real Interest Rate Differences (RID)	(Turkey Interbank Rate/CPI)-(ICF Interbank Rate/CPI)	IMF:IFS
USD BIST Index Change (BIST)	BIST Index/USD Nominal Exchange	CBRT
Short-Term External Debt to Non-Gold Reserves (STED/R)	STED/R	CBRT
Net Portfolio Flows and Net Portfolio Revenues Ratio of Reserves Excluding Gold (NPF/R)	[R-(NPA+NPR)]/R	CBRT
Financial Account Reserves Excluding Gold Ratio (FA/R)	(R-FA)/R	
Dollarization Indicator Group		
Foreign Currency Deposits / Reserves (FCD/R)	FCD/R	CBRT
Banking Sector Total Credits /Gold Excluding Reserves (C/R)	(C/USD Nominal Exchange Rate)/R	
Real M2 (TL) Supply (RM2TL)	TL M2 Money Supply/CPI	
Real Local Interest Rate (RLI)	Turkey Interbank Rate/CPI	
Real Domestic Debt Stock (RDDS)	Public Domestic Debt Stock/CPI	

Source: Research finding.

Table 5. Signal Approach Crisis Indicator OSN

Indicator	Sign	OSN		Indicator Group	Indicator	Sign	OSN		Indicator Group
		Crisis	Depression				Crisis	Depression	
CA/R	-	40	30	GST	RID	-	49	30	ICF
E/I	-	32	30	GST	BIST	-	32	75	ICF
RER	+	32	53	GST	STED/R	-	43	50	ICF
ECI	+	39	56	GST	NPF/R	-	36	78	ICF
WE	-	51	36	GST	FA/R	-	79	37	ICF
TIPI	-	79	38	GST	FCD	+	73	80	Dol.
WIPI	-	52	54	GST	RDDS	-	78	41	Dol.
TCLI	+	33	47	GST	C/R	+	58	78	Dol.
VIX	+	34	78	ICF	RM2TL	+	36	30	Dol.
RFEDA	-	64	33	ICF	RLI	-	77	30	Dol.

Source: Research finding.

For 348-month observations in the 1992:01-2020:12 period, the OSN value that minimizes the NSR in at least 30 and at most 80 signal intervals was determined according to equation (5).

$$OSN = \{minNSR_{ik} = \frac{B}{(B+D)} / \frac{A}{(A+C)} \quad (5)$$

Indicator index : $i = 1,2,\ldots,20$, number of alternative signals: $k = 30,36,\ldots 80$, The solution of the optimization is the NSR values of all signals in the range of 30 to 80 signal numbers given by the indicators. The signal threshold value of the indicator that gives the minimum NSR value has been determined.

5. Results and Analysis

5.1 Efficiency of Indicators in Currency Crisis and Currency Depression

The signal ratios obtained from the signal approach EWS model for the 12-month signalling window in Turkey 1992:1-2020:12, are given in Table 6. The second column represents a measure of the correct signaling efficiency of the indicator. As the ratio of possible correct signals, "A/(A+C)" is interpreted as the ratio of the number of correct signals for each indicator before the crisis to the period when no signals were received during the signalling window. The "B/(B+D)" ratio in the third column gives the false signal rate of each indicator under the same conditions. The ratio "A/(A+B)" in the last column shows the conditional probability of a crisis if the indicator gives a signal (Kaminsky et al., 1997).

The value in the fourth column is the NSR of each indicator, and the lower this ratio is than "1", the more effective the indicator is interpreted. If this ratio is greater than "1", it is considered that the indicator is not an effective indicator for the crisis EWS established with the signal approach (Kaminsky et al., 1997; Berg and Pattillo,1999; Chui, 2002). The indicators in Table 6 are listed according to the NSR value. Since the NSR of the Turkish Industrial Production Index (TIPI) and World Exports (WE) indicators in the GST group belonging to the currency crisis periods were found to be greater than "1", they were not effective indicators, and their signals were not taken into account.

The Turkish Composite Leading Indicator Index (TCLI), developed by the OECD, aims to predict the trend of economic activity over the next 6 to 9 months. The indicator is composed of different data, such as orders, stock changes, financial indicators such as the country's stock market due to imports confidence surveys regarding the economy, trends in the main sectors, and the economic situation in the important trading partners of the countries. An increase in this indicator is

considered an increase in future economic activities (OECD, 2021). Contrary to the general acceptance in the economic literature, the increase in this index appears as the most effective leading indicator for the Turkish currency crisis. However, this indicator interpretation, the expectation of an increase in economic activities in Turkey, can be concluded that the demand for foreign currency will increase for the Turkish economy, which is also effective in the currency crisis.

Table 6. Signal Approach Currency Crisis Indicator Effectiveness

Indicator	Correct Signal Ratio	False Signal Ratio	NSR	Conditional Crisis Probability
	A/(A+C)	B/(B+D)	B/(B+D) /(A/(A+C)	A/(A+B)
TCLI	0.28	0.03	0.10	0.82
E/I	0.21	0.05	0.26	0.63
ECI	0.25	0.07	0.27	0.62
RM2TL	0.18	0.09	0.49	0.47
RFEDA	0.31	0.16	0.499	0.47
CA/R	0.19	0.1	0.54	0.45
RID	0.23	0.12	0.54	0.45
VIX	0.16	0.09	0.56	0.44
RLI	0.33	0.21	0.62	0.42
RDDS	0.33	0.21	0.63	0.41
BIST	0.14	0.09	0.64	0.41
FA/R	0.33	0.21	0.64	0.41
WIPI	0.21	0.15	0.7	0.38
RER	0.13	0.09	0.73	0.38
STED/R	0.17	0.12	0.74	0.37
FCD/R	0.28	0.21	0.75	0.37
NPF/R	0.14	0.11	0.78	0.36
C/R	0.2	0.18	0.9	0.33
TIPI	**0.23**	**0.26**	**1.14**	**0.28**
WE	**0.11**	**0.18**	**1.59**	**0.22**

Source: Research finding.

In the currency crisis forecast, TCLI (0.1), E/I (0.26), ECI (0.27), RM2TL (0.49), and RFEDA (0.49) are calculated as effective indicators with NSR values less than 0.5. In addition, the signal taken from the TCLI indicator, during the signalling window, that economic activities will increase in the next period (ie, the need for foreign exchange will increase in the next period), is a preliminary indication that a currency crisis is expected in Turkey. In the signalling window in the Turkish economy, it was determined that the foreign currency that came with the capital flows was used to give the current account deficit (E/I). In addition to

this situation, it has been determined that the expectations deteriorated with the increase in energy costs and the increase in the real money supply, the deteriorating expectations and capital flows reversed, and as a result, incompatible interest and money supply policies were implemented. At the last stage, it was concluded that the crisis cases were accompanied by the tendency of the local market to foreign currency.

Similarly, 15 out of 20 indicators were found to be effective in the early forecasting of the currency depression. Indicator signal rates regarding the currency depression are given in Table 7. Three periods (1994, 2001, 2018) were identified as currency depression cases. Regarding the effectiveness of the indicators, it was determined that WIPI, RER, and WE in the GST indicator group, NPF/R in the ICF indicator group, and C/R in the dollarization indicator were not effective signals.

Table 7. Signal Approach Currency Depression Indicator Effectiveness

Indicator	**Correct Signal Ratio**	**False Signal Rate**	**NSR**	**Conditional Crisis Probability**
	A/(A+C)	**B/(B+D)**	**B/(B+D) /(A/(A+C)**	**A/(A+B)**
E/I	0.47	0.04	0.09	0.57
TCLI	0.67	0.12	0.18	0.39
CA/R	0.33	0.08	0.23	0.34
ECI	0.39	0.14	0.36	0.25
RFEDA	0.22	0.09	0.38	0.24
FA/R	0.25	0.1	0.41	0.23
RLI	0.19	0.08	0.42	0.22
STED/R	0.31	0.14	0.47	0.2
RID	0.17	0.09	0.51	0.19
RDDS	0.19	0.12	0.63	0.16
FCD/R	0.36	0.24	0.66	0.15
BIST	0.31	0.22	0.72	0.14
TIPI	0.14	0.12	0.83	0.13
RM2TL	0.11	0.09	0.83	0.13
VIX	0.25	0.24	0.95	0.11
WIPI	**0.17**	**0.18**	**1.07**	**0.1**
C/R	**0.19**	**0.25**	**1.27**	**0.09**
WE	**0.08**	**0.12**	**1.46**	**0.08**
NPF/R	**0.17**	**0.26**	**1.54**	**0.07**
RER	**0.06**	**0.2**	**3.61**	**0.03**

Source: Research finding.

In the currency depression forecast, E/I (0.09), TCLI (0.18), CA/R (0.23), ECI (0.36), RFEDA (0.38), FA/R (0.41), RLI (0.42), and STED/R (0.47) are calculated as indicators with an NSR value less than 0.5. Since the Turkish economy has an import-dependent production structure, the currency depression begins with the reduction of the reserves accumulated by capital flows due to imports. In Turkey, the process of depression continues by taking the expectation that the demand for foreign currency will increase due to increased economic activities in the future, the emergence of a phenomenon that will reduce or reverse the international capital flows, the increase in interest rates in the local market, and the tendency to hold foreign currency. In addition to all these indicators, it has been evaluated that a case of currency depression may occur in the Turkish economy, with the signs of decline in Turkish industrial production (TIPI). Finally, if the currency crisis occurred in the few months before the crisis, it can be concluded that the currency depression process has been entered.

Although the effectiveness coefficients of the TCLI and E/I indicators are different, they are the leading and effective indicators of both cases. Similarly, Alagöz et al. (2019) and Saçık et al. (2020), in line with the conclusion that energy imports are the most critical item in the current account deficit for the Turkish economy and are also effective in currency crises, the ECI indicator has also been identified as an effective leading indicator of these two cases.

5.2 NSR Weighted Composite Index and Probability of Currency Cases

When a crisis prediction index is created with all the effective indicators of the signal approach, it is considered that the predictive power of currency crises will provide a more accurate estimation. Kaminsky (1999) proposed a method of calculating an index formed by all indicators to evaluate the probability of an impending crisis. This Weighted Composite Index (I);

$$I_t = \sum_{t=1}^{348} \frac{S_{ti}}{NSR_i} \quad (6)$$

$t = 1,2,\ldots,348$, analysis period, $i = 1,2,\ldots,18$, and $i = 1,2,\ldots,15$ are the sequence numbers of the effective indicators of both cases separately and are calculated by equation (6). NSR of NSR_i ith indicator, S_{ti} value is when the indicator exceeds its own threshold value in the t th period and gives a signal by taking a value of 1, while the status of 0 is not receiving a signal from the indicator. This index is also called the currency crisis fragility index.

The probabilities of following a crisis or depression against a given WCI (I) value are estimated using Equation (7) (Kaminsky, 1999).

$$P\left(C_{t,t+h}\middle|I_i < I_h < I_j\right) = \frac{\sum \text{Months with } I_i<I_h<I_j \text{ and crisis within 12 months}}{\text{Months with } I_i<I_h<I_j} \quad (7)$$

Where P denotes probability, I represents WCI crisis or depression indicator, and $P\left(C_{t,t+12}|I_i < I_h < I_j\right)$ denotes the probability of crisis or depression occurrence in the case window of 12 months given the value of I_t lies between I_i and I_j at time t.

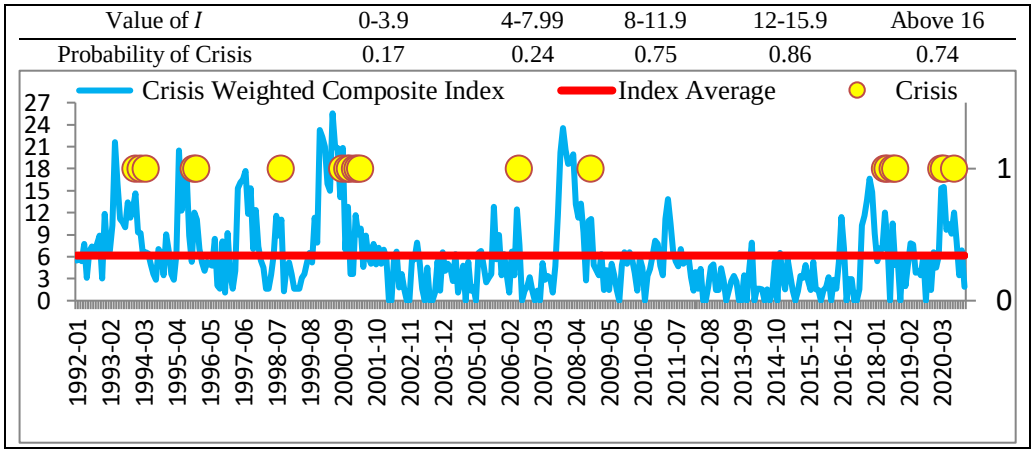

Figure 3. Currency Crises Weighted Composite Index and Probability of Crisis
Source: Research finding.

The representation of the currency crisis probabilities according to the WCI value range with the WCI graph is presented in Figure 3. It has been determined that the index average is 6.16 and fluctuates between 0 and 25.54 values. As seen in Figure 3, when the index takes the value of 12-15.9 during the crisis observation period, the probability of a currency crisis within 12 months is calculated as 86%.

Value of *I*	0-5.9	6-11.9	12-17.9	18-23.9	Above 24
Probability of Depression	0.01	0.07	0.52	0.62	0.75

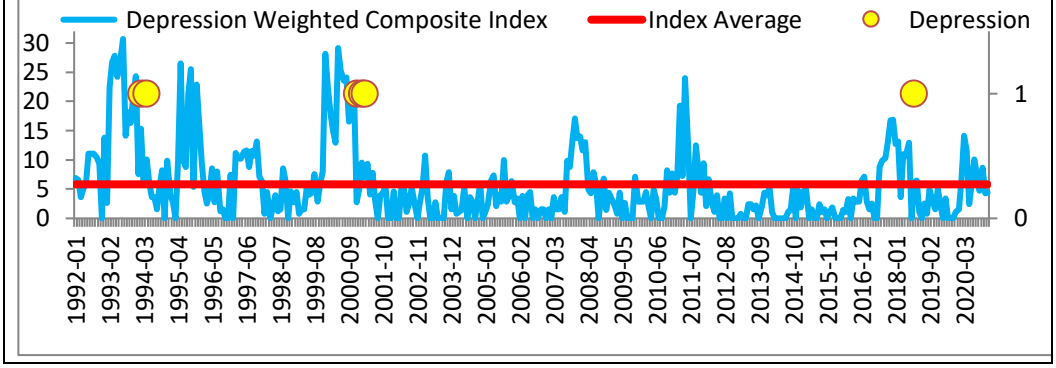

Figure 4. Currency Depression Weighted Composite Index
Source: Research finding.

The representation of the exchange rate depression probabilities according to the WCI value range with the WCI graph is given in Figure 4. The index average is 5.82, with the index fluctuating in the range of 0 to 30.7. As seen in Figure 4, when the index exceeds 24 during the depression observation period, the probability of a currency crisis occurring within 12 months is calculated as 75%.

When Figures 3 and 4 are examined, it is seen that estimating exchange rate events with WCI is an effective method. However, it has been determined that WCI did not give the same response in some cases, since each case period has a unique set of indicators.

5.3 Macroeconomic Consequences of Currency Crisis and Currency Depression Cases in the Turkish Economy

It is generally accepted in economics that financial crises have great economic costs. Many recessions are associated with financial crises, and financial crises often tend to make these recessions longer and deeper than a normal business cycle recession. It has been found that the average duration of a recession associated with a financial crisis is twice that of a normal recession and prevails over a period of about six quarters (Claessens and Kose, 2013).

The economic consequences of the currency crisis and currency depression that occurred in the 1992:1-2020:12 analysis period of the Turkish economy were analyzed. In the analysis period, 3 periods were identified as 1994, 2001, and 2018 as currency depression, and 5 periods as only currency crisis, 1995, 1998, 2006, 2008, and 2020. The course of macroeconomic indicators in the Turkish economy

in the 4-quarters after the currency depression and only the currency crisis is given in Tables 8 and 9.

Table 8. Macroeconomic Consequences of Currency Depression

Post-Depression Period	GDP (%)	Employment/ Population over 15 years old	CPI (%)	Interest (%)	Real Public Domestic Debt Stock Change (%)	Gross External Debt Stock Change (%)	CA/R (%)	FA/R (%)	World GDP (%)
1994I	4.30	50.28	16.05	80.06	18.99	0.46	91.3	106.3	3.30
1994II	-9.6	50.28	38.81	128.29	-6.47	-1.40	110.2	82.1	
1994III	-6.1	49.69	11.48	71.37	50.58	-0.53	112.1	85.6	
1994IV	-5.4	49.69	20.18	71.44	30.99	-1.11	102.1	98.7	
2001I	-0.98	43.05	8.86	87.36	40.39	-1.40	98.1	89.8	2.00
2001II	-9.80	47.27	20.53	81.05	60.44	-2.20	104.8	78.3	
20011III	-7.53	48.74	10.42	67.75	27.81	4.72	106.7	96.5	
2001IV	-10.34	43.60	15.57	62.64	10.35	-5.16	102.7	87.3	
2018II	5.84	48.05	4.81	18.50	0.02	-1.95	88.6	100.9	3.26
2018III	2.5	48.06	6.61	27.92	2.83	-2.94	102.4	84.3	
2018IV	-2.6	45.33	6.50	30.75	-0.04	-1.93	104.1	97.9	
2019I	-2.5	45.93	0.75	29.40	12.52	1.47	99.2	103.8	2.60

Source: https://evds2.tcmb.gov.tr/ and https://data.imf.org/.

After the crisis and depression cases in the Turkish economy, the changes in GDP quarterly growth, the ratio of the number of employed people to the population over the age of 15, the Consumer Price Index (CPI), the interbank overnight interest rate, the gross external debt stock and the inflation-adjusted public domestic debt stock indicators were examined. Quarterly effect of current account deficit on total reserves (CA/R) is calculated according to (Reserves+Current Deficit/Excess)/ Reserves equation. A CA/R indicator greater than 100 indicates a current account surplus, and a value less than 100 indicates a current account deficit. The effect of capital flows in the financial account on total reserves is calculated according to the (FA/R) indicator (Reserves-Financial Account)/Reserves equation. If the FA/R indicator is greater than 100, it indicates capital inflow to the Turkish economy, and less than 100 indicates capital outflow. The last indicator is the world annual growth (GDP) change, and it was taken to compare the effects of the Turkish currency crisis and currency depression case results from the world economy.

Table 9. Macroeconomic Consequences of Currency Crises

Post-Crisis Period	GDP (%)	Employment/ Population over 15 years old	CPI (%)	Interest (%)	Real Public Domestic Debt Stock Change (%)	Gross External Debt Stock Change (%)	CA/R (%)	FA/R (%)	World GDP (%)
1995IV	7.19	50.39	18.20	77.18	8.20	0.29	89.9	92.0	3.09
1996I	8.90	49.51	18.25	84.34	40.00	0.23	98.1	111.6	
1996II	7.50	49.51	16.57	79.43	16.20	3.34	94.2	112.1	3.61
1996III	5.60	50.44	11.10	79.65	31.39	0.45	101.8	98.7	
1998II	3.50	47.82	12.60	80.22	19.30	5.41	99.2	110.1	
1998III	2.46	49.66	11.48	75.32	19.76	5.88	104.3	69.0	2.79
198IV	-1.00	49.66	16.58	82.21	11.64	0.67	106.0	111.1	
1999I	-8.15	49.52	12.36	82.30	27.27	-1.49	104.4	104.1	3.50
2006II	8.27	42.99	2.98	19.42	-0.11	4.55	86.8	110.0	
2006III	4.83	42.81	1.83	23.80	1.85	2.65	94.8	108.9	4.50
2006IV	5.18	40.94	2.94	23.79	-0.84	5.20	91.7	111.6	
2007I	6.79	40.58	2.19	23.38	5.64	2.06	90.8	116.7	4.44
2008III	0.99	42.75	0.82	23.14	4.93	1.69	94.1	110.1	2.00
2008IV	-6.02	39.96	3.25	25.39	0.74	-5.45	95.1	94.3	
2009I	-14.54	39.18	0.43	19.33	9.35	-5.32	98.6	96.4	-1.31
2009II	-6.81	42.50	1.10	17.99	2.51	1.85	95.8	103.2	
2020II	-10.40	42.97	2.66	11.27	21.36	-0.84	90.6	100.3	
2020III	6.33	44.00	2.71	12.52	12.33	2.14	92.9	97.6	-3.36
2020IV	6.16	41.70	5.10	17.42	-6.28	3.71	94.5	111.1	
2021I	7.41	44.02	4.29	19.72	5.61	-0.60	94.3	100.3	

Source: https://evds2.tcmb.gov.tr/ and https://data.imf.org/

In the Turkish economy, the average of 1992I and 2021III quarterly growth figures was 4.79%. During the observation period, after the depression, although the world GDP grew, the quarterly growth average of the Turkish economy was -3.52%. It was observed that the average of the observation period after the currency crisis period was 1.7%. In the post-crisis period, a growth was realized, albeit below the general average growth. It has been determined that the economy has entered a contraction phase after the depression. Especially the 2008 GFC (2008) and the COVID-19 pandemic (2020) have affected all world economies. The reflection of these global phenomena was seen as a currency crisis in the Turkish economy. Except for these two special case periods, the Turkish economy was affected during the curency crisis, but there was no significant shrinkage in the economy during the post-crisis observation period.

In the observation period after the 1994 currency depression, the employment rate fell by only 0.59. This decrease in value, despite the large decrease in growth value, restrained this decrease in employment due to the increase in exports (current surplus) in 1994. In the 2001 currency depression, however, the employment rate decreased by 5.14 due to the fact that exports could

not respond to the increase in 1994. After the 2018 currency depression, the employment rate decreased by 2.73 due to the insufficient increase in exports. In the observation period of the currency crises, there was no significant decrease in the employment rate, except for the crises that took place during the 2008 GFC and 2020 COVID-19 pandemic periods.

While the average inflation rate for the 1994-2020 quarter was 6.67%, the average quarterly inflation rate during the currency depression observation periods was 13.38%, which is more than twice the general average. In the observation period of currency crises, inflation was realized with a value of 7.37%, which is close to the general average.

While the average interest rate for the 1994-2020 quarter was 36.85%, the quarterly average interest rate during the currency depression observation periods was 63.04%, which is close to twice the general average. In currency crises, this rate was realized with a value of 43.89%, which is close to the general average.

While the rate of increase in real public domestic debt in the quarter of 1994-2020 was 8.19%, the quarterly average real public domestic debt increase was 20.7% in the currency depression observation periods, and the quarterly average increase in the period of currency crises was 11.54%.

After the currency depression periods, the gross external debt decreased, and instead of borrowing, debt payment periods were realized. While the quarterly average change in gross external debt for the 1994-2020 period was 1.73%, the external debt decreased by 1% on average during the currency depression observation period. In addition, during the depression periods, capital inflows in the balance of payments financial account reversed and turned out to be an outflow. In the period of currency crises, the external debt increased, excluding 2008 GFC, and the quarterly average of the entire crisis observation period was 1.32%. Although the capital inflows to the financial account were interrupted after the observation periods of the currency crisis, the capital inflows were realized, albeit in a small way.

The 1994-2020 quarterly CA/R average was 94.85. In other words, the Turkish economy had a current account deficit in this period. The FA/R indicator, which is the financing of the current account deficit, was realized as 105.54 in the same period. In other words, in the analysis period, capital inflows from the financial account to the Turkish economy were realized. If these two indicators are evaluated together; The capital, which entered the financial account with international capital flows, went out again to the foreign world by importing more than the export of goods and services. The quarterly average of the currency

depression observation period CA/R and FA/R indicators was 101.85 and 92.63, respectively. Contrary to the period of 1994-2020, the Turkish economy has a current account surplus during the currency depression and its post-observation period, capital inflows reverse and exit values are formed. The average of the currency crisis observation period was 95.91 and 103.45 for the CA/R and FA/R indicators, respectively. In other words, as in the general situation on average during the period of currency crises, the Turkish economy runs a current account deficit and meets this with capital inflows from the financial account.

5. Conclusion

It is generally accepted in the literature that currency crises have a negative economic impact. However, there is no study in the literature that analyzes the economic consequences of the cases that differ according to the currency crisis severity and the initial conditions that differentiate these cases. While our study reveals the differences in the initial conditions that reveal the currency crisis and the currency depression, with the signal approach, it has also contributed to the literature by showing that the macroeconomic consequences of the currency crisis and currency depression are different.

In the application of the currency crisis EWS model signal approach, it has been determined that 18 of the 20 indicators, excluding TIPI and WE, are effective. According to the signal approach analysis, it has been determined that indicators such as TCLI, E/I, ECI, RM2TL, RFEDA are the most effective indicators with NSR less than 0.5, respectively, in estimating the currency crisis.

For the currency depression EWS model, 15 out of 20 indicators were found to be effective. In predicting the case of depression, indicators such as E/I, TCLI, CA/R, ECI, RFEDA, FA/R, RLI and STED/R were found to be the most effective indicators with NSR less than 0.5, respectively.

If the effectiveness of the leading indicators of the currency depression and the currency crisis are compared; E/I (188%), FA/R (56%), CA/R (135%), RLI (48%), RFEDA (32%), STED/R (57%), while TCLI (80%), ECI (33%), RM2TL (69%) are indicators with lower efficiency values. In addition, the TIPI indicator was calculated as an effective indicator within the scope of the currency depression, unlike the currency crisis. Finally, in the analysis period, a currency crisis is definitely seen a few months before the currency depression occurs. However, not every crisis is followed by a depression. As a result, it is concluded that when the currency crisis occurs, the crisis can be prevented from turning into a depression with correct and effective policies.

If the macroeconomic consequences of the currency depression and the currency crisis are compared; the four-quarter averages values such as growth (-3.52%, 1.7%) unemployment (employment/workable population: 2.85 and 2.1 percentage points decrease), inflation (13.38%, 7.37%), interest rate (63.04%, 43.89%) and real change in public domestic debt stock (20.7%, 11.54%), were calculated. Similarly, after the currency crisis, capital inflows (FA/R: 103.45) turned into outflows (FA/R: 92.63) after the currency depression, and the gross external debt change from borrowing (1.32%) after the currency crisis to paying debt (-1%) after the currency depression and the current account deficit after the currency crisis (CA/R: 95.91) turned into a current account surplus after the currency depression (CA/R: 101.8). It has been determined that the capital inflows of the Turkish economy have reversed in the post-currency depression periods, the gross foreign debt has decreased by making the payment, the exports have increased, the imports have decreased, and as a result, there has been a current account surplus. It has been determined that the Turkish economy maintains its economy positively as long as there is foreign capital inflow, such as growth, employment, low inflation, and low interest rates.

It has been seen that unless the Turkish economy solves the chronic current account deficit problem before the crisis and depression periods, it will cyclically encounter either a currency crisis or a currency depression according to the signal efficiencies of the above economic indicators, but the currency depressions to be experienced will affect the Turkish economy much more negatively than the currency crises.

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