

## An Empirical Investigation of Bubble in the Turkish Stock Market

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**ABSTRACT:** In this paper, twenty – four sectoral indices of stock prices operated in the Turkish stock market are analyzed for evidence of rational speculative bubbles using the generalized supremum Augmented – Dickey – Fuller (GSADF) test. Then, detecting rational speculative bubbles, we define a dummy variable to capture the bubble dates and ran the logit model to determine the factors that influence bubble formation. Empirical results depict that Foreign Portfolio Investment (FPI), Credit Default Swap Spreads (CDS), and Volatility Index (VIX) are the important variables that cause the probability of bubble formation in the Turkish stock market.

**Keywords:** Rational bubbles; GSADF test; Logistic regression; BIST; Turkey

**JEL Codes:** C1, C32, G12, E44

## Türkiye Hisse Senedi Piyasasında Spekülatif Balon Varlığının Ampirik İncelenmesi

**ÖZ:** Bu çalışmada, Türkiye pay piyasasında işlem gören 24 sektör ve gösterge endeksleri için, genelleştirilmiş eküs Augmented – Dickey – Fuller (GSADF) testi ile rasyonel spekülatif balonların varlığı analiz edilmiştir. İkinci aşamada, rasyonel spekülatif balonlarının görüldüğü tarihlere kukla değişken tanımlanarak balon oluşumunu etkileyen faktörler, logit modeli kullanılarak tespit edilmeye çalışılmıştır. Analiz sonuçlarına göre, Türkiye pay piyasasında balon oluşma olasılığını en fazla etkileyen değişkenlerin uluslararası portföy yatırımları (FPI), ülke kredi risk primi (CDS) ve uluslararası yatırımcıların risk algısı (VIX ) olduğu belirlenmiştir.

**Anahtar Kelimeler:** Rasyonel balonlar; GSADF testi; Lojistik regresyon; BİST; Türkiye

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## 1. Introduction

A stock market bubble is a form of the financial bubble that takes place in stock markets when the participants of the market drive stock prices beyond the stock valuation system estimates (Dwyer and Hafer, 2013). Behavioral finance theory asserts that stock market bubbles are a result of cognitive biases that contribute to herd behavior and groupthink tendencies. Researchers arguing that markets are not efficient, and therefore stock prices are not independent, focus on human psychology to explain the volatility in stocks. Studies conducted in behavioral finance have explained the reason for the ineffectiveness of markets by the feedback theory (Kurt-Cihangir, 2016).

Financial bubbles comprise of asset price bubbles and speculative bubbles. Asset price bubbles are price inflations that form when investors flock a particular asset class and may form in various asset classes, such as real estates, stock markets, oil industry, or gold industry (Dwyer and Hafer, 2013). There are various factors that contribute to the formation of these bubbles, such as low-interest rates in a particular asset class, a spike in demand of a product, or shortage of a particular commodity in the market. However, speculative bubble forms due to sheer speculation, and financial fundamentals of the asset class do not support asset inflation.

There are also rational and irrational bubbles in the stock market. A rational bubble involves investors buying stocks with the knowledge that the asset is over-valued and investors purchasing stocks at inflated prices after evaluating the market fundamentals and determining the chances of procuring profits (Dwyer and Hafer, 2013). However, an irrational bubble involves investors' purchasing stocks at inflated prices without considering important market fundamentals. Namely, in an irrational bubble, investors engage in a price bidding war to procure stocks. The two market bubbles differ in that rational bubbles are supported by fundamental market factors while irrational bubbles involve investors making rash decisions without regard for the market fundamentals (Salge, 2012). Investors usually employ the Capital Asset Pricing Model to determine the rationality of the market bubble.

This paper will be the first, to the best of our knowledge, investigate the impact of selected global financial indicators Credit Default Swap Spreads (CDS), *CBOE* Volatility Index (VIX), Exchange Rate (EX), and Foreign Portfolio Investment (FPI). The empirical methodology of this paper is based on two main econometric tools. First, we utilize the GSADF test to examine the existence of multiple bubbles in the Turkish sector-level indices operated in the stock market. Second, we apply widely used method, the logit binary regression, to predict the factors affecting the probability of speculative bubble in Turkish stock market.

In this context, this paper is structured as follows. Section 2 presents a concise review of empirical literature of rational speculative bubbles. Section 3 describes the data employed, empirical methodology and model. The estimation results are reported and discussed in Section 4, and section 5 concludes.

## 2. Literature Review

A speculative bubble is usually a result of unrealistic expectations of future growth, increase in prices, or other events that could contribute to an appreciation in the asset value (Mansharamani, 2019). Increased speculation and the market activities that it causes lead to investors rallying around the advertised asset class with the number of buyers outnumbering the sellers. The excess demand pushes the asset's prices above the prices on their fundamental value.

Bubble tests described in the literature can be examined into two groups: in the first group, bubbles are investigated with Variance Bound Test (Schiller, 1991; LeRoy and Porter, 1981; Gürkaynak, 2005), the Cointegration and the Unit-root process (Diba and Grossman, 1988; Campbell and Shiller, 1987; Gürkaynak, 2005; Parvar and Waters, 2010), the Run test (also called Geary test) (Blanchard and Watson, 1982; Santoni, 1987; Bozoklu ve Zeren, 2013), the Duration Dependence test (McQueen and Thorley, 1994; Chan et al., 1998; Yu and Hassan, 2010; Yanık ve Aytürk, 2011), and the Weibull Hazard model (Mudholkar, Srivastava and Kollia, 1996).

In the second group, the bubbles are investigated by Sup-Augmented Dickey Fuller (SADF) and generalized Sup-Augmented Dickey-Fuller (GSADF) tests, which are a most popular methods (Philips et al., 2011; Korkmaz et al., 2016; Çağlı and Mandacı, 2017; Koy, 2018).

A large amount of empirical studies have been documented to test the speculative bubbles on the different stock markets in the world. Regarding the uses of different methodologies, these studies yield mixed findings. In the existing literature, some studies suggest that there are speculative price (Taşçı and Okuyan, 2009; Yu and Hassan, 2010; Yanık ve Aytürk, 2011; Chang et al., 2016; Liaqat et al., 2018; ), while others find no such correlation (Korkmaz et al., 2016; Koy, 2018).

The results from the study by Gürkaynak (2005) attempts to answer the question whether asset price bubbles are detectable. The article discusses different bubble test methods and their limitations. As such, the report emphasizes the econometric techniques that various scholars have proposed for bubble detection, instead of focusing on the application of the test methods. The article critiques different scholarly works discussing rational bubble detection techniques. In the article, he asserts that the existing methodologies for bubble tests are not effective as they combine the null-hypothesis of no bubbles with fundamental market models that are not fully exhaustive. The article also claims that for each research that discovers a bubble in the economy, there is another research that relaxes an assumption on the market fundamentals and fits market rationale without concluding that a bubble exists in the market.

Another empirical study carried out by Yanık and Aytürk (2011), tests for the presence of a bubble in the Turkish equity market between 2002 and 2010 using a duration dependent. When using traditional bubble test methods, the results reveal

several characteristics consistent with rational speculative bubbles such as skewness, excess kurtosis, autocorrelation, and non-normality. The duration dependent test, however, conclusively proves the absence of rational speculative bubbles during the period, indicating that other factors unrelated to bubbles could have caused the above features. The research is essential as it proves the absence of bubbles in the Turkish economy, suggesting that the stock prices conform with fundamental market values during the period that the research covers.

Deev et al. (2014), attempt to establish the occurrence of speculative rational bubbles in three Central European stock exchange markets (The Czech Republic, Hungary, and Poland) and the possibility of stock bubbles, which arises from historical stock market inefficiency and the recent stock boom and crash. The study establishes the specific properties of studied stock markets and evaluates the prices of individual blue-chip stocks. The research plays a critical part in determining the occurrence of an asset bubble between 2004 and 2007 in the country and is significant in tracing the origins of the boom. In comparing countries, they detect speculative bubbles in the Polish chemical and energy company stock market and the Hungarian renewable-energy technology stocks during the sample period.

Studying international and emerging markets, Chang et al. (2016) focus to research the presence of many economic bubbles in BRICS (South Africa, Russia, China, India, and Brazil) stock exchange system. They employ various methodologies including the Augmented Dickey-Fuller test and use monthly stock price-dividend ratio statistics. The article established that there are plenty of economic bubbles in the BRICS stock exchange system. As such, the study affirms that the presence of many financial bubbles and lays a foundation for studies on economic bubbles within the countries that make up the BRICS stock trading.

Chen and Quan (2013), discuss how time variations affect returns and use both the traditional rational bubble tests and the modified tests to test the presence of rational bubbles in various stock markets in Asia. Assuming the absence of deterministic explosive bubbles in the stock market, the conventional theory of asset pricing proposes that the expected stock returns should be constant. However, various time factors impact the returns, necessitating the modification of rational bubble tests to account for the variations. The research confirm that the existence of both the rational bubble and deterministic explosive bubbles in most of the stock markets that the study covered, except in Hong Kong by applying the traditional bubble tests and the modified tests. The article is essential as it shows the importance of different bubble test methods and demonstrates their application in different markets.

In their study, Montasser et al. (2018), employ the recently established sequential ADF bubble tests to differentiate between explosive fundamental and rational speculative bubbles. The study confirms some significant differences between the new sequential ADF and the conventional ADF tests and indicates that GSADF tests are more reliable than the SADF tests. The authors also apply the various testing techniques to collect signs of a market bubble in the wake of the dot com

bubble. Moreover, they establish and discuss the merits and demerits of different test methods and determine that there is a stock bubble during the dot-com boom.

The work, which has attempted to detect bubbles in an emerging market, Liaqat *et al.* (2018), explore the presence or absence of many market bubbles in the Pakistan share market and the bubbles' similar events. The authors employ various bubble testing techniques, such as GSADF and SADF and confirms the presence of numerous bubbles in many sectors of Pakistan economy. Few industries that do not indicate the presence of stock bubbles include the Chemicals, Spinning, and Textile industries. The study is significant as it demonstrates the applications of SADF and GSADF methodologies and illustrates their effectiveness in the identification of many stock market bubbles in many regions across the world.

To work of Hatipoglu and Uyar (2011) proposes the close association of the indices of stock prices in comparatively big and developing markets can be used to illustrate that bubbles might spread from one country to another. The paper then suggests various methods that one can use to test the spillover effects of a bubble. In addition, this study analyses and provides empirical evidence of bubbles spilling into another country by citing different instances when economic bubbles in the U.S. spilled into the Turkish economy and assessing the impacts of the bubble spillover.

Lastly, Koy (2018) performs the SADF and GASDF bubble tests to detects bubbles tests to detect bubble actions in ten emerging markets, which plays a significant role in determining bubbles in the sample research area. The paper also traces the formation and ending dates of the bubbles. The research employs the use of SADF and GSADF bubble tests to detect bubble actions in ten developing share markets. The results of the study indicate that each of the stock markets sampled for the research deviated from their random walk severally within the period, that is, between 2001 and 2007. The deviation from market normality that this study discovers illustrate that the markets experienced bubbles during the period. The study plays a significant role in determining the presence of bubbles in the sample research area and demonstrates the applicability of GSADF and SADF techniques in the detection of bubbles.

Following those studies, this paper differs from existing studies in two important respects. The first part explores the existence of speculative bubbles in twenty-four<sup>2</sup> sectoral indices of stock prices traded on the Turkish stock market by applying the

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<sup>2</sup> **Benchmark Sectors:** BIST XU All; BIST XU100; BIST XU50; BIST XU30; **BIST Industrial:** BIST Food, Beverage; BIST Textile, Leather; BIST Wood, Paper, Printing; BIST Chemical, Petroleum, Plastic; BIST Non-Metal Mineral Products; BIST Basic Metal; BIST Metal Products, Machinery; **BIST Services:** BIST Transportation; BIST Tourism; BIST Wholesale and Retail Trade; BIST Telecommunication; **BIST Financial:** BIST Banks; BIST Insurance; BIST Leasing, Factoring; BIST Holding and Investment; BIST Real Est. Inv. Trusts; BIST Information Technology.

GSADF test. The second part examines whether international investors' decisions affect the speculative bubbles by using the Logit regression model.

### **3. Data, Empirical Methodology and Models**

#### **3.1. Variable Selection, Financial and International Factors**

In this study, to investigate the reasons behind the speculative bubbles in the sectoral indices of stock prices, we put forward our hypothesis as follows.

***Hypothesis 1:** The possibility for the existence of rational speculative bubbles in assets decreases with higher Sovereign Credit Default Swaps (CDS), holding other variables constant.*

Stock market prices have a strong relationship with a country's credit default swap (CDS) spreads. An increase in a country's CDS often triggers an increase in stock exchange rates and an increase in currency volatility and the risk of crashing. The link manifests in predictive settings for currency risk premiums. Sovereign risks also predict massive returns in the stock market, currency volatility, and skewness (Hafer, 2012). Furthermore, carry, and momentum strategies in the stock market generate high-security returns in countries with high sovereign risks, while countries with low sovereign risks generate minimum profits. As explained by Carboni (2011), CDS offers protection on an asset's par value, with the protection buyer paying a one-off premium or a periodic fee (spread) to a protection seller. When the credit event occurs, the protection seller makes the payment. Additionally, Carboni (2011) assessed the relationship between bond spreads and CDS. The results of the analysis demonstrate that the CDS market leads the bond market in price discovery.

***Hypothesis 2:** An increase in foreign exchange rate leads to rational speculative bubbles, holding all other independent variables constant.*

Stock asset prices relate to other stock asset prices globally, whereby foreign exchange markets act as a proliferation path between stock markets across the world. Although the stock prices correlate internationally, dividend procedures are autonomous (Mansharamani, 2019). The relationship between stock asset prices and foreign exchange rates offers a theoretical paradigm in preference of financial contagion (Salge, 2012).

***Hypothesis 3:** Foreign portfolio investment is associated with an increased rational probability of speculative bubbles, holding other variables constant.*

Foreign portfolio investment refers to securities and financial assets that a country's non-resident holds. Portfolio investments include the acquisition of stocks, bonds, debentures, debt securities, transactions in equity, and banknotes (Salge, 2012). Non-resident portfolio investment accrues profits and loses like a domestic investment in the stock market and they invest in a stock market in anticipation of earnings in a foreign stock market, especially when there is a rational market bubble. In addition, non-resident portfolio investment in the stock market usually

has the possibility of positive returns as a foreign investor typically invests when there is a rational bubble.

**Hypothesis 4:** *A lower (higher) CBOE Volatility Index (VIX) reduces (increases) the chance of the speculative bubble in stock market, holding the effect of the other variables fixed.*

### 3.2. Data

Volatility index tracks a range of factors and acts as a market volatility predictor for approximately thirty days. Volatility index declines as the stock market grows strong and increases as stock market declines (Mansharamani, 2019). An increase in market volatility causes an increase in stock market risk and represents a decrease in stock's returns. A market bubble involves decreased market volatility.

Based on the data availability, the paper consists of 170 monthly closing indices spanning the period from January 2005 to February 2019. Each index is regressed on financial variables specific to Turkey, such as 5-years Sovereign Credit Default Spreads (CDS) that measure the country's default risk; Foreign Portfolio Investment (or Equity Stock, FPI) that shows the transactions in the shares held by non-residents; the Exchange Rate (ER), which is measured as local currency (Turkish Lira) units against the US dollars. In addition, the Chicago Board Options Exchange (CBOE) Volatility Index (VIX) (also known as 'fear index') that gauges the world's equity market volatility is also used. Data for stock indices were collected from the FINNET Financial Analyze Program (Retrieved from [www.finnet.com.tr](http://www.finnet.com.tr)). Besides, the data for financial variables are downloaded from Datastream. All nominal series are transformed by taking natural logarithms. The descriptive statistics for all twenty-four series and the financial control variables used in the study are reported in Table 1. However, Figure 1 (see Appendix) plots the evolution of all variables under study.

As shown in Figure 1(a), the 5-year CDS spreads for Turkey fluctuate over time and it soared sharply to 415 basis points on April, 2019 from 254 basis points on January, 2005, which is the highest recorded CDS spreads since 2008 global financial crisis.

Figure 1(b) shows a time series plot of the U.S. Dollar exchange rate in Turkish Lira that generally indicates an increasing trend (depreciation of Turkish Lira) since 2010. Figure 1(c) illustrates Foreign Portfolio Investment (FPI) that has risen in almost every year from 2010 and 2015, then FPI movements acted to decrease in 2016. Lastly, over the period 2005–2018, the CBOE Volatility Index (VIX) fluctuates between the years, as Figure 1(d) shows.

**Table 1:** Descriptive Statistics

Variable	Mean	SD	Min	Max
<i>Panel A: Sector Indices</i>				
<i>BIST XUAll</i>	64128.54	24148.35	22641.60	121046.4
<i>BIST XU100</i>	64244.57	23493.71	23591.64	119528.8
<i>BIST XU50</i>	62465.27	22087.31	23717.57	114203.7
<i>BIST XU30</i>	79465.78	28494.84	30319.42	146553.9
<i>BIST Industrial</i>	60258.71	30540.97	19100.54	133725.8
BIST Food, Beverage	85709.65	37015.38	25484.74	142489.7
BIST Textile, Leather	13165.70	7790.46	3174.72	40148.80
BIST Wood, Paper, Printing	35463.41	9585.51	13641.82	59377.27
BIST Chemical, Petroleum, Plastic	47591.49	28740.16	14139.23	123028.5
BIST Non-Metal Mineral Products	60227.18	15229.08	24744.59	89227.33
BIST Basic Metal	88511.56	66651.97	20524.97	296228.3
BIST Metal Products, Machinery	69900.52	43216.87	11294.43	163399.3
<i>BIST Services</i>	42995.37	18027.29	13160.51	86482.55
BIST Transportation	52619.66	45185.66	6811.01	193474.9
BIST Tourism	6999.03	1898.28	3115.69	12641.46
BIST Wholesale and Retail Trade	95889.29	57317.06	15132.13	210701.9
BIST Telecommunication	26466.15	5804.86	13864.29	38257.58
<i>BIST Financial</i>	87851.30	26548.73	31459.89	145544.5
BIST Banks	118344.7	34614.28	45501.90	189922
BIST Insurance	147893	66882.95	36475.20	320137.3
BIST Leasing, Factoring	21806.34	16986.61	5092.63	125420.3
BIST Holding and Investment	51616.19	18672.97	14904.48	94686.56
BIST Real Est. Inv. Trusts	34146.35	7516.32	11436.90	46557.81
BIST Information Technology	35599.07	34421.62	4208.43	138311.30
<i>Panel B: Financial Variables</i>				
<i>ln(CDS)</i>	5,38	0,30	4,76	6,32
<i>ln(EX)</i>	0,70	0,42	0,15	1,85
<i>ln(FPI)</i>	10,66	0,34	9,69	11,26
<i>ln(VIX)</i>	2,85	0,36	2,25	4,09

Source: Datasetream and FINNET, 2019

### 3.3. Modelling Bubbles

The theoretical model in this paper builds on the work pioneered by Philips, Shi, and Yu (2013) and the generalized form of the sup ADF (GSADF) test method proposed by Philips, Shi, and Yu (2015a, PSY hereinafter), who develop a framework to capture for multiple speculative bubbles on the stock market prices. Their approach use the right-tailed Augmented Dickey-Fuller (ADF) regression equation with a rolling window procedure and the econometric time series model can be expressed

as follows:

$$\Delta y_t = \alpha_{r_1, r_2} + \beta_{r_1, r_2} y_{t-1} + \sum_{j=1}^p \phi_{r_1, r_2}^j \Delta y_{t-j} + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma_{r_w}^2), \quad t = 1, \dots, T, \quad (1)$$

where  $y_t$  denotes a time series process (in our case, the monthly closing price of the different sectorial indices),  $p$  is the maximum number of lags included in the procedure,  $\Delta$  is the first difference operator,  $r_1$  and  $r_2$  are the beginning and the ending points of rolling window regression based on the fraction of the total sample size, where the size of window<sup>3</sup> is  $r_w = r_2 - r_1$ , and  $\varepsilon_t$  is the error term. Then, we are interested in the null hypothesis of a unit root,  $H_0: \beta_{r_1, r_2} = 1$ , which represents linear stochastic time series follow a unit root versus alternative hypothesis  $H_A: \beta_{r_1, r_2} > 1$ . (explosive behaviour).

The following regressions perform a recursive *supremum* ADF (SADF) statistic (Philips and Yu, 2011b) and a generalized *supremum* ADF (GSADF) statistic (Philips et al., 2015), to detect the explosive behaviour periods:

$$SADF_{r_2}(r_0) = \sup_{r_1 \in [0, r_2 - r_0]} ADF_{r_1}^{r_2} \quad (2)$$

$$GSADF(r_0) = \sup_{r_2 \in [r_0, 1]} SADF_{r_2}(r_0) \quad (3)$$

where  $r_1, r_2 \in [0, 1]$  are a series of subsamples. The SADF approach, a right-tailed ADF test, based on repeated determination of the ADF test, where the endpoint of the subsample is fixed at a fraction  $r_2$  of the whole sample and the window size is expanded from an initial fraction  $r_0$  to  $r_2$  (Caspi *et al.*, 2014). Since the SADF test detects sequential collapsing bubbles, Philips *et al.* (2015) then have introduced the GSADF test to overcome this deficiency. The GSADF approach is more efficiently to detect the multiple bubbles compared with the SADF test.

After detecting the rational speculative bubbles in the Turkish stock market by applying the GSADF test, we focus on the case where the dates of the bubbles to analyze of the reasons behind the speculative bubble in the stock market estimating by logistic regression models. Therefore, the formal econometric model to be estimated is:

$$Bubble_{it} = \alpha + \beta X_t + \varepsilon_{it} \quad (4)$$

where  $Bubble_i$  denotes the speculative bubble dates for sector  $i$ , which is equal to one if there is a bubble, and to zero otherwise;  $X_t$  is a vector of exogenous control variables such as FPI, CDS, EX, and VIX;  $\alpha$  and  $\beta$  are vectors of parameters to be estimated, and  $\varepsilon_{it}$  is an *i.i.d.* error term.

<sup>3</sup> The initial window size constitutes approximately 2% of the whole sample.

#### 4. Data

Table 2 presents the estimated results of GSADF t-statistic for each index followed by the corresponding critical values (right-tail) for 90%, 95%, and 99%, which are obtained from the simulated statistic's distribution. In our empirical application, we select the smallest window  $r_0$  by 4 observations, corresponding to approximately 2% of the data (Philips *et al.*, 2013). The critical values for the GSADF test were obtained applying Monte Carlo simulations with 1000 replications.

As reported in Table 2, the impact of bubbles for each sector are analyzed separately and the results confirm that the GSADF statistics for all indices (except BIST Banks, BIST Holding and Investment, and BIST Information Technology) exceeds the different right tailed critical values, which indicate there are multiple bubbles in the Turkish stock market.

**Table 2:** The GSADF test-sectorial analysis

No	BIST Stock Indices	t-statistic	Prob.*
1	BIST XUAll	4,77**	0.03
2	BIST XU100	3,76*	0.05
3	BIST XU50	5,12**	0.03
4	BIST XU30	2,84*	0.07
5	<b>BIST Industrial</b>	4,85**	0.04
6	BIST Food, Beverage	5,97**	0.02
7	BIST Textile, Leather	4,15**	0.04
8	BIST Wood, Paper, Printing	4,15**	0.04
9	BIST Chemical, Petroleum, Plastic	4,17**	0.04
10	BIST Non-Metal Mineral Products	9,05**	0.01
11	BIST Basic Metal	5,17**	0.03
12	BIST Metal Products, Machinery	7,05**	0.01
13	<b>BIST Services</b>	4,03**	0.04
14	BIST Transportation	5,31**	0.03
15	BIST Tourism	6,29**	0.02
16	BIST Wholesale and Retail Trade	3,29*	0.06
17	BIST Telecommunication	9,10**	0.01
18	<b>BIST Financial</b>	4,11**	0.04
19	BIST Banks	8.11	0.74
20	BIST Insurance	3,81**	0.04
21	BIST Leasing, Factoring	4,57**	0.04
22	BIST Holding and Investment	1,95	0.11
23	BIST Real Est. Inv. Trusts	22,46****	0.00
24	BIST Information Technology	19,47	0.42

**Note:** GSADF is the generalized sup Augmented Dickey-Fuller statistic. Critical values for the GSADF tests are 9.48, 3.79, and 2.26 for the statistical significance levels of 1%, 5%, and 10%, respectively and are derived from Monte Carlo Simulations with 1,000 replications

Before performing logistic regression analysis, we check the stationarity assumptions of data series for independent variables using Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979). The ADF test has as the null

hypothesis that a time series has a unit root against the alternative that the time series is stationary. All other variables are expressed in logs. Table 3 presents the ADF test unit root test results for all variables in their level and first difference values. As can be seen from Table 3, all variables are stationary at their level, except exchange rate (EX), which is stationary in its first difference, that is,  $I(1)$ .

**Table 3:** Results of Unit Root Test

Variable	ADF statistic	Probability	Conclusion
<b>CDS</b>			
Level	-3.422	0.011	No unit root
Differenced	-	-	-
<b>EX</b>			
Level	0.968	0.996	Unit root
Differenced	-11.646	0.000	No unit root
<b>FPI</b>			
Level	-2.931	0.043	No unit root
Differenced	-	-	-
<b>VIX</b>			
Level	-3.920	0.002	No unit root
Differenced	-	-	-

**Source:** Output of Stata, Version 15.1

As stated above, the regression was estimated for each sector separately by applying the logit model:

$$Bubble_{it} = \alpha_0 + \alpha_1 FPI_t + \alpha_2 CDS_t + \alpha_3 \Delta EX_t + \alpha_4 VIX_t + \varepsilon_{it} \quad (5)$$

where  $\Delta$  is the difference operator,  $\alpha_i$ 's are the coefficients to be estimated, the variables FPI, CDS, EX, and VIX are as stated earlier, and  $\varepsilon_{it}$  is an i.i.d. error term.

The dependent variable is coded 1 if there is a bubble, and to 0, otherwise. In the logit (or probit regressions)<sup>4</sup>, we only focus on the marginal effects rather than the coefficients. Table 4 summarizes the marginal effect results from estimating the logit model for each sectoral indices. The logistic regression includes four independent variables. When considering the results for each industry group, there are a number of points to take note of. First, the effect of EX and VIX is statistically insignificant for all benchmark sectors. Second, FPI has a positive impact on the probability of speculative bubble formation in case of benchmark sectors of BIST XUAll, BIST XU100, and BIST XU50, whereas CDS has only negative impact on the probability of speculative bubble for the sectors of BIST XUAll and BIST XU100. These results are consistent with the current situation in Turkey. Because an increasing CDS risk premium of a country will reduce the risk appetite of foreign investors against the country. In such a case, Turkish stock price indices fall and the number of the bubble decreases. In addition, the likelihood of a bubble decreases as non-residents' portfolio investment increases, which means the non-residents hold their equities for the purpose of investment. More specifically, holding the

<sup>4</sup> The results for the logit regressions are available upon request.

other variables are constant, a 1 percent increase in FPI increases the probability of bubble formation by 0.21 percent for BIST XUAll, 0.16 percent for BIST XU100 and 0.22 percent for BIST XU50. All these findings are consistent with the hypothesis.

Surprisingly, the variable EX has no statistically significant effect on the financial indices in contrast to what we expected. These results are especially important for the Banking sector, which makes up 82 percent of the financial system in Turkey. However, the influence of FPI and CDS are statistically significant in one case, which is BIST Real Estate. In estimated models, an increase in FPI and CDS by 1 percent decreases the probability of bubble formation for BIST Real Estate by about 0.15 percent and 0.20 percent respectively, when all other variables remain unchanged. This result is interesting for the variable FPI. In such a case, foreign stock investors might behave more rationally. Another noteworthy point is that VIX variable was found out to be negative and statistically important in one case where BIST Leasing, though it is unexpectedly positive in the case of BIST Real Estate, according to marginal effects. These results indicate that a 1 percent increase of VIX cause the probability of bubble formation for BIST Leasing to decrease by 0.31 percent, holding constant the remaining three variables. Lastly, in terms of BIST Real Estate, the effect of VIX on the estimated probability of a speculative bubble goes up by about 0.11 percent if VIX increases 1 percent, which is consistent with the hypothesis, keeping all other variables constant.

Regarding industrial indices, we find that the estimates of EX are insignificant all the cases, except for BIST Industrial, which suggests that if EX goes up by 1 percent, the likelihood of speculative bubble formation goes down by 0.91 percent, which is the opposite of our hypothesis, holding the other variables are constant. Besides, the effect of FPI on the probability of a speculative bubble is only statistically significant for BIST Non-Metal, which illustrates a 1 percent increase in FPI takes 0.40 percent increase in the likelihood of bubble formation. Observing CDS premium, it yields three cases of negative and statistically significant impact, namely the cases with BIST Food Beverage, BIST Textile Leather, and BIST Non-Metal. These results imply that a one percent increase in CDS premium would have reduced the probability of speculative bubble formation by 0.48 percent for BIST Food Beverage, by 0.53 percent for BIST Textile Leather, and 0.49 percent for BIST Non-Metal, keeping all other variables constant. Finally, the impact of VIX on the likelihood of speculative bubble formation is found to be statistically significant in the cases where BIST Food Beverage, BIST Wood Paper, BIST Chemical, and BIST Basic Metal and related negatively. The negative and statistically significant coefficients indicate that a 1 percent increase in VIX index causes a 0.14 percent, a 0.11 percent, a 0.29 percent and a 0.40 percent decline the probability of speculative bubble formation for BIST Food Beverage, BIST Wood Paper, BIST Chemical, and BIST Basic Metal, respectively, when all other variables remain unchanged.

**Table 4.** The Estimation Results of Marjinal Effects

		FPI	CDS	EX	VIX
Benchmark Indices	BIST XUAll	0.217**	-0.306***	-0.038	0.008
	BIST XU100	0.166**	-0.312***	-0.064	0.033
	BIST XU50	0.221**	-0.087	-0.596	-0.071
	BIST XU30	0.046	-0.047	0.189	-0.003
Financial Indices	BIST Financial	0.098	-0.140	0.126	0.035
	BIST Banks	0.012	0.024	0.017	-0.005
	BIST Holding & Inv.	0.040	-0.068	-0.047	0.024
	BIST Leasing	0.0416	-0.010	0.043	-0.310***
	BIST Insurance	0.205	-0.279	0.676	-0.229
	BIST Real Est.	-0.158**	-0.207**	-0.268	0.105**
Industrial Indices	BIST Industrial	0.675	-0.088	-0.913*	0.079
	BIST Food Bev.	0.008	-0.488***	0.070	-0.149*
	BIST Wood Paper	0.033	0.062	0.187	-0.116*
	BIST Metal Prod.	0.038	-0.163	0.027	-0.151
	BIST Chemical	0.143	-0.167	0.717	-0.292***
	BIST Basic Metal	0.178	0.042	0.621	-0.405***
	BIST Textile Le.	0.015	-0.530***	0.252	0.020
	BIST Non-Metal	0.401***	-0.495***	0.365	0.026
Service Indices	BIST Services	0.151	-0.141***	-0.593	0.047
	BIST Telecom.	0.025	-0.028	-0.239	0.033
	BIST Trade	-0.431***	-1.046***	0.006	0.213*
	BIST Transport.	0.281	-0.411***	3.050***	0.017
	BIST Tourism	0.165*	-0.101	-0.207	-0.063
Technology Indices	BIST Inf. Tech.	0.169	-0.161	0.126	0.121

**Notes:** \*\*\*, \*\*, and \* denote significance levels at 1 percent, 5 percent and 10 percent, respectively.

For service indices, the probability of speculative bubble formation increases when the variables EX and VIX goes up for BIST Transportation and BIST Trade sectors. On the other hand, the effect of FPI and CDS is positive an statistically significant coefficients imply that the CDS increases by 1 percent; the likelihood of speculative bubble decreases by 1.04 percent and 0.41 percent in BIST Trade and BIST Transportation, respectively, while the FPI decreases the probability by 0.43 percent. Again, the coefficient of FPI is negative in contrast to what we expected, which shows investors might have the more knowledge about the market.

## 5. Conclusion

This study attempts to investigate whether there exist multiple bubbles in the Turkish stock market using the GSADF test proposed Philips et al. (2013) and how

international investors' decisions affect the rational speculative bubbles. To sum up, our results, based on the significance of GSADF test statistics indicate that the null hypothesis of no bubbles is rejected for BIST Insurance, BIST Holding and Investment, and BIST Information Technology only. Regarding the logit model results, we conclude that several sectoral indices are prone to suffer rational speculative bubbles and the variables FPI, CDS, and VIX are the most important variables in order to explain the likelihood of the rational speculative bubbles.

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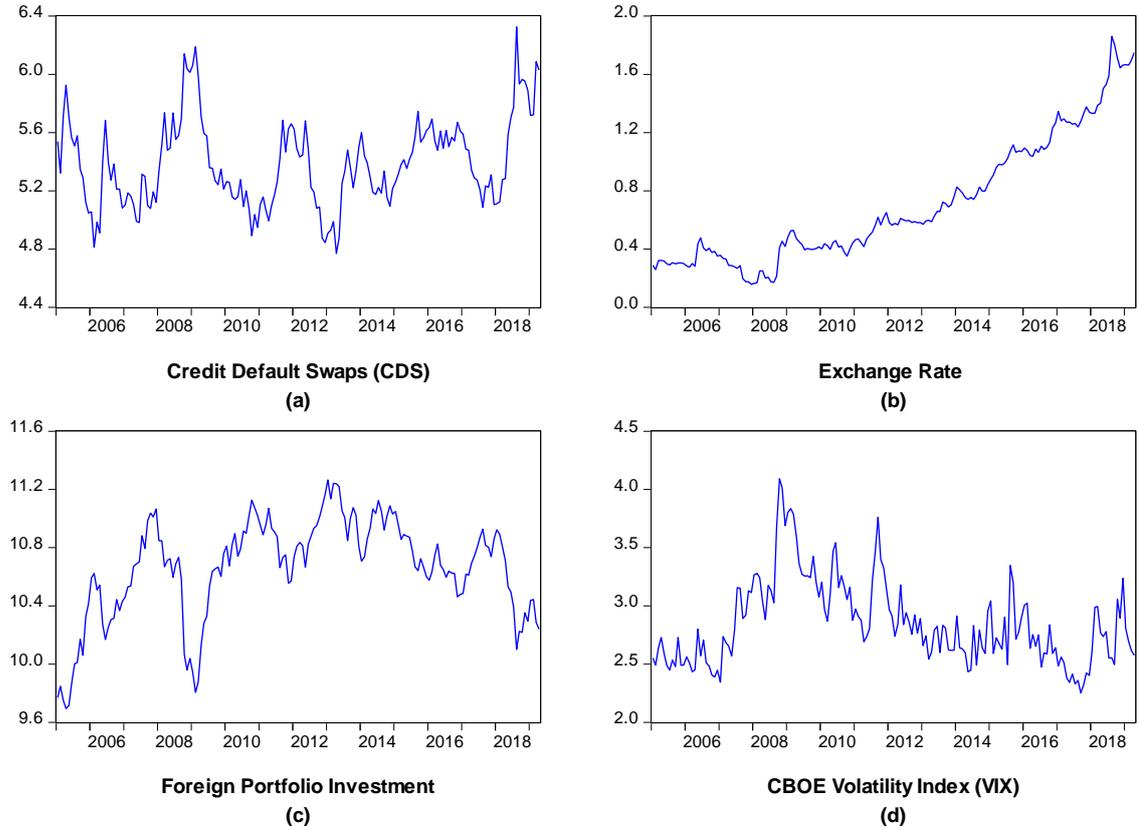
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## Appendix

**Figure 1: Variable Series (natural logs)**



**Source:** Datasetream, 2019