Chapter 4

Price Bubble in the Turkish Stock Market during Pre- and Post-Covid: Evidence from the SADF and GSADF Test

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Abstract

The study examines the possibility of a stock market price bubble in four sub-sector stock indices (financial, industrial, service, and technology) and the BIST 100 composite index in Turkey by using the monthly data spans from 2000 to 2023. To capture the irrational prosperity in Turkish stock markets, we employ the supremum augmented Dickey-Fuller (SADF) and the generalized supremum augmented Dickey-Fuller (GSADF) methodologies. Our primary focus is on the construction of price bubbles, particularly in the aftermath of the COVID-19 pandemic. Presently, there are ongoing and intense discussions regarding the potential emergence of such bubbles. The conclusion implies the presence of speculative bubbles in all sector-specific stock market indexes, with the exception of the technology index, subsequent to the complete removal of COVID-19 restrictions by the Turkish government. Moreover, the results show that exuberant investor behavior also occurred in some sub-periods other than the post-COVID-19 period for all stock market indices.

1. Introduction

The speculative bubbles have long been discussed in literature. A bubble is characterized as a period of unsustainable expansion, during which the value of an asset experiences rapid and escalating development, followed by alternating stages of corrections and rebounds. From a technical standpoint, during a bubble phase, the price exhibits a growth pattern that is faster than exponential, typically accompanied by log-periodic oscillations (Sornette & Cauwels, 2015). The occurrence of substantial surges in stock values followed by abrupt declines has prompted several researchers to investigate

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https://doi.org/10.58830/ozgur.pub395.c1722

the existence of speculative bubbles. Several notable contributions have been made in the field of bubble detection over the past decades (Papastamatiou & Karakasidis, 2022). Noteworthy works include Shiller (1981) and LeRoy & Porter (1981), who introduced variance bounds tests as a means of identifying bubbles. Another significant contribution is the two-step test for bubbles developed by West (1987). Additionally, Froot & Obstfeld (1991) explored the concept of intrinsic bubbles, further enriching the discourse on this topic. On the other side, Phillips et al. (2015) proposed a recursive testing process that exhibits selective capability in identifying regularly collapsing bubbles, thereby addressing a limitation of unit root tests in the context of economic bubbles[2]. The use of a real-time financial bubble recognition method, as presented by Phillips et al. (2015), is employed in this study.

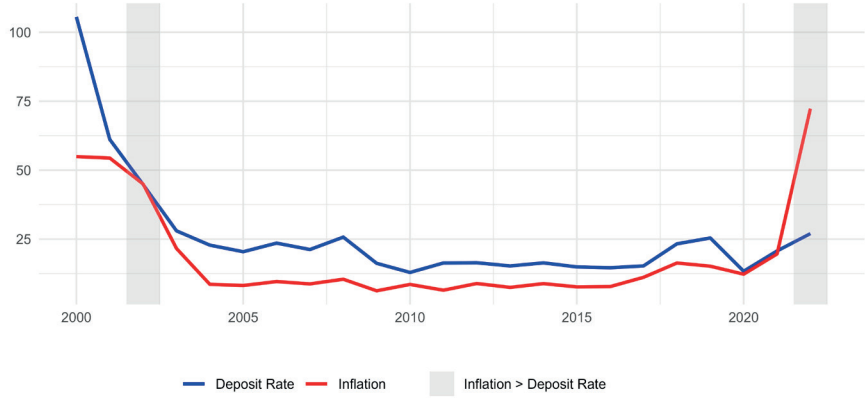
The objective of this study is to examine the existence of stock bubbles in composite and four sectors (i.e., service, financial, industrial, and technology) of the stock market in Turkiye over the period from 2000-M6 to 2023-M9. Our primary focus is to examine if the bubble exists across the stock market in Turkiye as a whole or restricted to certain sectors. According to Greenwood et al. (2019), a pronounced escalation in the value of an asset creates a substantial likelihood of an impending collapse. Hence, the precise recognition of asset price bubbles and the prediction of their eventual collapse earlier have substantial importance for both market players and macro regulatory agencies. This study is expected to provide valuable insights for those investing in the Turkish stock market.

The data used in this study was obtained from the Central Bank of Turkey (CBRT) database. We tried to go back as far as possible, depending on the availability of data. We focus on the BIST 100 index as well as four different sub-sectors indices. The observation period covers approximately a quarter-century period that Turkey has experienced since the 2001 economic crisis. The observation period used in the study covers very important financial and economic events such as the 2008 Global Financial Crisis, the 2018 exchange rate crisis in Turkey, and the COVID-19 pandemic. Figure 1 presents the temporal progression of the 3-month deposit rate and the year-on-year inflation rate in Turkey, spanning the years 2002 to 2022. The shaded region represents time intervals during which the deposit rate is below the inflation rate. To put it differently, the cost of borrowing cash is currently quite low. It can be postulated that during periods characterized by low interest rates,

2 See Gürkaynak (2008) and Vogel & Werner (2015) to get comprehensive understanding of the methodologies used in prior seminal research on bubbles, crashes, and volatility.

individuals contribute to the formation of asset price bubbles through the acquisition of loans from banks. This study also examines the accuracy of this postulation.

Figure 1 Deposit rate and inflation over years



The contribution of this paper can be classified into three distinct aspects. First, this study aims to examine the phenomenon of bubble formation within sub-sectors of the Turkish stock markets, representing a novel contribution to the existing body of knowledge. The empirical evidence reveals a certain degree of similarity in the occurrence of bubble periods within corresponding sectors. Nevertheless, it is worth noting that technology stocks exhibit distinct patterns of movement in comparison to other sectors. Second, the analysis periods encompass a range of significant economic events, including but not limited to the 2001 economic crisis, the 2008 global financial crisis, the Europe debt crisis, Brexit, the 2018 Turkish exchange crisis, and the recent COVID-19 health crisis, all of which exert an influence on the Turkish stock markets. Examining the potential overvaluation of the stock market across various time periods enables us to draw insightful retrospective conclusions. Third, it is important to note that empirical results provide evidence of the presence of spillover effects between these sectors.

The findings obtained in this study are briefly summarized as follows: (1) Unprecedented price bubble formation is observed in all sub-stock indices, excluding the technology index, after the post-covid period. (2) The technology index has seen a persistent price bubble subsequent to the year 2016. However, this is not valid for other stock indices. (3) A

similar situation is observed inside the banking industry subsequent to the year 2005. (4) Following the occurrence of the 2008 Global Financial Crisis, it can be observed that the presence of excessive liquidity stemming from unconventional monetary policy measures does not lead to any kind of overvaluation within the Turkish stock market. Nevertheless, explosive behavior is documented across all other industries in the aftermath of the COVID-19 pandemic.

The remainder of the study is as follows: The subsequent section provides an overview of the existing body of literature. The third section of the paper presents the methodology employed in the study. The fourth section of the paper presents the empirical findings, while the final section serves as the conclusion.

2. Literature Review

Stock prices in several countries have increased significantly since COVID-19 ended with its negative health effects. To give one example, the S&P 500 index, which fell to 2300 immediately after COVID-19 began in March 2020, crossed the 4800 criteria by the end of 2021. The DAX index fell to almost 9000 during the same period and jumped to nearly 16000. Global central banks adopted an expansionary policy posture in reaction to the COVID-19 pandemic (Cantú et al., 2021). The equities market, which has long been seen as an indicator of the overall health of the national economy, is among the most crucial elements of the economic system that reacts to a pandemic (Salisu & Sikiru, 2020). Furthermore, the COVID-19 pandemic caused the stock market to crash globally, causing considerable fear and unrest in the financial markets (Nicola et al., 2020). This implies that pandemics have an impact on investors' expectations as well, which could result in a decline in stock returns. Nevertheless, the exponential surge in the financial markets following the outbreak has sparked conversations about "The Fear of Missing Out" and the possibility of a speculative bubble.

Several research in the literature have investigated the impact of the COVID-19 pandemic on financial assets, specifically focusing on the phenomenon known as the bubble effect. Li et al. (2021) investigates the presence of a price bubble in medical masks, with particular emphasis on the COVID-19 pandemic. The empirical findings demonstrate the presence of several bubbles in the year 2020, which exhibit a correlation with events related to COVID-19. In addition, Wang et al., (2022) utilize both the SADF and GSADF tests to examine the presence of bubbles in the tourism stock markets of Taiwan and Mainland China. Th evidence indicates the presence

of bubbles in the Taiwan tourism stock market over certain periods, including the recent COVID-19 epidemic. (Azman Aziz et al. (2022) examine the impact of the COVID-19 pandemic on asset price bubbles in the stock and oil markets of the United States and Malaysia by using GSADF method. The empirical findings indicate that five out of the six stocks, including the oil price indexes, exhibited numerous bubbles. Chang et al. (2021) examines the existence of speculative bubbles in the United States markets from 2015 to 2019, with a particular emphasis on the time affected by the COVID-19 pandemic and they find evidence to support the presence of a market bubble in the US stock market for certain sub-sample time periods.

There are several studies done so far have focused on the presence of bubble in In Turkish stock market. For instance, in his recent study, Şahin (2020) investigates the existence of speculative bubble price formation is tested using the GSADF test using the daily closing prices from 2006 to 2019 for Istanbul Stock Exchange Istanbul 100 (XU100). The study provides though evidence of the formation of bubble in the XU100 Index. On the other hand, (Yanık & Aytürk, 2011) examines the 2002–2010 Turkish stock market bubble. The duration dependence test detects rational speculative bubbles in Turkish stocks. The non-parametric duration dependence test also shows no negative duration dependence in runs of positive excess returns, indicating no rational expectations bubbles over the sample period.

Another empirical study carried out by Çıtak (2019) examines four sectoral indices of stock prices operated in the Turkish stock market and analyzes evidence of rational speculative bubbles using the GSADF test. He finds that foreign portfolio investment (FPI), credit default swap spreads (CDS), and volatility index (VIX) are the important indicators that cause the probability of bubble formation in the Turkish stock market. Hatipoglu & Uyar (2012) examine the external factors that contribute to the formation of bubbles in the Turkish stock market and conclude that the bubble in the US stock market had a direct impact on the bubble in Turkey during the major financial crises of the past two decades. Like in this study, Yıldırım & Akdağ (2021) examine the presence of price bubbles in the BIST100 and 23 sector indices, particularly during the pandemic period. They utilize the Generalized Sup-Augmented Dickey Fuller (GSADF) test on daily opening data from March 11, 2020, to December 31, 2020. Statistical analysis of 23 sector indexes during the pandemic showed that a price bubble was present in ten of them, while the remaining 13 did not exhibit any signs of a price bubble. We can exemplify various important studies (i.e., Akkaya, 2018; Çağlı & Mandacı, 2017; Gök, 2021; Işıldak, 2022; Karcıoğlu & Akyol Özcan, 2023; Kılıç, 2020; Korkmaz et al., 2016; Ünal & Çömlekçi, 2021;

Ural, 2022; Yıldırım & Akdağ, 2021) to investigate bubble formation in Turkish stock market.

This study makes a substantial contribution to the current body of literature investigating the phenomenon of bubble building in the Turkish stock market. We expand upon the prior research to encompass the post-Covid era, characterized by an unprecedented rise in stock prices. We compare our empirical findings and discuss them with previous findings in Section 5.

3. Methodology

The research technique employed in this study is founded upon an innovative approach to asset bubbles that addresses the rapid and unpredictable fluctuations in asset prices. The methodology for assessing the asset bubble was initially proposed by Phillips et al. (2011), which was then expanded upon by Phillips et al. (2015) and further improved by Shi & Phillips (2023), as stated by Trojanek et al. (2023).

The bubble test is fundamentally grounded in the ADF regression model, and the ADF model can be constructed as shown below:

$$y_t = \alpha_{r1,r2} + \beta_{r1,r2} y_{t-1} + \sum_{i=1}^{k} \delta^{i}_{r1,r2} \Delta y_{t-1} + \varepsilon_t \qquad (1)$$

where y_t represents the actual stock price in Turkey. The error term is denoted as ε_t, the intercept is represented by $\alpha_{r1,r2}$, the autoregressive coefficient is denoted as $\beta_{r1,r2}$, and the beginning and ending points used in the estimate technique are respectively referred to as r_1 and r_2. The initial difference operator is denoted as Δ, while the number of delays is represented by k.

Based on equation (1), we test mildly explosive root by using null hypothesis H0: $\beta_{r1,r2} = 1$ (no bubble) against H1: $\beta_{r1,r2} > 1$ (explosive behavior) as stated by Phillips & Magdalinos (2007).

In addition to conventional ADF statistics computed for the whole time period, this study employs the Supremum Augmented Dickey-Fuller (SADF) test proposed by Phillips et al. (2011) PWY. This corresponding test relies on supremum t-statistics derived through forward recursive estimation, as outlined in the work by Caspi (2015).

$$\mathrm{SADF}_{(r0)} = \sup_{r2\in[r0,1]} \mathrm{ADF}_0^{r2}$$

stock price explosions are identified by date-stamping. Recursive windows in the PWY approach provide consistent identification of the first bubble's start and finish (stamping relevant dates). If bubbles arise again, their effectiveness is limited. Phillips et al. (2015) show that the PWY technique fails when numerous explosive periods occur in an observation period. This study employs another bubble indicator developed by (Phillips et al., 2015) that based on Generalized Supremum Augmented Dickey-Fuller (GSADF) test to account for several bubbles. Sample sequences with observation ranges from 0 to r2-r0 and r0 to 1 are tested.

$$\mathrm{GSADF}_{(r0)} = \sup_{r1\in[0,r2-r0]r2\in[r0,1]}\mathrm{ADF}_{r1}^{r2}$$

Monte Carlo simulations are used to determine critical values for right-tailed SADF and GSADF tests. We also give the empirical results of SADF and GSADF test procedures to detect regional stock price dynamics in Turkiye.

4. Data and Descriptive Statistics

The data utilized in this study was acquired from the database of the Central Bank of the Republic of Turkiye (CBRT). The data is collected on a monthly basis and covers the time period from June 2000 to September 2023. We utilize sector indexes, specifically the financial (XUMAL), industrial (XUSIN), service (XUHIZ), and technology (XUTEK) sectors, in addition to the BIST 100 composite index (XU100). Table 1 presents the fundamental descriptive data of the associated composite and sub-sector indexes.

Table 1 Descriptive Statistics

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
Composite	868.41	633.00	7956.75	71.17	1110.47	3.68	18.41	3400.95***
Financial	1015.32	921.75	8122.57	93.48	1049.91	3.58	18.87	3536.63***
Industrial	1115.83	548.43	12996.72	56.93	1884.53	3.66	17.59	3108.43***
Service	654.89	413.36	7277.55	40.44	983.72	4.02	21.34	4675.42***
Technology	744.19	232.36	8978.43	38.50	1284.38	3.35	16.13	2535.54***

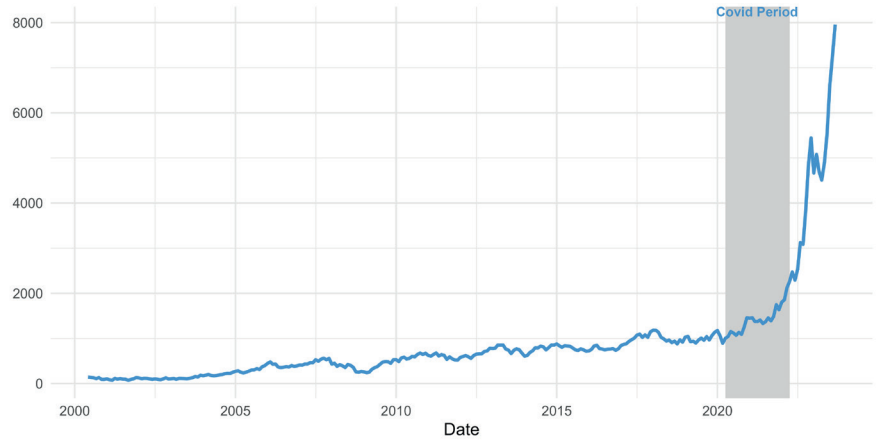
Note: The symbols *, **, and *** represent the levels of significance at 10%, 5%, and 1%, respectively.

In countries experiencing strong inflation, the prices of products and services produced by firms rise, and total sales and total profits grow in nominal value, even if not in reel value. It is important to adjust stock prices

based on inflation because high inflation may mislead investors when trying to understand the presence of a bubble. When obtaining inflation-adjusted series, we utilize the monthly Consumer Price Index (CPI) index.

Figure 2 depicts the BIST 100 composite index corrected for inflation over the observation period. As depicted in the diagram, there is a clear linear pattern observed prior to the onset of the COVID-19 pandemic. Amidst the COVID-19 period, there was a steady rise in the trend. However, in the aftermath of the COVID-19 pandemic, the index has experienced a significant and rapid increase. The graph clearly demonstrates the significance of studying the period of bubble formation, hence enhancing the importance of this research.

Figure 2 Inflation-Adjusted BIST 100 Composite Index Over Time



Note: On March, 2020, the first case of coronavirus confirmed. On May 5, 2023, the World Health Organization (WHO) terminated its proclamation of a Public Health Emergency of International Concern (PHEIC).

5. Empirical Results

The computation of the test statistics for the recursive unit root test requires choosing the minimum window size, r_0, and the autoregressive lag duration, k. The minimum window size must be sufficiently large to accommodate early estimation; however, it should be controllable to prevent the omission of brief moments of exuberance. In accordance with the guideline of Phillips et al. (2015), we determined the minimum window size using the rule of thumb: $r_0 = (0.01 + 1.8/\sqrt{T})T$, where T denotes the sample size. The sample size in this study is 280, so we used 36 as a window

size. We chose a lag length of 1 since the recommended right-tailed unit root works well when the number of lags is small, as proposed by Vasilopoulos et al. (2022). Regarding the autoregressive lag length, denoted as k, we primarily analyze our findings for two scenarios: when k is equal to 0 and 1. The sensitivity of our findings to the lag length specification is negligible. The only difference comes from the technology index. When we select $k=0$, the bubble formation exists for XUTEK after the whole period after the COVID-19 outbreak. We do not say the same thing when selecting $k=1$[3].

Table 2 shows SADF and GSDAF results for Turkiye real stock prices in different industries. The two econometric tests showed no significant differences. Both test results show evidence of exuberance in all sectors, according to the GSADF. Based on the exceptional power qualities of the GSADF test, we can conclude that bouts of excessive enthusiasm were prevalent in the stock market in Turkish sub-sectors. These results support some previous studies, such as Çağlı & Mandacı (2017) and Işıldak (2022), but contrast with other academic papers (i.e., Kılıç, 2020).

Table 2 Results for the univariate SADF and GSADF tests (lag = 1)

Code	SADF	GSADF
Composite	7.23***	7.52***
Service	9.12***	9.16***
Financial	7.45***	7.45***
Industrial	6.60***	6.60***
Technology	3.95***	4.22***

Note: The SADF bootstrap critical values are 1.90, 1.41, and 1.14 at the 1%, 5%, and 10% levels, respectively, while the GSADF values are 2.66, 2.09, and 1.80 at the corresponding significance levels.

Figs. 3 and 4 display a chronological representation of the times of exuberance identified by inflation-adjusted stock price. These plots provide very crucial information to us about when a bubble occurs in Turkish stock markets. The red line shows the beginning and end of the COVID-19 health crisis. The duration of COVID-19 in Turkey was around 2 years. We designated March 2020 as the commencement date of the COVID-19 pandemic. This is the day of the formal announcement of the first reported case. March 2022 marked the conclusion of COVID-19, as it was the

3 The output of this analysis will be provided upon request.

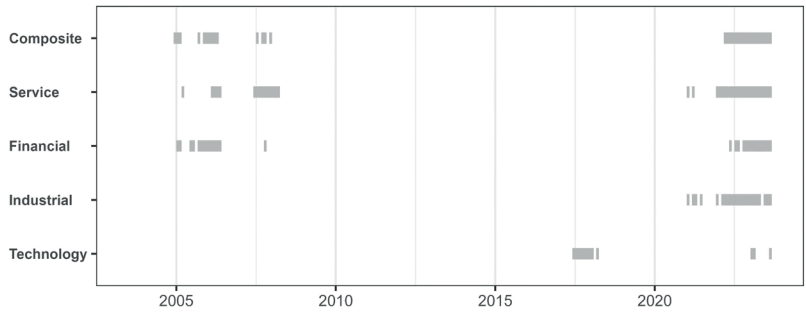
official date when all the restrictions imposed by COVID were lifted. As depicted in the diagram, there is an absence of any speculative bubbles in the Turkish stock markets over this time frame. However, with the removal of all COVID-related constraints, the creation of bubbles has been witnessed in all indices except for the technology index, and this situation is now ongoing[4]. Stock investors diversifying their investments beyond the technology sector should exercise caution over abrupt market downturns following a speculative bubble. Another noteworthy finding is that the composite, service, and financial indices all exhibited the formation of a speculative bubble prior to the 2008 Global Crisis. Moreover, the results obtained based on the technology index indicate the existence of a period of exuberance in the years 2015–2017.

Figure 3 Date-stamping periods of exuberance in different Turkish housing market regions (GSADF method results)[5]

4 When k is set to 0, we can detect the emergence of a bubble in the technology index following the COVID-19 pandemic.

5 The outcomes of the GSADF have recently been incorporated. According to Phillips et al. (2015), the GSADF method yields superior outcomes in situations where the likelihood of numerous bubbles recurring is high. Upon request, the author can provide the empirical findings of the SADF method.

Figure 4 Date-stamping periods of exuberance in different Turkish housing market regions



6. Conclusion

The study of stock market bubbles continues to be a fascinating subject for financial research. This study examines the identification of stock market bubbles in major Turkish stock indices between 2000 and 2023. We especially focus on the pre- and post-COVID periods, as we observed an unprecedented increase in stock prices following the pandemic. The question of whether this situation constitutes a bubble is a subject of ongoing discussion among economists. It was previously anticipated that the Turkish stock market would see significant declines following the rise in interest rates after the general election. However, contrary to these predictions, such collapses did not occur.

This study adds to the growing economic literature of stock bubble in Turkey. The first finding of our study demonstrates the presence of a stock bubble in Turkiye once the Turkish government completely lifted the restrictions, they put in place to curb the coronavirus outbreak. We have robust evidence that stock market indices other than technology are overpriced following COVID-19. In line with some popular beliefs expressed in the media, we observe signs of explosive behavior in the Turkish stock market after COVID-19 restrictions were lifted completely. It is worth noting that the preceding occurrence of a bubble in technology stocks was noted subsequent to mid-2017. Moreover, empirical results do not provide evidence to support bubble formation in stock markets after the 2008 financial crisis. This is crucial because, the Federal Reserve acquired significant amounts of assets with medium and long maturities as part of its efforts to loosen monetary policy to mitigate the impact of the worsening

economic outlook. The relationship between a significant increase in monetary supply and the emergence of speculative bubbles in financial assets aftermath is a subject of debate among academic environment.

Even if the Turkish economics and finance literature has explored the causes of asset bubbles, it has largely overlooked the impact of international capital flows on financial asset price, particularly during periods of free money following crises. It is wise to think that doing researches on this area will make a substantial contribution to the existing body of knowledge. Examining the effects of variables (i.e., global uncertainty, global quantitative easing) on the formation of asset bubbles may give particularly intriguing results.

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