

İlbasmış, Metin

## Article

# Underpricing and aftermarket performance of IPOs during the Covid-19 period: Evidence from Istanbul stock exchange

Borsa İstanbul Review

## Provided in Cooperation with:

Borsa İstanbul Anonim Şirketi, İstanbul

*Suggested Citation:* İlbasmış, Metin (2023) : Underpricing and aftermarket performance of IPOs during the Covid-19 period: Evidence from Istanbul stock exchange, Borsa İstanbul Review, ISSN 2214-8469, Elsevier, Amsterdam, Vol. 23, Iss. 3, pp. 662-673, <https://doi.org/10.1016/j.bir.2023.01.004>

This Version is available at:

<https://hdl.handle.net/10419/340388>

### Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

### Terms of use:

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<https://creativecommons.org/licenses/by-nc-nd/4.0/>

## Underpricing and aftermarket performance of IPOs during the Covid-19 period: Evidence from Istanbul stock exchange

Metin İlbasmış

Aksaray University, Faculty of Economics and Administrative Sciences, Aksaray 68100, Türkiye

Received 7 June 2022; revised 7 January 2023; accepted 9 January 2023

Available online 30 January 2023

### Abstract

The effect of uncertainty on IPO underpricing, short-term performance after IPO, and hot-and-cold-IPO market cycles have received a great deal of attention in the literature. This study revisits these issues of IPO activities under the Covid-19 pandemic with a focus on the Turkish IPO market. Measuring the underpricing and aftermarket performance of IPOs based on the cumulative abnormal returns of the first, second, third, fourth, fifth, tenth, and twenty-first days, we examine how underpricing and aftermarket performances are influenced by Covid-19 and some uncertainty proxies, such as some company characteristics (age, total assets), offering characteristics (gross proceeds, IPO price risk), and aftermarket variables (first-day trading volume, standard deviation of stock prices after the IPO) after controlling for firm, industry and market level variables (first-day trading value, the portion of the firm offered to public, price-earnings ratio, dummy variables for technology, manufacturing, and financial institutions sectors, standard deviation of a market index, moving average return of a market index). The study documents that while an IPO launched during the Covid-19 period has larger underpricing, an average IPO firm that is older, has more assets, generates larger proceeds, trades more on its first day of trading, is expected to fluctuate less after the IPO has a smaller underpricing at its initial public offering. Empirical results show that short-term market-adjusted abnormal returns of IPO firms during the pandemic are much larger than those before the pandemic.

Copyright © 2023 Borsa İstanbul Anonim Şirketi. Published by Elsevier B.V. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

*JEL Classification:* G14; G18; G32; H12

*Keywords:* Initial public offerings; Short-term performance; IPO Underpricing; Uncertainty; Covid-19

### 1. Introduction

The declaration of COVID-19 virus as a pandemic in March 2020 by the World Health Organization led to a substantial slowdown in economic activity, stock market indices plummeted, and financial markets experienced extraordinary volatility. The World Bank records indicate that the global GDP in

2020 fell by 3.3% when compared with 2019.<sup>1</sup> From February to March 2020, the CBOE Volatility Index (VIX) increased by more than 340%.<sup>2</sup> However, despite the deterioration of the world economy and financial markets, IPO activity has experienced a dramatic increase. The PWC Global IPO Watch reports that in 2020 and 2021, IPO activity increased by 36.9% and 89.4%, respectively. In contrast to the worldwide IPO activity during the COVID-19 period, the Turkish IPO market showed a more significant increase. A total of 8 Turkish IPOs took place in 2020, up 33%, and 53 IPOs took place in 2021, representing an increase of 563%. Türkiye recorded the highest annual number of IPOs in its history in 2021.

Although there is a relatively mature empirical literature on IPOs, there is a dearth of studies examining the activities of IPOs during a time of global pandemic. As a result of the

*E-mail address:* [metinilbasmiss@gmail.com](mailto:metinilbasmiss@gmail.com).

Peer review under responsibility of Borsa İstanbul Anonim Şirketi.

<sup>1</sup> The World GDP data are available at this URL: <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?end=2020&start=2015>.

<sup>2</sup> The number of IPOs by quarters is available at this URL: <https://www.pwc.com/gx/en/services/audit-assurance/ipocentre/ipo-journey/ipo-watch-data-explore-exchange.html>.

unprecedented level of IPO activity in 2020 and 2021, this time period merits academic attention. In this study, we revisit some of the well-known issues in the IPO literature and provide insights into these issues in the context of the Turkish IPO market within the Covid-19 framework. Specifically, the study analyzes (i) the trend in IPO underpricing during the Covid-19 era, (ii) the factors that influence underpricing, and (iii) the effects of Covid-19 on underpricing and aftermarket performance of IPOs.

We measure the underpricing and aftermarket performance of IPOs based on the cumulative market-adjusted abnormal returns of the first, second, third, fourth, fifth, tenth, and twenty-first days. In this study, we examine how underpricing and aftermarket performance of IPOs are influenced by Covid-19 and uncertainty proxies, such as some company characteristics, offering characteristics, and aftermarket variables. A dataset that includes all IPOs on the Istanbul Stock Exchange from January 2010 to December 2021 is used to empirically show that IPO underpricing exists and is influenced by Covid-19. Our findings document that while IPO underpricing was not observed during a seven-year timeframe preceding the Covid-19 period, heavy underpricing in IPO prices is observed after the Covid-19 virus strikes. During the Covid-19 period, there was a high volume of IPOs and huge discounts at IPO prices, suggesting there is a hot market for IPOs. In addition, the study documents an association between IPO underpricing and firm, industry, and market level uncertainty. A key finding of the study is the following. While an IPO launched during the Covid-19 period has larger underpricing, an average IPO firm that is older, has more assets, generates larger proceeds, trades more on its first day of trading, is expected to fluctuate less after the IPO has a smaller underpricing at its initial public offering. Furthermore, an IPO clustering is observed across manufacturing and financial institutions sectors, but these industries do not appear to have any impact on underpricing. In terms of short-term performances of IPO firms, empirical results show significant differences before and during the pandemic; short-term market-adjusted abnormal returns of IPO firms during the pandemic are much larger than those before the pandemic.

The remainder of the paper proceeds as follows. Hypotheses are developed in Section 2 along with a review of literature. Section 3 describes the sample and presents the sample statistics. Empirical results on the uncertainty of IPO firms during the Covid-19 period, the relationship between underpricing of IPO and Covid-19, and aftermarket performances of IPOs are given in Section 4. The final Section 5 discusses our overall findings and makes concluding remarks.

## 2. Hypothesis development and literature review

IPO underpricing has received considerable attention and been well documented by a number of researchers around the world (Ibbotson, 1975; Loughran et al., 1994; Loughran & Ritter, 2004; Rock, 1986; Zhou & Sadeghi, 2019). IPO literature does not present a universal underpricing theory that can be applied to all times or countries. A review of the literature suggests that IPO underpricing can be explained by four primary theories: asymmetric information, institutional explanations,

ownership and control of the firm considerations, and behavioral explanations. Asymmetric information models, a key approach in most theoretical interpretations, account for underpricing of IPOs through numerous factors, such as information asymmetry between issuers and investors (Allen & Faulhaber, 1989; Booth & Smith, 1986; Ibbotson, 1975), information asymmetry between issuers and underwriters (Baron, 1982), and information asymmetry among investors (Beatty & Ritter, 1986; Rock, 1986; Welch, 1992). A common assumption in these approaches is that underpricing helps overcome any uncertainty harming the firm during the IPO process by reducing the possible negative effects on ex-ante uncertainty about the IPO firm. Further, IPO underpricing is explained by signaling theory based on Ross (1977), which states that capital structure decisions by managers serve as a signal to the market about the firm's future performance. Allen and Faulhaber (1989); Grinblatt and Hwang (1989) and Welch (1989) are some well-known studies proposing signaling-based theories, which assume that the issuer knows the true value of the firm and uses underpricing as a way to distinguish itself from low-quality firms. The literature supports this concept by arguing that underpricing is more likely to occur when there is ex-ante uncertainty regarding the company's true value (Beatty & Ritter, 1986; Keasey & Short, 1992; Kiyamaz, 2000; Ritter, 1984, 1987, 1991).

External shocks to the market through the influence of ex-ante uncertainties may also directly or indirectly affect the severity of information asymmetry problems, in addition to those related to issuers, underwriters, and investors. A market shock such as a pandemic may exacerbate the need for high-quality firms to distinguish themselves from low-quality firms by increasing ex-ante uncertainty. Studies relating underpricing with ex-ante uncertainty, whether influenced by internal or external effects, overwhelmingly predict and document a positive association between the two (Braun & Fawcett, 2006; Michaely & Shaw, 1994; Mok & Hui, 1998). A variety of proxies have been used to measure ex-ante uncertainty. Company characteristics such as age (Engelen & Van Essen, 2010; Ljungqvist & Wilhelm, 2003; Megginson & Weiss, 1991; Ritter, 1984), size (Beatty & Ritter, 1986; Ritter, 1984), industry data (Benveniste et al., 2003; Ritter, 1984); offering characteristics such as gross proceeds and the inverse of IPO price (Beatty & Ritter, 1986; Ljungqvist & Wilhelm, 2003; Ritter, 1987; Rock, 1986); aftermarket variables such as trading volume (Miller & Reilly, 1987) or volatility (Ritter, 1984, 1987) are the most widely accepted variables to measure IPO uncertainty.

The Covid-19 pandemic has raised questions about whether the ex-ante uncertainty, as predicted by the above studies, has increased as a result of the pandemic. A hypothesis is therefore offered as a means of testing this notion.

**Hypothesis 1.** Ex-ante uncertainty has increased during the Covid-19 pandemic period.

A key implication of asymmetric information theories is that there is a positive relationship between underpricing and ex-ante uncertainty about IPO firms. Among the most well-known papers in this area are Ritter (1984); Beatty & Ritter

(1986), which suggested that underpricing should increase in uncertainty about a firm's value after its IPO. The greater the ex-ante uncertainty about the value of the IPO, the more underpricing is needed. The intuition provided is as follows. Investors of the companies that go public face an information asymmetry problem, which is why these companies offer a discounted price on their IPO. The IPO firms will leave some 'money on the table' as compensation for the costs of collecting information about the true value of their firm. This is to ensure that investors participate in the IPO. These studies are followed by several studies (Ljungqvist, 2007; Megginson & Weiss, 1991; Miller & Reilly, 1987; Ritter, 1984, 1987), which document the relationship between first-day returns and ex-ante uncertainty.

A financial market that is disrupted by the Covid-19 pandemic may increase the severity of information asymmetry and the cost of allocating information about a firm's true value. To ensure a successful IPO, firms going public may need to further discount their IPO price. Therefore, since investors pay to gather information, during the Covid-19 pandemic period, becoming an informed investor must become increasingly difficult as the problem of asymmetric information becomes more severe. We anticipate this will lead IPO firms to offer heavy discounts in the IPO price to attract investors and encourage them to participate in the IPO process. Based on the potential effects of Covid-19-related outbreaks on financial markets, we propose the following hypothesis.

**Hypothesis 2.** During the Covid-19 pandemic period, underpricing increased as compared to the period before the pandemic.

The literature shows that IPO underpricing is prevalent. However, while investors enjoyed positive abnormal returns on the first day of trading due to the underpricing, aftermarket returns for these firms declined. This study adds to the IPO underpricing literature by investigating short-term aftermarket performance of IPO firms during the Covid-19 pandemic period and comparing it with the performance during the pre-pandemic period. Thus, the study provides a comparative assessment of the impact of the Covid-19 pandemic on IPO activity by examining the short-term aftermarket performance of IPOs.

Despite outstanding initial day returns, empirical evidence on the performance of IPOs over the short term is mixed. US IPOs are usually associated with negative aftermarket returns (Aggarwal & Rivoli, 1990; Loughran & Ritter, 1995; Reilly, 1977; Ritter, 1991). Using data on Turkish initial public offerings between 1990 and 1996, Kıymaz (2000) finds positive and significant aftermarket performance up to four weeks after the IPO. Taking into account the uncertain duration of the underpricing resulting from the higher ex-ante uncertainty during the Covid-19 period, and the lack of consensus within the empirical literature regarding the performance of the firm following its IPO, the following hypothesis is proposed.

**Hypothesis 3.** IPO aftermarket performance is unrelated to the Covid-19 period.

### 3. Data and sampling

#### 3.1. Data

The sample for this study includes 166 firms that completed public offerings on the Istanbul stock exchange between January 2010 and December 2021. 105 of these IPOs occurred before Covid-19 began, while 61 of them occurred during Covid-19. The time window was chosen in order to ensure that there are enough data points and a sufficient variation in the sample. Firm and index prices are collected from Borsa İstanbul<sup>5</sup>, accounting data and firms sector information are obtained from the Turkish Public Disclosure Platform<sup>6</sup>, ages are taken from firms official websites, consumer price index (CPI) data to calculate inflation are retrieved from Eurostat data.

In accordance with the literature on IPO underpricing, the initial day abnormal returns and cumulative abnormal returns for each company are calculated as follows;

$$AR_{it} = \frac{CP_{it} - OP_i}{OP_i} - R_{mt} \quad (1)$$

where,  $AR_{it}$  is the abnormal return of the firm,  $OP_i$  is the offer price at IPO,  $CP_{it}$  is the closing price of the firm and  $R_{mt}$  is the cumulative return on the market index from the day of the firm's IPO. When  $t = 1$ , the first day of trading, IPO underpricing is calculated.

$$CAR_{it} = \sum_{t=1}^n AR_{it} \quad (2)$$

where,  $CAR_{it}$  is the cumulative abnormal return of the firm from its IPO day.  $t$  takes values of 1, 2, 3, 4, 5, 10, and 21. The initial day return may not capture the market's full reaction to the initial price at IPO since daily price fluctuations are restricted in the Turkish stock market. Therefore, it may not represent the extent of underpricing. By using return measures covering a longer window, we allow investors to correct the underpricing of IPO price to a greater degree. Thus, cumulative abnormal returns up to a month after the stock offering are considered due to daily volatility limits. These aftermarket performance measures are 1st, 2nd, 3rd, 4th, 5th, 10th, and 21st day returns.

#### 3.2. Data statistics

Table 1 reports the total number of IPO firms in each year during the sample period of 2010–2021, as well as the sum of gross proceeds from these IPOs in both Turkish lira (TL) and the U.S. dollar (USD) terms. The table shows that 61 of 166 firms that went public during the Covid-19 period, raised around 22 billion TL or 2.5 billion USD, the vast majority taking place after the first quarter of 2021, an IPO record for

Table 1

**Descriptive Statistics of Gross Proceeds.** This table presents the annual number of initial public offerings and their gross proceeds from January-2010 to December-2021. Gross proceeds are given in both the Turkish lira and the U.S. dollar. Exchange rates on the last day of public offering sales are used to convert amounts into dollar. The sample consists of 166 firms, 105 of which sold shares to the public before and 61 of which did so during the Covid-19 period.

Year	N	Frequency (%)	Gross Proceeds (TL)	Gross Proceeds (USD)
2010	22	13.25	142.0	95.6
2011	25	15.06	52.1	33.1
2012	16	9.64	33.2	18.6
2013	9	5.42	145.0	80.3
2014	9	5.42	76.7	34.3
2015	4	2.41	27.4	10.3
2016	2	1.20	172.0	58.7
2017	3	1.81	418.0	118.0
2018	9	5.42	602.0	152.0
2019	6	3.61	44.0	7.6
2020	8	4.82	140.0	18.5
2021	53	31.93	407.0	46.2
Total	166	100	2259.4	673.2

the national public offering market despite the uncertainty created by Covid-19. This is also evident in Fig. 1, which depicts the annual number of IPOs from 2010 to 2021, and the level and the volume of a market index from the Istanbul stock exchange. The figure also shows that IPO activities do not seem to be affected by changes in the nominal level and volume of the market index in Turkey.<sup>3</sup>

Table 2 reports the total number of IPOs before and during the Covid-19 period across Turkish industries. A noteworthy observation is that most of the IPO activity took place in the manufacturing and financial institutions sectors, both before and during the Covid-19 period. The literature on IPOs documents industry clustering as well (Helwege & Liang, 2004; Ibbotson et al., 1988, 1994; Ibbotson & Jaffe, 1975; Ritter, 1984). Mazumder and Saha (2021) investigate the association between IPO performance and the variables related to the Covid-19. Loughran et al. (1994)'s high-tech industry classification is used in the study to assess the relationship between hi-tech firms and IPO performances during the COVID-19 period. Using the definitions provided by Loughran & Ritter (2004), we define a technology industry in Türkiye as a combination of three sectors, namely, a sector focused on professional, scientific, and technical activities, a sector devoted to technology, and a sector focused on telecommunications. We chose these industries based on the operating activities of companies that went public during the Covid-19 period. The combined movement of these three sectors reveals that the technology sector increased its IPO activity in Türkiye during the Covid-19 period.

<sup>3</sup> The inflation rate during the Covid-19 period is around 40% according to Eurostat CPI data. Thus, the increase in the nominal value and volume of the market index do not necessarily indicate a well performing market index.

Table 3 provides a descriptive summary of the initial day underpricing and aftermarket performances of IPOs before and after the Covid-19 period, as one of the main objectives of this study is to document changes in the IPO underpricing with Covid-19. As shown in the table, both aftermarket performance and underpricing increased during Covid-19, which is consistent with our second hypothesis. The table reports the aftermarket performance for 105 Turkish firms that went public before the Covid-19 period and 61 firms that did so during the Covid-19 period. CARs of day 1 through day 21 during the Covid-19 period are larger than those before Covid-19. While the average initial day abnormal return is 5.66% during the non-Covid-19 era, it increases to 7.63% after the market is hit by the Covid-19 virus. However, a closer investigation of the table shows the effects of daily limits on price movements. The Istanbul stock exchange set 10% downward and 20% upward daily price limits, which has become plus or minus 10% in the second quarter of 2020. Because of these price movement limits, the initial day returns of the Covid-19 era do not represent the extent of IPO underpricing. Thus, it makes more sense to use a longer window to measure underpricing. In addition to the initial day returns, this study uses cumulative abnormal returns up to a month after the firm is publicly traded.

On the basis of the descriptive statistics analyzed thus far, during the period of the Covid-19, not only were IPOs significantly more active than in the previous decade, but IPO underpricing and post-IPO performance also increased. Results are consistent with our hypotheses, which will be tested statistically in the next section.

#### 4. Empirical results

The empirical analysis entails three stages. In the first stage, we investigate changes in uncertainty and aftermarket performance of the IPO firm before and during the Covid-19 period by using measures offered in the literature. A regression analysis is then used to determine whether Covid-19 affects underpricing and aftermarket performance. Finally, we compare the cumulative abnormal returns of IPOs before and during Covid-19 in order to assess their aftermarket performance.

##### 4.1. Uncertainty of IPO with Covid-19 period

In this section, we examine the uncertainty that existed before and during the Covid-19 period in order to test the first hypothesis. The literature provides company characteristics such as age, size, and industry information; offering characteristics such as gross proceeds and offer price risk; and aftermarket variables such as volatility and trading volume to measure the ex-ante uncertainty.<sup>4</sup> It is important to note that the aftermarket variables may be endogenous to the IPO results. It is more likely that heavily underpriced IPOs generate more

<sup>4</sup> Interested readers are referred to Ljungqvist (2007) for a review of the principle theories on the IPO underpricing and proxies of ex-ante uncertainty.

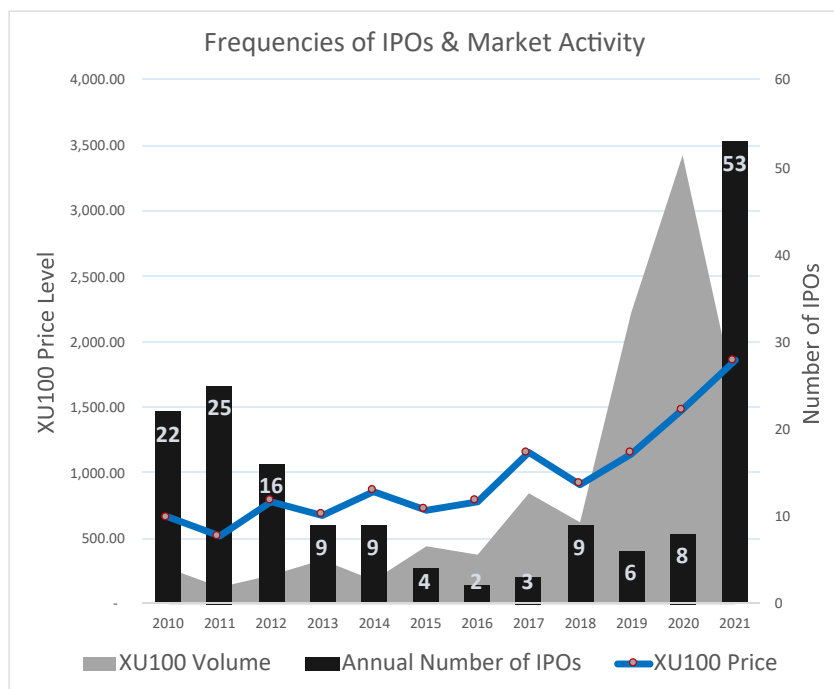


Fig. 1. Frequencies of IPOs & market activity.

Table 2

**IPO Issuing Activity.** This table presents the frequency distribution of 166 IPO firms in the sample before and during the Covid-19 period, listed by sectors. Currently, there are 14 sectors in Turkey, according to the Turkish Public Disclosure Platform. The sample consists of IPO data from January 2010 and December 2021.

Sector	Pre-Covid-19	During Covid-20	Total
ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	4	1	5
AGRICULTURE, FORESTRY AND FISHING	2	0	2
CONSTRUCTION AND PUBLIC WORKS	3	2	5
EDUCATION, HEALTH, SPORTS AND OTHER SOCIAL SERVICES	2	1	3
ELECTRICITY GAS AND WATER	5	9	14
FINANCIAL INSTITUTIONS	29	9	38
INFORMATION AND COMMUNICATION	0	1	1
MANUFACTURING	34	21	55
MINING AND QUARRYING	1	0	1
PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	0	3	3
REAL ESTATE ACTIVITIES	2	0	2
TECHNOLOGY	6	9	15
TRANSPORTATION STORAGE AND TELECOMMUNICATION	6	1	7
WHOLESALE AND RETAIL TRADE, RESTAURANTS AND HOTELS	11	4	15
Total	105	61	166

investor interest, and consequently more aftermarket trading, as a consequence of the underpricing rather than the other way around. This study employs all proxies that are borrowed from the literature; the firms operating history, its total assets prior to IPO and gross proceeds, reciprocal of offer price, sector information, and the volume on the first trading day.<sup>5</sup>

Using the data on the 105 IPOs between 2010 and 2019, and the 61 IPOs between 2020 and 2021, Panel A of Table 4

<sup>5</sup> Sectoral codes are not used in the analysis since there is not enough firms and data variation within each industry of the sample. Instead, dummy variables only for those industries with a clustering of IPOs are included.

reports the two sample *t*-test results for uncertainty proxies and variables known to have an effect on the IPO underpricing.

Uncertainty proxies are age (AGE) and total assets (ASSETS) as company characteristics, total gross proceeds (PROCEEDS) and the firm's IPO offer risk (RISK) calculated as the reciprocal of the IPO price as offering characteristics and total traded volume of the IPO stock on the first day of trading (VOLUME), and standard deviation of daily stock prices during the first month after the firm's public offerings (STDDEV) as aftermarket variables. Further, we analyze some additional variables that are considered to be related to the IPO underpricing, such as total value of stocks traded on the first trading day (VALUE), the ratio of the firm being offered to

Table 3

**Descriptive statistics of market performance.** This table summarizes the cumulative abnormal return statistics from the initial public offering day to the 1st, 2nd, 3rd, 4th, 5th, 10th, and 21st day for the period before and during the Covid-19. The cumulative abnormal return is the sum of all abnormal returns, which is the difference between the closing price on the day in question and the offer price divided by the offer price and then subtracted by the market return. In total, 166 IPOs between January 2010 and December 2021 are included in the sample. The sample of Initial Public Offerings are divided into two groups: prior to Covid-19 and during Covid-19. In the former group, there are 105 companies going public before January 2020, while in the latter, there are 61 companies going public after March 2020.

Mean(%)	SD(%)	Min(%)	Max(%)	N	
A: Pre-Covid-19 Period					
1-day CAR	5.66	10.13	-17.29	41.10	105
2-day CAR	7.92	15.57	-15.25	47.90	105
3-day CAR	9.15	21.26	-19.45	77.14	105
4-day CAR	9.69	24.06	-19.89	112.66	105
5-day CAR	10.61	25.52	-21.00	123.00	105
10-day CAR	10.10	28.78	-26.55	154.07	105
21-day CAR	11.04	32.90	-27.84	168.98	105
B: During Covid-19 Period					
1-day CAR	7.63	5.47	-10.00	20.54	61
2-day CAR	13.39	11.54	-18.29	45.00	61
3-day CAR	18.43	18.14	-21.50	75.87	61
4-day CAR	23.57	24.92	-23.57	109.20	61
5-day CAR	28.87	32.08	-23.82	150.32	61
10-day CAR	39.06	53.55	-26.79	168.00	61
21-day CAR	54.03	98.94	-36.37	637.25	61

public at IPO (RATIO), price-earning ratio (PE), dummy variables for high technology (TECH), manufacturing (MANUF), and financial institutions (FI) sectors since these sectors exhibit industry clustering of IPOs, standard deviation of the market index one month before the IPO date (MKTVOL) and finally one-month moving average of market index return on the day of IPO (INVSENT) as a measure of investor sentiment during one month period prior the IPO date.

Two-sample *t*-test results show that although all uncertainty variables experienced an increase during the Covid-19 period, only the change in AGE, RISK, and STDDEV proxies of uncertainty are statistically different from zero. These empirical results indicate that firms with a longer operating history launched their IPOs and daily stock prices experienced much larger variations during the Covid-19 period. Thus, we document some evidence to support our first hypothesis that IPO uncertainty increases during the Covid-19 period.

Several interesting results were revealed by the two-sample *t*-test of our control variables. The table indicates that during the Covid-19 period the value of stocks traded on the first day of trading, the riskiness of the IPO because of a higher price, the market's volatility before the IPO, and investors' optimism increased significantly. Additionally, even though the ratio of technology IPOs to the total number of all IPOs increased during the period of Covid-19, the weight of IPOs within the financial institutions sector decreased.

In light of the fact that two of the IPO uncertainty measures and several of the control variables increased during the Covid-19 period, we next examine whether the Covid-19 is related to the underpricing and aftermarket performance of IPOs.

Table 4

**Two Sample T-test Results.** This table presents univariate tests results for ex-ante uncertainty proxies of company characteristics (AGE, ASSETS), offering characteristics (PROCEEDS), aftermarket variables (VOLUME, STDDEV) and for control variables of firm, industry and market level control variables (VALUE, RISK, RATIO, PE, TECH, MANUF, FI, MKTVOL, and INVSENT).

	n	mean	n	mean	p-value
AGE	105	18.22	61	22.43	0.05
ASSETS	104	837.04	61	1217.96	0.29
PROCEEDS	105	378.93	61	457.47	0.438
RISK	105	0.31	61	0.15	0
VOLUME	105	24.32	61	29.53	0.648
STDDEV	105	0.32	61	2.42	0
VALUE	105	122.86	61	236.02	0.071
RATIO	105	29.35	61	29.17	0.924
PE	104	1388.47	60	2241.19	0.698
TECH	105	0.06	61	0.2	0.015
MANUF	105	0.32	61	0.34	0.79
FI	105	0.28	61	0.15	0.044
MKTVOL	105	0.01	61	0.01	0.017
INVSENT	105	0	61	0	0.004

#### 4.2. Underpricing of IPO during Covid-19 period

This section contains an empirical analysis that tests the second hypothesis. Using CARs of different subperiods of the sample, we first conduct independent sample *t*-tests to determine whether underpricing increased during the Covid-19 period. In order to gain a more comprehensive understanding of IPO underpricing and aftermarket performances, we test whether the means of CARs for a specific year are different from those for the previous year, starting with the first two years of the sample period and so on. In addition to comparing each year's mean CAR with the previous year's mean CAR, we also compare three different versions of the Covid-19 sub-period (2020 alone, 2021 alone, and both years combined) to the period covering before the Covid-19 period (2010–2019 combined).

Table 5 reports the differences in means of two sub-samples and corresponding *p*-values from independent sample *t*-test results. The *p*-values of the mean differences indicate that before the Covid-19 period, the mean CARs of a year are statistically indifferent from the previous years mean CARs. However, when any sub-period of the Covid-19 period is compared with the non-Covid-19 era, we find that mean CARs of the two samples are different from one another. Specifically, we find that mean CARs from the Covid-19 subperiods are always larger than those from the non-Covid-19 sub-periods. Considering the theories of IPO underpricing summarized above, the larger IPO underpricing and aftermarket performances of the Covid-19 sub-sample represent strong empirical evidence for an increase in ex-ante uncertainty of IPO firms.

Despite the empirical support for hypothesis 2 provided by the table above, it is unable to explain whether Covid-19 has a direct or an indirect influence on underpricing and aftermarket performance measures. Next, we will test whether the Covid-19 period has an indirect effect on CARs through uncertainty

Table 5

**Mean in Difference between Years.** The table present mean-in-difference of cumulative abnormal returns of two samples containing data from different years and corresponding p-values from independent-sample *t*-test results.

Sample 1	vs.	Sample 2	CARd1	CARd2	CARd3	CARd4	CARd5	CARd10	CARd21
2010	vs.	2011	-0.00851	0.00481	0.0337	0.00353	0.00695	-0.0025	-0.0896
		<i>p</i> -value	(-0.774)	(-0.924)	(-0.635)	(-0.965)	(-0.937)	(-0.979)	(-0.412)
2011	vs.	2012	-0.00473	-0.011	-0.0327	-0.0156	-0.0225	0.0173	0.0596
		<i>p</i> -value	(-0.888)	(-0.837)	(-0.659)	(-0.862)	(-0.818)	(-0.886)	(-0.682)
2012	vs.	2013	0.0497	0.105*	0.133	0.129	0.148	0.132	0.0959
		<i>p</i> -value	(-0.188)	(-0.042)	(-0.059)	(-0.107)	(-0.091)	(-0.22)	(-0.445)
2013	vs.	2014	-0.0143	-0.0289	-0.0138	0.00572	-0.000216	0.00361	0.0708
		<i>p</i> -value	(-0.723)	(-0.466)	(-0.699)	(-0.867)	(-0.996)	(-0.94)	(-0.198)
2014	vs.	2015	-0.0682	-0.0769	-0.101	-0.136	-0.181	-0.119	-0.16
		<i>p</i> -value	(-0.564)	(-0.486)	(-0.369)	(-0.308)	(-0.126)	(-0.289)	(-0.15)
2015	vs.	2016	0.105	0.0987	0.115	0.148	0.178	0.129	0.189
		<i>p</i> -value	(-0.381)	(-0.372)	(-0.312)	(-0.281)	(-0.132)	(-0.255)	(-0.175)
2016	vs.	2017	-0.0351	-0.0247	-0.0215	-0.0362	-0.0954	-0.115	-0.18
		<i>p</i> -value	(-0.192)	(-0.422)	(-0.475)	(-0.53)	(-0.445)	(-0.477)	(-0.475)
2017	vs.	2018	-0.0264	-0.0743	-0.0917	-0.0668	0.0253	0.0286	0.0718
		<i>p</i> -value	(-0.539)	(-0.26)	(-0.226)	(-0.38)	(-0.843)	(-0.851)	(-0.758)
2018	vs.	2019	-0.0109	0.00666	-0.0216	-0.047	-0.0415	-0.0343	-0.0397
		<i>p</i> -value	(-0.855)	(-0.947)	(-0.884)	(-0.778)	(-0.782)	(-0.817)	(-0.766)
2019	vs.	2020	-0.0423	-0.135	-0.241	-0.383	-0.580**	-1.027***	-1.067**
		<i>p</i> -value	(-0.397)	(-0.16)	(-0.123)	(-0.052)	(-0.006)	(-0.001)	(-0.001)
2020	vs.	2021	0.0413*	0.113**	0.215**	0.330**	0.471**	0.850**	0.712*
		<i>p</i> -value	(-0.015)	(-0.008)	(-0.005)	(-0.004)	(-0.004)	(-0.002)	(-0.013)
<(2020)	vs.	=2020	-0.0555**	-0.153**	-0.280**	-0.425***	-0.592**	-1.028***	-1.049**
		<i>p</i> -value	(-0.003)	(-0.001)	(-0.001)	(-0.001)	(-0.001)	(-0.001)	(-0.001)
<(2020)	vs.	=2021	-0.0142	-0.0398	-0.0646*	-0.0955*	-0.121**	-0.178*	-0.336*
		<i>p</i> -value	(-0.256)	(-0.068)	(-0.04)	(-0.015)	(-0.009)	(-0.01)	(-0.021)
<(2020)	vs.	>=2020	-0.0196	-0.0547*	-0.0928**	-0.139***	-0.183***	-0.290***	-0.430**
		<i>p</i> -value	(-0.107)	(-0.011)	(-0.003)	(-0.001)	(0.000)	(0.000)	(-0.002)

*p*-values in parentheses. \* *p* < 0.05, \*\* *p* < 0.01, \*\*\* *p* < 0.001.

variables, or whether it has a direct link with CARs. In order to test the Covid-19 periods direct link with CARs, the underpricing proxies and aftermarket performance variables considered in this study are regressed on a Covid-19 dummy variable, controlling for the ex-ante uncertainty variables and for the IPO underpricing determinants. The selection of which variables to include in the regression model is not supported by a formal theory. Therefore, following the literature, this study controls for offer risk, investor sentiment, market volatility, offer rate, standard deviation of daily stock returns 30 days after the firms IPO, P/E ratio, and method of going public (Baig & Chen, 2021; Beatty & Ritter, 1986 ; Chen et al., 2004; Clarkson, 1994; Engelen & Van Essen, 2010; Kiyamaz, 2000; Ljungqvist, 2007; Loughran & Ritter, 2004; Mazumder & Saha, 2021; Rathnayake et al., 2019; Ritter, 1984).

$$CAR_{it} = \beta_0 + \beta_1 COVID19 + \beta_2 AGE + \beta_3 ASSETS + \beta_4 PROCEEDS + \beta_5 VOLUME + \beta_6 STDDEV + \beta_7 RISK + \beta_8 VALUE + \beta_9 RATIO + \beta_{10} PE \quad (3)$$

Where 1st, 2nd, 3rd, 4th, 5th, 10th, and 21st day cumulative market adjusted abnormal returns are dependent variables. As mentioned previously, due to daily volatility limits on stock price movements imposed by the Istanbul stock exchange, the correction of a large underpricing in the IPO price will not be possible on the first day of trading. Therefore, the market takes longer to adjust the stock price to the equilibrium of supply and

demand. As a result, the study utilizes CARs up to a month in order to allow enough time for aftermarket prices to reach an equilibrium. However, despite using underpricing variables up to a month and reporting the coefficient estimates for all models, we focus on the initial day underpricing when investigating the relationship between underpricing and independent variables of this study using a regression design to be comparable with the literature results.

The model includes 15 independent variables: COVID19 is a dummy variable that is equal to 1 for 2020 and 2021 and zero otherwise; AGE refers to the company's history since its foundation; ASSETS are the total assets of the IPO firm in its previous year's balance sheet before it went public (in million); PROCEEDS represents the amount of funds raised in the IPO by the firm (in millions); VALUE and VOLUME denote total traded value and volume of the IPO shares on the day of IPO; STDDEV indicates the standard deviation of IPO share returns one month after its IPO day and serves as a proxy for ex-ante uncertainty; RISK is the reciprocal of an IPO offer price (1/IPO offer price); RATIO denotes the ratio of the IPO firm being offered to public; PE refers to price/earnings ratio calculated using the offer price and total income of the IPO firm in its previous year's balance sheet before it went public and used as a measure of future performance; dummy variables for high technology (TECH), manufacturing (MANUF), and financial institutions (FI) sectors to capture any relationship between industry clustering and underpricing; MKTVOL is the standard

Table 6

**Regression results.** This table reports the estimated effects of the Covid-19 and ex-ante uncertainty proxies on the underpricing of IPOs. COVID19 is measured by a dummy variable that is equal to 1 for 2020 and 2021 and zero otherwise. Ex-ante uncertainty proxies are company characteristics (AGE, ASSETS), offering characteristics (PROCEEDS), aftermarket variables (VOLUME, STDDEV). Control variables include firm, industry and market level control variables (VALUE, RISK, RATIO, PE, TECH, MANUF, FI, MKTVOL, and INVSENT). IPO underpricing proxies are 1st, 2nd, 3rd, 4th, 5th, 10th, and 21st day cumulative market adjusted abnormal returns (CARs). All standard errors are robust.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	CAR1st	CAR2nd	CAR3rd	CAR4th	CAR5th	CAR10th	CAR21st
COVID19	0.048*** (0.007)	0.082*** (0.004)	0.115*** (0.004)	0.149*** (0.002)	0.184*** (0.001)	0.239*** (0.001)	0.209** (0.030)
AGE	-0.001 (0.201)	-0.001 (0.291)	-0.002 (0.230)	-0.001 (0.346)	-0.002 (0.342)	-0.004* (0.071)	-0.006* (0.082)
ASSETS	-0.010** (0.037)	-0.011 (0.160)	-0.009 (0.415)	-0.013 (0.323)	-0.015 (0.323)	-0.019 (0.332)	-0.020 (0.455)
PROCEEDS	-0.024*** (0.003)	-0.026** (0.046)	-0.026 (0.152)	-0.023 (0.271)	-0.018 (0.448)	-0.004 (0.892)	-0.000 (0.999)
RISK	0.309*** (0.000)	0.481*** (0.000)	0.666*** (0.000)	0.646*** (0.002)	0.618*** (0.007)	0.259 (0.399)	-0.540 (0.197)
VOLUME	-0.062*** (0.001)	-0.080*** (0.010)	-0.112*** (0.010)	-0.102** (0.046)	-0.089 (0.116)	0.053 (0.484)	0.337*** (0.001)
STDDEV	-0.001 (0.787)	-0.000 (0.957)	-0.001 (0.914)	0.002 (0.827)	0.006 (0.567)	0.054*** (0.000)	0.202*** (0.000)
VALUE	0.064*** (0.001)	0.070** (0.024)	0.086** (0.047)	0.064 (0.210)	0.039 (0.496)	-0.113 (0.141)	-0.375*** (0.000)
RATIO	-0.001 (0.363)	-0.001 (0.397)	-0.001 (0.539)	-0.000 (0.878)	0.001 (0.706)	0.001 (0.707)	0.003 (0.455)
PE	0.000 (0.970)	-0.000 (0.755)	-0.000 (0.768)	-0.000 (0.885)	-0.000 (0.906)	-0.000 (0.676)	-0.000 (0.531)
TECH	0.006 (0.815)	0.011 (0.788)	0.027 (0.626)	0.049 (0.453)	0.070 (0.332)	0.087 (0.378)	-0.024 (0.857)
MANUF	-0.005 (0.771)	-0.020 (0.504)	-0.038 (0.354)	-0.049 (0.317)	-0.046 (0.399)	0.031 (0.668)	0.084 (0.399)
FI	-0.027 (0.214)	-0.080** (0.026)	-0.111** (0.027)	-0.146** (0.014)	-0.153** (0.021)	-0.142 (0.111)	-0.080 (0.507)
MKTVOL	2.992* (0.091)	3.351 (0.248)	3.635 (0.370)	6.372 (0.183)	7.738 (0.146)	-0.615 (0.932)	-4.209 (0.667)
INVSENT	1.326 (0.543)	2.423 (0.499)	0.536 (0.915)	3.715 (0.530)	3.969 (0.546)	-1.051 (0.906)	-7.464 (0.537)
Constant	0.478 (0.000)	0.703*** (0.002)	0.864*** (0.006)	1.079*** (0.003)	1.206*** (0.003)	1.640*** (0.003)	1.840** (0.014)
Observations	157	157	157	157	157	157	157
	0.254	0.273	0.316	0.367	0.420	0.481	0.642

*p*-values in parentheses \* *p* < 0.10, \*\* *p* < 0.05, \*\*\* *p* < 0.01.

deviation of market index returns one month prior to the IPO day; INVSENT is one-month moving average return on the market index prior to the IPO day, which is a proxy for investor sentiment.<sup>6,7,8</sup>

The main coefficient of interest in this part of the study is  $\beta_1$  coefficient of COVID19 variable in Equation (3). A positive and significant coefficient estimate would indicate that

<sup>6</sup> COVID-19 was declared a pandemic by the World Health Organization (WHO) in March 2020. In January 2020, there is only one IPO in Turkey and excluding it from the Covid-19 period yields qualitatively similar results.

<sup>7</sup> Following Loughran & Ritter (2004)'s definitions for high tech industry sectors, IPO firms in "Professional, Scientific and Technical Activities, Technology, and Telecommunication" sectors are labeled as high tech firms. Therefore, HiTech is equal to 1 if the IPO firm in HiTech sector, zero otherwise.

<sup>8</sup> Note that VOLUME and STDDEV variables are ex-post variables calculated using aftermarket daily stock returns. It is assumed that investors have perfect information about the volatility of IPO firm prior its IPO.

underpricing and aftermarket performance of IPO increases during the Covid-19 period. Table 6 reports regression results of Equation (3). The model is run using all underpricing proxies for robustness purposes and to investigate the persistence of the effect of independent variables. The empirical results documented in the table show that Covid-19 is significantly and positively related to underpricing at IPO and this effect does not die away in the first month of stock trading. That is, the firms that launched IPOs during the Covid-19 period discounted their IPO price more than those firms that went public before the Covid-19 era.

Our next focus is on the uncertainty variables of age, assets, gross proceeds, trading volume, and standard deviation of stock prices. Three out of the six uncertainty variables, ASSETS, PROCEEDS, and VOLUME have significantly negative coefficient estimates when the initial day underpricing is considered, the first column of the table. This effect disappears on the second day of trading or remains significant only up to

four days of trading. Some care needs to be taken in interpreting the coefficient estimates since a negative coefficient of uncertainty variables indicates a decreasing effect on the underpricing of IPO. For example, the negative effects on the ASSETS variable on CARs indicate that larger firms are considered to be less speculative, therefore have lower underpricing. The relationships of PROCEEDS and VOLUME with underpricing are also negative and this is an expected result since it is considered that if a firm is able to generate large proceeds, investors have less uncertainty about the future of the firm, which leads to larger proceeds as well as a larger trading volume. By the same token, other uncertainty variables AGE and STDDEV variables are expected and found to have negative effects on the initial day underpricing, however, the negative coefficients are insignificant. Another uncertainty variable RISK has a positive coefficient estimate. The RISK variable measures the risk presented by the level of offer price. The higher the offer price, the harder it gets for an average investor to afford the stock. Recall that the RISK variable is the reciprocal of the offer price. As the offer price gets larger, the RISK variable gets smaller. A positive coefficient estimate for the RISK variable documented in the table indicates that underpricing magnitude is highlighted for low-priced stocks at IPO. These results are consistent with (Chen et al., 2004; Gao et al., 2020; Kirkulak & Davis, 2005; Kıymaz, 2000; Kıymaz, 1997; Li et al., 2019; Rathnayake et al., 2019), who also document an inverse relationship between IPO underpricing and uncertainty variables, and Wong et al. (2017), who document a positive coefficient estimate for the RISK variable.

We additionally find that VALUE, and MKTVOL variables have significantly positive effects on the initial day underpricing. The significance of a positive parameter estimate of the VALUE variable indicates that firms with larger underpricing at IPO were traded more on the first day of trading, which is also an expected outcome. More investors would be interested in buying a stock that is discounted more heavily compared to a stock that is not discounted, for example, which would lead to a larger traded value of the discounted stock. Finally, a positive and significant MKTVOL variable indicates that large fluctuations in the stock market index that were observed during one month prior to the IPO date are related to large discounts in the offer price. That is an expected outcome. Since market-wide fluctuations in stock prices indicate a riskier market, investor's judgment on the IPO firm may also be clouded or it may become more difficult and more costly to collect information in such market conditions. In anticipation of that, firms offer prices that are discounted more heavily, in line with Ritter (1984) and Beatty & Ritter (1986).

Overall, empirical results of t-tests presented in Table 6 and coefficient estimates of Equation (3) reported in Table 6 provide evidence supporting the hypothesis 2. It is concluded that IPO underpricing has increased during the Covid-19 period in addition to increase due to the uncertainty variables.

#### 4.2.1. Robustness check

Our main focus was to estimate regressions under heteroscedasticity by using the OLS estimation framework. In this

part of the study, a robustness check is performed using the Feasible Generalized Least Squares (FGLS) method by estimating the structure of heteroscedasticity from the OLS, as discussed by Wooldridge (2015). For the main variable of interest, COVID19, and all uncertainty variables, FGLS empirical results match the general OLS results reported in Table 6. Hence, we do not report our FGLS results in the paper.<sup>9</sup> So, our results appear to be robust.

#### 4.3. Aftermarket performance during Covid-19 period

Fig. 2 reports the aftermarket performances of 166 IPOs between 2010 and 2021. The initial day abnormal returns (1-day CAR) and one month cumulative market-adjusted returns (21-day CAR) are chosen for demonstration purposes. Positive returns represent underpricing of the stock at IPO and negative returns overpricing. During the Covid-19 period, 7 (15) out of 66 IPOs had negative cumulative returns on the 1st (21st) day of trading. 8 IPOs with a price increase on the offering day completed the 21st day of trading with a price lower than the offer price. These firms were considered underpriced on the initial day of trading and later were decided to be overpriced at IPO. So their one month performance turns negative.

Another observation on the figure is related to how the price limits imposed by the Istanbul stock exchange prevent stocks from showing their true performance. Due to the 20% and 10% upward price limits, the majority of IPOs recorded the highest possible price movement on the initial day of trading. 44 out of 66 IPOs during the Covid-19 era increased their prices at the maximum level allowed by the price movement restrictions. Some of these firms continued their overperformance during the first month of trading; 10 firms had a cumulative abnormal return between 100 and 200 percent, 1 firm above 200 percent, and 1 firm recorded a return above 600 percent. Overall, the figure depicts a dramatic increase in aftermarket performances of the Covid-19 era IPOs up to one month of trading.

Although the figure above demonstrates the performance differences post IPO for first launched offering before and during the Covid-19 period, whether the overperformance of the Covid-19 era IPOs is statistically different from zero needs to be investigated. If these high cumulative abnormal returns recorded during the Covid-19 period are indifferent from zero, we cannot conclude that the Covid-19 period IPOs really overperformed compared to IPOs of the previous period. Therefore, we create a sub-sample of the data for each year of the sample period and compare the mean values of the samples to zero using a one-sample *t*-test.

Table 7 reports one-sample *t*-test of zero mean. First, the table documents that all means of CARs up to one month after the IPO are positive and statistically significant during both years of the Covid-19 period. While the CARs in both years are positive, the first year of the Covid-19 era, 2020, records historically high market-adjusted returns of IPO firms. In 2020 (2021), an average IPO investor earned a cumulative abnormal

<sup>9</sup> The coefficient estimates from the FGLS model are available upon request.

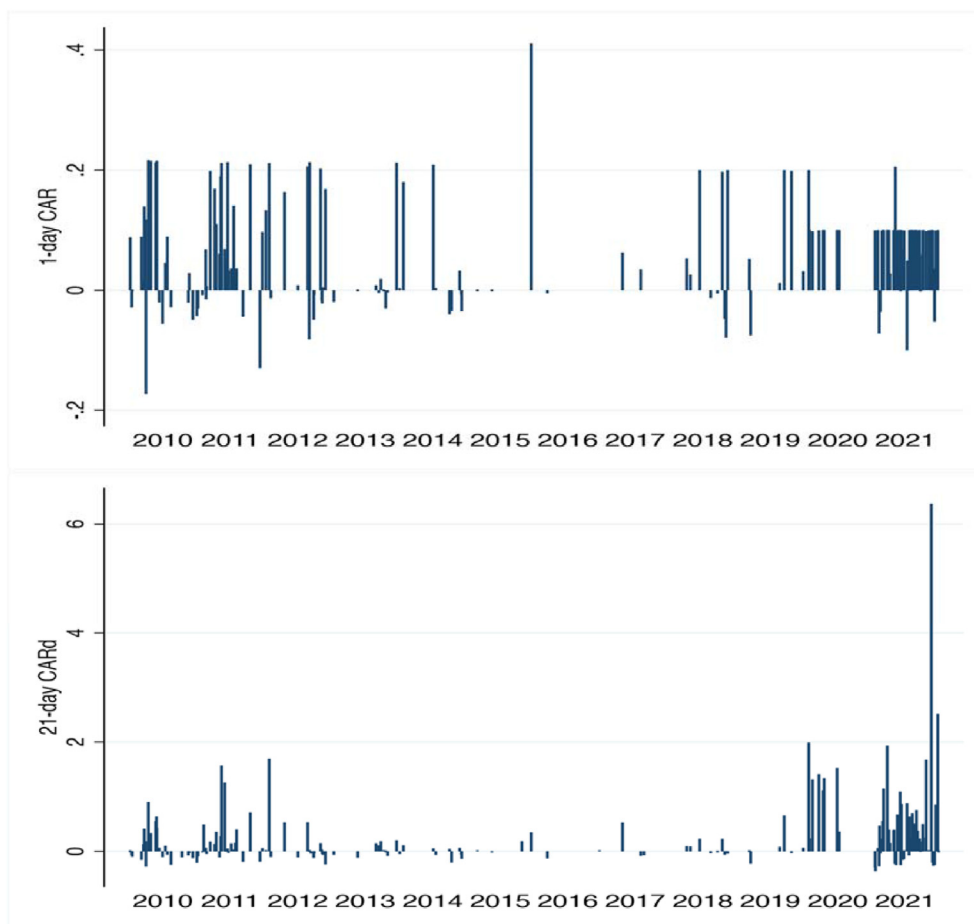


Fig. 2. Cumulative abnormal returns over years.

return of 11.21% (7.08%) on the first day and 115.93% (44.69%) on the 21st day of trading. The significance of the overperformance of IPO firms during the Covid-19 period is highlighted when compared to the performance of IPOs before the Covid-19 era. During a seven-year period before Covid-19, the marketadjusted cumulative returns of IPOs are indistinguishable from zero in statistical terms. The first three years of the sample period also reports overperformance (or underpricing in that sense) of IPOs compared to the performance of the market index, which indicates that overperformance of Turkish IPOs is not unique to the Covid-19 era.

Note that Table 7 reports the significance of cumulative abnormal returns for different time-horizons from day 1 to day 21. That means a cumulative return is the sum of all returns during a shorter horizon plus the return during the incremental horizon. For example, CARd2 is the sum of CARd1 and the abnormal return on the second day, the second day being the incremental horizon; and so on. Although cumulative abnormal returns are widely used in the literature as a measure of performance, there might exist some statistical issues with them. For instance, the sum of a statistically significant mean CAR and a statistically insignificant mean CAR may still be a statistically significant mean CAR, given that the former CARs are large enough. In this study, we use seven time horizons; starting from the IPO of the firm to the end of the 1st, 2nd, 3rd,

4th, 5th, 10th, and 21st trading day. The table above reported that the cumulative abnormal returns of all time horizons are statistically different from zero during the Covid-19 period. However, the table does not inform us about whether the incremental return of a time horizon is actually significantly different from zero.

Next, we ask whether each incremental return that is added to the CAR of a shorter horizon is also a statistically significant return. In order to answer that question, we first calculate the incremental average abnormal return of each time horizon using Equation (4).

$$iAAR_{i,t} = CAR_{i,t} - CAR_{i,t-1} \tag{4}$$

where  $iAAR_t$  is defined as incremental average abnormal return and  $CAR_t$  is defined in Equation (2).  $t$  is equal to 2, 3, 4, 5, 10, and 21. After calculating the incremental average abnormal returns for the Covid-19 periods, we use a one-sample  $t$ -test to test whether these incremental returns are also distinguishable from zero.

$iAARd21$  in Table 8 represents the incremental returns from day 10th to day 21st.  $iAARd10$  represents the incremental returns from day 5th to day 10th, and so on. Note that  $iAARd1$  is equal to  $CARd1$  by definition. The results of the table show that the overperformance of IPOs during the Covid-19 period

Table 7

**One-Sample t-test of CARs.** This table presents one-sample tests results for cumulative abnormal returns each year separately and corresponding p-values from the t-test results.

	CARd1	CARd2	CARd3	CARd4	CARd5	CARd10	CARd21	N
2010	5.673*	9.655*	12.980*	12.308	13.59	14.243*	10.953	22
p-value	(0.02)	(0.02)	(0.04)	(0.05)	(0.05)	(0.05)	(0.11)	
2011	6.525**	9.174**	9.607*	11.955*	12.895*	14.493*	19.913*	25
p-value	(0.00)	(0.01)	(0.02)	(0.03)	(0.03)	(0.04)	(0.03)	
2012	6.998*	10.278*	12.88	13.518	15.14	12.766	13.953	16
p-value	(0.02)	(0.03)	(0.06)	(0.08)	(0.07)	(0.21)	(0.25)	
2013	2.023	-0.199	-0.443	0.627	0.322	-0.465	4.361	9
p-value	(0.43)	(0.93)	(0.83)	(0.8)	(0.91)	(0.9)	(0.31)	
2014	3.456	2.686	0.937	0.055	0.343	-0.826	-2.717	9
p-value	(0.3)	(0.43)	(0.75)	(0.98)	(0.9)	(0.81)	(0.45)	
2015	10.275	10.374	11.008	13.642	18.459	11.025	13.326	4
p-value	(0.39)	(0.35)	(0.33)	(0.3)	(0.12)	(0.31)	(0.21)	
2016	-0.25	0.501	-0.464	-1.115	0.611	-1.826	-5.566	2
p-value	(0.5)	(0.44)	(0.86)	(0.81)	(0.75)	(0.62)	(0.58)	
2017	3.258	2.968	1.684	2.504	10.155	9.679	12.453	3
p-value	(0.22)	(0.35)	(0.36)	(0.53)	(0.42)	(0.54)	(0.6)	
2018	5.895	10.395	10.856	9.186	7.621	6.817	5.274	9
p-value	(0.15)	(0.11)	(0.15)	(0.19)	(0.27)	(0.1)	(0.2)	
2019	6.98	9.729	13.018	13.89	11.767	10.246	9.24	6
p-value	(0.18)	(0.27)	(0.35)	(0.39)	(0.41)	(0.49)	(0.48)	
2020	11.212***	23.215***	37.124***	52.219***	69.802***	112.909***	115.925***	8
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
2021	7.084***	11.905***	15.606***	19.245***	22.694***	27.917***	44.689**	53
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	

p-values in parentheses. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

Table 8

**One-sample T-test of incremental AARs.** This table presents one-sample t-tests results for incremental cumulative abnormal returns each year separately and corresponding p-values from the t-test results. Incremental cumulative abnormal returns are defined in Equation (2), where  $t$  is equal to 2, 3, 4, 5, 10, and 21.

	iAARd1	iAARd2	iAARd3	iAARd4	iAARd5	iAARd10	iAARd21	N
2020	11.212***	12.003***	13.909***	15.095***	17.583**	8.621*	0.274	8
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.04)	(0.77)	
2021	7.084***	4.822***	3.701**	3.639**	3.449**	1.045	1.525	53
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.21)	(0.1)	

p-values in parentheses. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

did not continue up to a month after going public. Instead, IPOs stopped overperforming after the 10th day in 2020 and the 5th day in 2021 since iAARs up to the 10th day in 2020 and the 5th day in 2021 are significantly different from zero.

Since the study proxies IPO underpricing with CARs, iAARs can be considered as a measure of incremental underpricing of the IPO firm. Table 8 reports empirical evidence that an IPO's underpricing is corrected in 10 days in 2020, on average, and in 5 days in 2021.

### 5. Conclusion

This study examines the phenomenon of underpricing during the Covid-19 era, factors related to the underpricing, and short-term firm performance post-IPO. We test three main hypotheses of the IPO literature in this study for the IPOs that occurred before and during the Covid-19 era. Firstly, we examine whether ex-ante uncertainty about the IPO firm and its underpricing has changed with Covid-19. We then examine the relationship between underpricing of IPOs and ex-ante uncertainty about the IPO firms while controlling for some factors

known to be related to underpricing. Finally, we examine the performance of the IPO firms during the Covid-19 period and compare it to their performance before Covid-19.

The results show that there is significant underpricing during Covid-19, the period encompassing the years 2020 and 2021 in this study, and there is a positive and significant relationship between underpricing and Covid-19. In addition, we find that IPO underpricing and factors related to underpricing during the Covid-19 period are significantly different from those prior to the Covid-19 period. Firms that went public during the Covid-19 period face more uncertainty than firms that went public before the Covid-19. Consistent with IPO underpricing theory proposed by Ritter (1984); Beatty & Ritter (1986) and the follow-up empirical literature, we find that not only Covid-19 increases underpricing but also firms with more uncertainty before their IPOs offer larger discounts in their IPO prices. In addition, we document that although the short-term performance of firms that went public before Covid-19 is indifferent from zero, the performance of firms that went public during Covid-19 is positive, historically large, and significantly different from zero. Finally, we report that IPOs outperform the market in 2020 over an

extended period compared with 2021. Incremental market-adjusted returns for 2020 are positive and significant during a ten day period while the incremental returns for 2021 are positive and significant during only a five day period.

### Declaration of competing interest

There are no conflicts of interest associated with this research and no funding was received.

### Acknowledgement

We thank the editor (Professor Ali M. Kutan) and the anonymous referee(s) for their helpful comments and suggestions.

### References

- Aggarwal, R., & Rivoli, P. (1990). Fads in the initial public offering market? *Financial Management*, 45–57.
- Allen, F., & Faulhaber, G. R. (1989). Signalling by underpricing in the ipo market. *Journal of Financial Economics*, 23, 303–323.
- Baig, A. S., & Chen, M. (2021). Did the covid-19 pandemic (really) positively impact the ipo market? An analysis of information uncertainty. *Finance Research Letters*, Article 102372.
- Baron, D. P. (1982). A model of the demand for investment banking advising and distribution services for new issues. *The Journal of Finance*, 37, 955–976.
- Beatty, R. P., & Ritter, J. R. (1986). Investment banking, reputation, and the underpricing of initial public offerings. *Journal of Financial Economics*, 15, 213–232.
- Benveniste, L. M., Ljungqvist, A., Wilhelm, W. J., Jr., & Yu, X. (2003). Evidence of information spillovers in the production of investment banking services. *The Journal of Finance*, 58, 577–608.
- Booth, J. R., & Smith, R. L., II (1986). Capital raising, underwriting and the certification hypothesis. *Journal of Financial Economics*, 15, 261–281.
- Brau, J. C., & Fawcett, S. E. (2006). Initial public offerings: An analysis of theory and practice. *The Journal of Finance*, 61, 399–436.
- Chen, G., Firth, M., & Kim, J.-B. (2004). Ipo underpricing in chinas new stock markets. *Journal of Multinational Financial Management*, 14, 283–302.
- Clarkson, P. M. (1994). The underpricing of initial public offerings, ex ante uncertainty, and proxy selection. *Accounting and Finance*, 34, 67–78.
- Engelen, P.-J., & Van Essen, M. (2010). Underpricing of ipos: Firm-, issue- and country-specific characteristics. *Journal of Banking & Finance*, 34, 1958–1969.
- Gao, S., Brockman, P., Meng, Q., & Yan, X. (2020). Differences of opinion, institutional bids, and ipo underpricing. *Journal of Corporate Finance*, 60, Article 101540.
- Grinblatt, M., & Hwang, C. Y. (1989). Signalling and the pricing of new issues. *The Journal of Finance*, 44, 393–420.
- Helwege, J., & Liang, N. (2004). Initial public offerings in hot and cold markets. *Journal of Financial and Quantitative Analysis*, 39, 541–569.
- Ibbotson, R. G. (1975). Price performance of common stock new issues. *Journal of Financial Economics*, 2, 235–272.
- Ibbotson, R. G., & Jaffe, J. F. (1975). Hot issue markets. *The Journal of Finance*, 30, 1027–1042.
- Ibbotson, R. G., Sindelar, J. L., & Ritter, J. R. (1988). Initial public offerings. *The Journal of Applied Corporate Finance*, 1, 37–45.
- Ibbotson, R. G., Sindelar, J. L., & Ritter, J. R. (1994). The market's problems with the pricing of initial public offerings. *The Journal of Applied Corporate Finance*, 7, 66–74.
- Keasey, K., & Short, H. (1992). The underpricing of initial public offerings: Some UK evidence. *Omega*, 20, 457–466.
- Kirkulak, B., & Davis, C. (2005). Underwriter reputation and underpricing: Evidence from the Japanese ipo market. *Pacific-Basin Finance Journal*, 13, 451–470.
- Kıymaz, H. (1997). The long run performances of Turkish industrial ipos. *The Privatization of Stock Exchanges: The Case of Stockholm Stock Exchange*, 1, 43.
- Kıymaz, H. (2000). The initial and aftermarket performance of ipos in an emerging market: Evidence from istanbul stock exchange. *Journal of Multinational Financial Management*, 10, 213–227.
- Li, X., Wang, S. S., & Wang, X. (2019). Trust and ipo underpricing. *Journal of Corporate Finance*, 56, 224–248.
- Ljungqvist, A. (2007). *Ipo underpricing. Handbook of empirical corporate finance* (pp. 375–422).
- Ljungqvist, A., & Wilhelm, W. J. (2003). Ipo pricing in the dot-com bubble. *The Journal of Finance*, 58, 723–752.
- Loughran, T., & Ritter, J. R. (1995). The new issues puzzle. *The Journal of Finance*, 50, 23–51.
- Loughran, T., & Ritter, J. (2004). Why has ipo underpricing changed over time? *Financial Management*, 5–37.
- Loughran, T., Ritter, J. R., & Rydqvist, K. (1994). Initial public offerings: International insights. *Pacific-Basin Finance Journal*, 2, 165–199.
- Mazumder, S., & Saha, P. (2021). Covid-19: Fear of pandemic and short-term ipo performance. *Finance Research Letters*, 43, Article 101977.
- Meggison, W. L., & Weiss, K. A. (1991). Venture capitalist certification in initial public offerings. *The Journal of Finance*, 46, 879–903.
- Michaely, R., & Shaw, W. H. (1994). The pricing of initial public offerings: Tests of adverse-selection and signaling theories. *Review of Financial Studies*, 7, 279–319.
- Miller, R. E., & Reilly, F. K. (1987). An examination of mispricing, returns, and uncertainty for initial public offerings. *Financial Management*, 33–38.
- Mok, H. M., & Hui, Y. (1998). Underpricing and aftermarket performance of ipos in shanghai, China. *Pacific-Basin Finance Journal*, 6, 453–474.
- Rathnayake, D. N., Louembé, P. A., Kassi, D. F., Sun, G., & Ning, D. (2019). Are ipos underpriced or overpriced? Evidence from an emerging market. *Research in International Business and Finance*, 50, 171–190.
- Reilly, F. K. (1977). New issues revisited. *Financial Management*, 28–42.
- Ritter, J. R. (1984). The “hot issue” market of 1980. *Journal of Business*, 57, 215–240.
- Ritter, J. R. (1987). The costs of going public. *Journal of Financial Economics*, 19, 269–281.
- Ritter, J. R. (1991). The long-run performance of initial public offerings. *The Journal of Finance*, 46, 3–27.
- Rock, K. (1986). Why new issues are underpriced. *Journal of Financial Economics*, 15, 187–212.
- Ross, S. A. (1977). The determination of financial structure: The incentive-signalling approach. *The Bell Journal of Economics*, 23–40.
- Welch, I. (1989). Seasoned offerings, imitation costs, and the underpricing of initial public offerings. *The Journal of Finance*, 44, 421–449.
- Welch, I. (1992). Sequential sales, learning, and cascades. *The Journal of Finance*, 47, 695–732.
- Wong, E. S., WB, R. W., & Ting, L. S. (2017). Initial public offering (IPO) underpricing in Malaysian settings. *Journal of Economic & Financial Studies*, 5, 14–25.
- Wooldridge, J. M. (2015). Control function methods in applied econometrics. *Journal of Human Resources*, 50, 420–445.
- Zhou, L. J., & Sadeghi, M. (2019). The impact of innovation on ipo short-term performance—evidence from the Chinese markets. *Pacific-Basin Finance Journal*, 53, 208–235.