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THE EFFECT OF IPO UNDERPRICING ON THE REACTIONS OF CAPITAL MARKET INVESTORS: A STUDY OF THE WARSAW STOCK EXCHANGE – RESEARCH RESULTS FOR THE PERIOD 2013-2023

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Purpose: The aim of the article is to investigate and disclose the presence of underpricing in the initial public offering (IPO) prices of companies listed on the Warsaw Stock Exchange over the period 2013-2023. Furthermore, the study aims to analyze the post-IPO stock price performance of these companies over three- and six-month periods following their initial listing.
Design/methodology/approach: The scientific objective of the article is pursued through a meticulous review of the existing literature. Furthermore, to examine the underpricing of initial public offerings (IPOs), the study employs the ordinary least squares (OLS) method and linear regression analysis, incorporating explanatory variables, such as the subscription reduction rate, offer value, changes in the WIG index, and the risk-free interest rate. Additionally, Parkinson's extreme value measure is applied to estimate the uncertainty risk on the IPO listing day.
Findings: The results of empirical analyses conducted in this study indicate that the most significant determinants of the examined phenomenon are factors related to information asymmetry, followed—though to a lesser extent—by behavioral factors and those associated with ownership and control structures.
Research limitations/implications: The analysis is based on a limited sample of companies conducting public offerings, which may introduce a degree of bias due to the deterministic approach employed in the sample selection process.
Practical implications: Knowledge about the stock price changes of companies following underpriced equity offerings is highly important for both investors and fund managers.
Social implications: Among the social implications of this article, the most significant appears to be a potential shift in investors' attitudes toward participation in public offerings, alongside an improved understanding of stock price behavior during the initial months of trading.
Originality/value: A novel contribution of this study is the analysis of stock price changes of companies conducting equity offerings at underpriced levels over three- and six-month periods following their initial listing. Moreover, the research incorporates a current timeframe, covering equity offerings from 2013 to 2023, including the period of heightened volatility caused by the global COVID-19 pandemic.
Keywords: initial public offering (IPO), investor, underpricing, investment portfolio.
Category of the paper: Research paper.

1. Introduction

Investors operating in the financial market most commonly include shares of domestic or foreign issuers among the components of their investment portfolios, aiming, on the one hand, to achieve high rates of return, and, on the other, to protect themselves against a real decline in the value of their accumulated capital. Investments in shares of issuers can be made both on the secondary market and at the time of the company's public offering, that is, on the primary market. The introduction of shares to trading is one of the common methods by which companies raise capital. However, observations indicate that instead of maximizing the raised capital by setting the issue price of shares at a level adequate to their true value—known by the management and owners of the company based on conducted valuations—shares are often issued at prices lower than those determined by the market. This phenomenon, known as underpricing of initial public offerings (IPOs), has been observed by many researchers across various markets. According to some scholars, this phenomenon is caused by information asymmetry among different parties interested in the offering (Rock, 1986, p. 206). Other authors, such as M.J. Brennan and J.R. Franks (Brennan, Franks, 1997, p. 412), argue that it may be driven by managers seeking to retain control over the company or intentionally ceding part of it to investors (Stoughton, Zechner, 1998, p. 74). Another potential cause of this phenomenon is the behavior of entrepreneurs who make investment decisions based on irrational premises (Kahneman, Tversky, 1979, pp. 274-280; Welch, 1992, p. 695; Ljungqvist, Nanda, Singh, 2004, p. 1669). In some cases, this issue can also be attributed to institutional conditions prevailing in a given country at the time of the debut (Tinic, 1988, p. 797; Rydqvist, 1997, p. 296). However, these theories can be considered inadequate for the studied market due to the absence of conditions which, according to these theories, could justify issuing shares at a price lower than the market value.

The aim of this article is to investigate the causes of the occurrence of this phenomenon on the Warsaw Stock Exchange during the period 2013–2023, to identify which group of theories explaining the phenomenon is most applicable to this market, and to reveal the impact of IPO underpricing on the stock price performance of these companies over three- and six-month periods following their share issuance.

The research scope covers companies that conducted their initial public offerings on the Warsaw Stock Exchange between 2013 and 2023, excluding those whose listings were transferred from the NewConnect Market. These were excluded because they were already present in the trading system, and therefore more information was available about them compared to other companies. Ultimately, the study considered a sample of 80 companies. The analysis was conducted using multiple regression. Following the approach of previous researchers (Sieradzki, 2019, pp. 148-163), various variables associated with different groups of theories explaining IPO underpricing were selected to investigate the causes of this

phenomenon. Additionally, to examine the impact of IPO underpricing on stock performance over three- and six-month periods, linear regression was employed with three control variables included to ensure model accuracy, although these variables were not subject to further interpretation.

It is worth noting that the examined phenomenon has already been analyzed by selected authors for the periods 2003-2013 (Sieradzki, 2019) and 2005-2016 (Pomykalski, Filipiak, 2020). However, these studies did not cover the period of heightened volatility in capital markets caused by the global COVID-19 pandemic, which in turn led to the emergence of another speculative bubble[1]. Additionally, they did not consider the impact of IPO underpricing on the stock price performance of these companies over three- and six-month periods following their initial listing.

2. Literature review and research hypotheses development

Underpricing of initial public offerings (IPOs) is a phenomenon that has been extensively studied through various approaches. Within this body of research, four main groups of theories have emerged to explain the phenomenon (Ljungqvist, 2005, p. 378): information asymmetry, ownership and control, institutional settings, and behavioral theories, including aspects of investor psychology in capital markets (Ljungqvist, 2005; Plummer, 1995; Rock, 1986; Baron, 1982; Michaely, Shaw, 1994; Zaleśkiewicz, 2003; Zielonka, 2011), focusing on investors' behaviors and decisions, which are often irrational from the perspective of economic assumptions or stock market cycles (Kubiak, Skwarek 2021).

A rational investor primarily acts to maximize profits without succumbing to emotional influences or peer pressure, relying solely on information derived from rigorous financial analysis (so-called fundamental data) (Zaleśkiewicz, 2003, pp. 9-10). Moreover, research by Benartzi and Thaler (1995) indicates that investors frequently revise their portfolios excessively, thereby failing to treat investing as a long-term process. The authors emphasize that returns are a result of a combination of loss aversion and frequent performance evaluations, including portfolio rebalancing (Benartzi et al., 1995, pp. 73-92).

Such investor behavior, including loss aversion, manifests clearly in investments in companies conducting public offerings. Investors subscribing to a company's shares often sell them on the first trading day, aiming to profit from the period between subscription[2] and initial trading. The short-term investment horizon among shareholders is supported by studies

[1] As a result, the COVID-19-driven bull market led to an influx of individual investors into the stock market, who were focused on achieving above-average returns within a short time frame.
[2] Specifically, the date of allocation of shares to a given investor.

conducted by Thaler (1999), Nofsinger (2001), and Lea, Tarpy, and Webley (1987, cited in Zaleśkiewicz, 2003, p. 123), which show that most investors make financial decisions in an impatient and impulsive manner, disliking long waits for profits. Investors behave this way even when it results in lower returns than could be obtained with a longer-term perspective. Participation in new share offerings thus facilitates the realization of such investor traits and attitudes. This also applies to the demand generated by investors during an initial public offering (Gemra, Kwestarz, 2024). Additionally, it has been noted that investors are often impulsive, lack self-control, and struggle with delaying financial gratification. Meanwhile, investing – especially long-term – requires patience and often prolonged waiting for a suitable moment to sell shares (see also Zaleśkiewicz, 2003, pp. 123-125). Furthermore, Kahneman and Tversky (1979, pp. 263-291) demonstrate through their studies that investors are influenced by the certainty effect, whereby they prefer a guaranteed gain rather than risk, even when the risk is small (see also Zaleśkiewicz, 2003, pp. 167-168).

On the other hand, information asymmetry theories assume that one party involved in the offering has more information about the true value of shares than others, profiting from issuing shares at a price lower than market value. The most well-known among these theories is the winner's curse (Rock, 1986, p. 206), which posits two types of investors— informed and uninformed. This theory assumes that the presence of both groups is necessary for market functioning. Informed investors know which IPOs are profitable, while the uninformed invest "blindly" in hopes of gains. When an IPO yields profits, uninformed investors receive a smaller share due to the larger number of participants. However, when it results in losses, they bear the full cost, leading to their discouragement. To retain these investors, shares are offered at a discounted price. Another theory in this category is Baron's model (Baron, 1982, p. 957), which attributes the phenomenon to the underwriter's role in setting the offer price. The underwriter charges a form of fee for lending their expertise and reputation during the IPO process, reflected in the form of underpriced shares. According to this theory, the degree of underpricing should be proportional to the underwriter's reputation.

Ownership and control theories posit that the reasons for issuing shares at undervalued prices are related to the company's ownership structure and control over it. Some researchers argue that IPO underpricing is motivated by the desire to maintain control over the company (Brennan, Franks, 1997, p. 412), while others suggest that the motivation is to diversify the ownership structure and obtain external oversight over the company's operations (Stoughton, Zechner, 1998, p. 74). These two theories developed independently, and their differences are explained by the underlying assumptions. Brennan and Franks' theory assumes proportional allocation of shares to all subscribing investors, whereas Stoughton and Zechner's theory assumes that a predetermined portion of shares is assigned to a single institution, enabling organized supervision by the investor. Institutional setting theories are based on the assumption that, due to legal or regulatory conditions, it may be more advantageous for a company to issue shares at undervalued prices. This could be intended to avoid lawsuits (Tinic, 1988, p. 797) or

to reduce tax liabilities (Rydqvist, 1997, p. 296). However, the conditions described by these theories were not present during the period and market under study, and thus they will not be considered in the current research. Behavioral theories suggest that the observed phenomenon is driven by irrational decisions made by groups of investors. One of the earliest researchers of crowd behavior was Gustave Le Bon (Le Bon, 1986, cited in Plummer, 1995, p. 11). Subsequent studies by S. Freud, C. Jung, and A. Koestler confirmed Le Bon's conclusions. Le Bon viewed the crowd as a psychological rather than a physical phenomenon. Such investors base their decisions not only on available rational premises but also on their own intuitions and the actions of other investors, leading to investment decisions that are difficult to understand or justify. This group includes the information cascade theory (Welch, 1992, p. 695), which assumes that each subsequent investor relies on the transactions of all previous investors, increasing the amount of available information but decreasing its accuracy, thereby leading to irrational decisions. Another theory in this category is the sentimental investor theory (Ljungqvist, Nanda, Singh, 2004, p. 1669), which postulates that investors make decisions based on their belief in a company's success, even if this belief is not supported by empirical evidence.

Based on the literature review and the identified research gaps, the following research hypotheses have been formulated:

H_1: There is no evidence of IPO underpricing on the Warsaw Stock Exchange.

H_2: A higher level of IPO underpricing has a negative impact on stock performance over three- and six-month periods following the debut.

3. Sample selection and methodology

For the purposes of achieving the article's objective, the study covered all companies that conducted their initial public offerings on the Main Market of the Warsaw Stock Exchange between 2013 and 2023, excluding those whose listings had been transferred from the NewConnect Market. These companies were excluded due to their prior presence in the trading system, which meant that more information was publicly available about them than about other firms. Ultimately, the sample consisted of 80 companies, namely: AATHOLD, ALLEGRO, ALTUSTFI, ALUMETAL, ANSWEAR, ARCHICOM, ARTIFEX, ATAL, AUTOPARTN, BIGCHEESE, BIK, BOOMBIT, CAPTORTX, CAVATINA, CDRL, CLNPHARMA, CPGROUP, DADELO, DEKPOL, DINOPL, ENERGA, ENTER, FEERUM, GAMEOPS, GAMFACTOR, GETBACK, GPRE, GRUPRACUJ, HUUUGE, I2DEV, IDEABANK, INPOST, KRKGL, KRVITAMIN, LIVECHAT, LOKUM, MASTERPHA, MAXCOM, MERCATOR, MFO, MLPGROUP, MLSYSTEM, MURAPOL, NANOGROUP, NEWAG, NOVATURAS, OAT, ONDE, OTLOG, PBKM, PCCROKITA, PCFGROUP, PCM, PEIXIN, PEKABEX, PEMANAGER, PEPCO, PHN, PKPCARGO, PLAY, PLAYWAY, POLTREG,

POLWAX, R22, SHOPER, SILVAIR-REGS, SKARBIEC, STELMET, STSHOLDING, TARCZYNSKI, TORPOL, TSGAMES, TXM, UNIWHEELS, VERCOM, VIGOSYS, VISTAL, WIRTUALNA, WITTCHEN, and XTB. These companies operate in the following sectors: finance, industrial and construction manufacturing, consumer goods, healthcare, trade and services, and technology. The authors note that the research covers an exceptionally specific period marked by the global SARS-CoV-2 pandemic, which had a significant impact on investor behavior as well as the number of share offerings conducted during that time.

The research was conducted in the following stages:

1. Stage one – Companies listed on the Warsaw Stock Exchange that conducted their initial public offerings during the period 2013–2023 were identified.
2. Stage two – The level of IPO underpricing was calculated for the selected companies' shares, adjusted for changes in the WIG index on the day of the debut.
3. Stage three – The reputation of brokerage houses responsible for the share offerings of the analyzed companies was assessed.
4. Stage four – The phenomenon of IPO underpricing was examined in relation to the stock performance three and six months after the date of the initial public offering.

The degree of underpricing of the selected companies' shares was determined as the rate of return from an investment made at the issue price and liquidated at the closing price on the first day of trading, in accordance with the following formula:

$$IR = \frac{P_t - P_e}{P_e} \tag{1}$$

where:

IR – interest rate,

P_e – emission price,

P_t – the price at the moment t.

To confirm the occurrence of the phenomenon in the examined market, the level of stock price underestimation was also calculated after adjusting for the change in the WIG index during the debut day. This aims to ensure that the phenomenon is not merely a result of overall market fluctuations and prevailing trends. This value was calculated using the following formula:

$$AIR = IR - \Delta WIG \tag{2}$$

where:

AIR – adjusted investment return,

IR – interest rate,

ΔWIG – change in the WIG index during the specified period.

An analysis of the phenomenon was also conducted from the perspective of brokerage houses representing companies as underwriters. This analysis aimed to verify the hypotheses proposed by researchers R. Michaely and W.H. Shaw (Michaely, Shaw, 1994, p. 295), who observed that the level of underpricing depends on the reputation of the brokerage house representing the company. Since the reputation of the institution in question is relevant to the phenomenon from this perspective, companies represented by the bank and those represented by the brokerage house affiliated with that bank were grouped together. This allowed for an increase in group size and thus enhanced the reliability of the study. Additionally, only organizations that served this role in at least four different IPOs during the period were considered. In cases where more than one organization performed this function, the three listed first in the prospectus were included. Ultimately, this approach yielded 59 data points. If a relationship between the level of the studied phenomenon and the reputation of the underwriter is observed, Baron's model can be considered an adequate explanation of the phenomenon in the Polish market.

An econometric model was used to investigate the causes of the studied phenomenon. The assessment of the adequacy of the given theory was based on the significance level of the corresponding variables determined through the Student's t-test. These variables are:

- The rate of subscription reduction in the individual investors' tranche, intended to simulate demand for shares among investors. This variable thus approximates the influence of information asymmetry theory on the studied phenomenon.
- The offer value, serving as an analogy for company size. Larger companies are expected to have more available information, which in theory should reduce information asymmetry. Therefore, a negative relationship between this variable and the dependent variable is anticipated.
- The level of free float, defined as the ratio of shares freely traded to the total number of shares. A high level may indicate that current investors, managers, and insiders lack confidence in the company's long-term success, leading them to sell their shares. The significance of this variable helps to assess the adequacy of ownership and control theories.
- Change in the WIG index level, included to determine the extent to which the studied phenomenon is influenced by overall market fluctuations.
- Turnover ratio, defined as the ratio of the value of shares traded on the IPO day to the offer value. It is used as an indicator of the number of investors purchasing shares with the intention of quick resale. Similar to the free float level, it measures the adequacy of ownership and control theories. A higher value of this variable indicates a greater managerial interest in diversifying company ownership and benefiting from investor oversight.
- The risk-free rate.

- The issue price.
- Parkinson's Extreme Value (PEV), successfully used by J. Knopf and J.L. Teall (Knopf, Teall, 1999, p. 53) to estimate uncertainty risk on the IPO day, calculated using the formula:

$$\mathrm{PEV} = \ln\left(\frac{\mathrm{P_{dmax}}}{\mathrm{P_{dmin}}}\right) \tag{3}$$

where:

$\mathrm{P_{dmax}}$ – the maximum share price on the IPO day,

$\mathrm{P_{dmin}}$ – the minimum share price on the IPO day.

In this case, uncertainty is theoretically directly proportional to the level of information asymmetry between investors and the issuer, which allows this measure to be used for verifying the adequacy of theories from this group.

In the study of the impact of IPO underpricing on stock performance over 3- and 6-month periods, in addition to the explanatory variable, which is the previously calculated level of IR (Initial Return), control variables were used to ensure model accuracy; however, these variables were not subject to interpretation. The selected control variables are:

- Offer value, intended to simulate the size of the issuer and thus the amount of information available about it.
- The company's ROA (Return on Assets) ratio. This variable accounts for the company's success in its core operations, thereby improving the model's accuracy.
- The age of the company at the time of the IPO, which is intended to simulate the amount of knowledge investors may have about the company.

Including these variables allows for a comparison of the impact of individual factors on the company's performance with the effect of IPO underpricing. Analyses conducted by the aforementioned researchers suggest that a higher level of IPO underpricing should result in poorer stock performance; therefore, the relationship between them is expected to be negative.

In studying the influence of IPO underpricing on stock performance over three- and six-month periods, a linear regression was employed with three control variables intended to ensure model accuracy but not subject to further interpretation.

4. Analysis of IPO Underpricing of Companies Listed on the Warsaw Stock Exchange – Research Results for the Period 2013-2023

In order to calculate the underpricing of selected stocks and the underpricing adjusted for changes in the WIG index on the IPO day, stock offerings on the Warsaw Stock Exchange during the period 2013-2023 were analyzed. The means and medians of returns for the analyzed periods are presented in Table 1.

Table 1.
Average and Median Rates of Return for the Analyzed Periods

Measure	IR			AIR		
Period	1D	3M	6M	1D	3M	6M
Mean	7,51%	12,79%	11,54%	7,49%	11,41%	8,39%
Median	2,18%	7,55%	12,14%	2,50%	8,54%	9,22%

Source: Own elaboration based on data published by the Warsaw Stock Exchange.

The data presented in Table 1 indicate the presence of underpricing in the initial public offerings (IPOs) of the analyzed companies. Regardless of the chosen measure (IR or AIR), stock returns on the first day (1D) and over the following periods of 3 months (3M) and 6 months (6M) were positive for companies conducting IPOs. In order to verify the role of the underwriter's reputation and to test the assumptions of Baron's model, an analysis was conducted of the reputation of brokerage houses and the level of IPO underpricing in offerings in which they participated. Significant variations were observed between more and less prominent institutions. A summary of brokerage houses, the average underpricing levels for IPOs in which they acted as underwriters, and the number of such IPOs is presented in Table 2.

Table 2.
Summary of the Average Level of IPO Underpricing for Companies Underwritten by a Given Brokerage House and the Number of IPOs in Which It Acted as Underwriter

Brokerage House	Number of IPOs	Level of Underpricing
Dom Maklerski PKO Banku Polskiego	9	13,74%
Dom Maklerski Banku Ochrony Środowiska S.A.	5	3,53%
Trigon Dom Maklerski S.A.	17	7,35%
Dom Maklerski mBanku S.A.	10	7,05%
Pekao Investment Banking S.A.	4	5,29%
Ipopema S.A.	4	-5,65%
Vestor Dom Maklerski S.A.	4	2,74%
Bank Zachodni WBK S.A.	6	1,44%

Source: Own elaboration based on data published by the Warsaw Stock Exchange and the prospectuses of individual companies.

The data presented in Table 2 suggest that more prominent—and thus better-regarded—brokerage houses tend to underwrite IPOs with price underpricing levels that are closer to the overall average for the entire period. Due to the relatively small sample size and the long analysis period, the average IR values for each year were also considered and compared with the annual mean. Unfortunately, none of the brokerage houses acted as underwriter in every year of the analyzed time frame. This summary is presented in Table 3.

Table 3.
Average Levels of IPO Underpricing Achieved by Companies Represented by Specific Brokerage Houses Compared with the Average IPO Underpricing Level in the Respective Year

Brokerage House	2013	2014	2015	2016	2017	2018	2020	2021
Dom Maklerski PKO Banku Polskiego	12,05%	3,38%	-0,91%	-	11,94%	-	62,79%	-
Dom Maklerski Banku Ochrony Środowiska S.A.	18,59%	-	-4,11%	2,29%	-	-	-	-1,43%
Trigon Dom Maklerski S.A.	22,11%	1,14%	-4,49%	2,98%	-	2,36%	18,88%	8,12%

Cont. table 3.

Dom Maklerski mBanku S.A.	-	1,71%	6,00%	5,50%	-	-	-	11,14%
Pekao Investment Banking S.A.	-	-	2,38%	-	-	-	-	8,19%
Ipopema S.A.	-	-	-2,12%	-	-	-	-	-9,17%
Vestor Dom Maklerski S.A.	-	-	-	0,00%	-5,26%	1,48%	-	-
Bank Zachodni WBK S.A.	-	-	-	8,18%	0,21%	-	-	-
Annual Average	**10,80%**	**1,97%**	**2,52%**	**5,17%**	**1,94%**	**8,67%**	**43,88%**	**4,69%**

Source: Own elaboration based on data published by the Warsaw Stock Exchange and the prospectuses of individual companies.

The calculations presented in Table 3 indicate that in none of the analyzed periods was Dom Maklerski Trigon closest to the average value, despite the fact that it was the most frequently chosen institution to participate in IPOs. The IPOs involving DM mBank, which was selected far less often, were much closer to this average. However, with few exceptions, the presented values seem to follow the trend set by the average of all offerings in a given year — when the average level increases compared to the previous year, the underpricing level of shares represented by DM Trigon also rises. The only noticeable exception to this trend occurred between 2017 and 2019, when values for this brokerage house decreased despite an increase in the annual average. A similar, though less pronounced, relationship can be observed for other popular brokerage houses: DM PKO BP, DM mBank, and DM BOŚ. Based on the data presented regarding brokerage houses, it can be concluded that the reputation of a brokerage house has a significant impact on the level of IPO underpricing. It appears that brokerage houses with the highest reputations strive to maintain a moderate level of returns from IPO stocks or at least to follow the overall market trend.

For the purpose of conducting the next stage of the research, an econometric model simulating the studied phenomenon was developed. The explanatory variables described in Chapter 3 were used. The resulting multiple regression model took the following form:

$$\mathrm{IR} = 0{,}01398 + 0{,}06378 * \mathrm{RED} - 0{,}11627 * \mathrm{FF} - 0{,}72288 * \Delta\mathrm{WIG} - 0{,}00302 * \mathrm{TRN} - 0{,}79712 * \mathrm{RFR} + 0{,}00003 * \mathrm{OV} - 0{,}000167 * \mathrm{EP} + 0{,}72565 * \mathrm{PEV} \quad (4)$$

where:

RED – subscription reduction rate in the individual investors' tranche,

FF – free float level,

ΔWIG – change in the WIG index level during the IPO day,

TRN – turnover ratio,

RFR – reference rate of the National Bank of Poland,

OV – offering value,

EP – issue price,

PEV – Parkinson's extreme value.

The R^2 value of the obtained model was 0,2064, while the adjusted R^2 amounted to 0,117. These values are higher or comparable to those reported by P. Pomykalski and P. Filipiak (Pomykalski, Filipiak, 2020, p. 12). The correlation matrix of the variables is presented in Table 4.

Table 4.
Correlation Matrix of Variables Used in the IR Model

	IR	RED	FF	ΔWIG	TRN	RFR	OV	EP	PEV
IR	1								
RED	0,1757	1							
FF	-0,0766	0,12118	1						
ΔWIG	-0,0828	-0,2168	-0,1033	1					
TRN	-0,0817	-0,1688	-0,0913	0,02113	1				
RFR	-0,2077	-0,1347	-0,0001	0,11552	-0,0178	1			
OV	0,2848	0,12535	-0,0033	-0,1289	-0,0313	-0,213	1		
EP	0,0040	0,13162	0,08141	-0,1178	-0,0929	-0,1351	0,0859	1	
PEV	0,3016	-0,0223	-0,052	0,01303	0,2182	-0,3353	0,07995	-0,05	1

Source: Own elaboration based on data collected by the Warsaw Stock Exchange, contained in documents published by individual companies, and from the Stockwatch.pl service.

The model derived from equation (4) was subjected to a Student's t-test to verify the significance of individual variables. The results are presented in Table 5.

Table 5.
Significance Levels of Individual Explanatory Variables in the IR Model

Significance level	0,5	0,2	0,1	0,05	0,02	0,01
RED	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
FF	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
ΔWIG	Nieistotne	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
TRN	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
RFR	Nieistotne	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
OV	Significant	Significant	Significant	Not Significant	Not Significant	Not Significant
EP	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
PEV	Significant	Significant	Significant	Significant	Not Significant	Not Significant

Source: Own elaboration based on data published by the Warsaw Stock Exchange, contained in documents released by individual companies, and from the Stockwatch.pl service.

The results presented in Table 5 indicate that some of the selected explanatory variables do not have a significant impact on the dependent variable. These variables include the change in the WIG index during the IPO day, the risk-free rate, and—surprisingly—the issue price. The most significant variables proved to be OV and PEV, both related to information asymmetry. To a lesser extent, TRN and FF, which correspond to ownership and control

theories, were also significant. The variables ΔWIG, RFR, and EP were found to be completely insignificant, indicating a very low adequacy of behavioral theories.

In the next and final stage of the research, two models were developed to explain whether the underpricing of the initial stock offering affects stock price behavior over longer time periods. Two separate models were created for this purpose, covering periods of three and six months from the date of the IPO. Both models are presented in equations (5) and (6):

$$\mathrm{ROI3M} = 0{,}02363 + 1{,}17064 * \mathrm{IR} + 1{,}00252 * \mathrm{ROA} + 0{,}00001 * \mathrm{OV} - 0{,}00096 * \mathrm{AGE} \quad (5)$$

$$ROI6M = 0{,}0555 + 0{,}53527 * IR + 0{,}49356 * ROA - 0{,}0000004 * OV - 0{,}00011 * AGE \quad (6)$$

where:

ROI3M – rate of return on investment made at the issue price over a three-month horizon,
ROI6M – rate of return on investment made at the issue price over a six-month horizon,
IR – Instant return – level of IPO underpricing,
ROA – Return on assets,
OV – Offer Value – value of the initial public offering,
AGE – age of the company.

For equation (5), the R^2 value of the obtained model was 0,488, with an adjusted R^2 of 0,4607. Considering the complexity and number of factors affecting stock market performance, this value is satisfactory. The correlation matrix of the variables is presented in Table 6.

Table 6.
Correlation Matrix of Variables Used in the ROI3M

	ROI 3M	IR	ROA	OV	AGE
ROI 3M	1				
IR	0,67083	1			
ROA	0,27475	0,14693	1		
OV	0,22607	0,28483	-0,0674	1	
AGE	-0,02083	0,06722	-0,0512	0,01413	1

Source: Own elaboration based on data provided by the Warsaw Stock Exchange and contained in periodic reports of the companies included in the study.

No variables were excluded from the model, despite some explanatory variables exhibiting higher correlations with other explanatory variables than with the dependent variable. This approach was taken because this phenomenon occurred only in the case of control variables, which are not subject to interpretation. The significance levels at which individual variables were found to be significant for the overall model are presented in Table 7.

Table 7.
Significance Levels of Control Variables and the Explanatory Variable in the ROI3M Model

Significance level	0,5	0,2	0,1	0,05	0,02	0,01	0,005	0,002
IR	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant
ROA	Significant	Significant	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
OV	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
AGE	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

Source: Own elaboration based on data provided by the Warsaw Stock Exchange and contained in periodic reports of the companies included in the study.

The level of underpricing proved to be highly significant for stock performance, and the relationship between the variables was found to be positive. This contradicts the general interpretation of the phenomenon, according to which this relationship should be negative. Possible explanations for this discrepancy include poor selection of variables for the model or the specific characteristics of the market during the analyzed period.

For equation (6), the R^2 value of the model was 0,0914, while the adjusted R^2 amounted to 0,4629. A noticeable decrease in the coefficient linking IR to the dependent variable was observed, indicating at least a weakening of the relationship found in the previous model. A decline in both statistics was expected, as longer time horizons typically involve more influencing factors. The correlation matrix of the variables is presented in Table 8.

Table 8.
Correlation Matrix of Variables Used in the ROI6M

	ROI 6M	IR	ROA	OV	AGE
ROI 6M	1				
IR	0,2579	1			
ROA	0,1880	0,1217	1		
OV	0,0556	0,2848	-0,0695	1	
AGE	0,0058	0,0643	-0,0283	0,0147	1

Source: Own elaboration based on data provided by the Warsaw Stock Exchange and contained in periodic reports of the companies included in the study.

As in the previous model, the variables were not excluded despite strong indications to do so. The significance levels at which individual variables were found to be relevant to the overall model are presented in Table 9.

Table 9.
Significance Levels of Control Variables and the Explanatory Variable in the ROI6M

Significance level	0,5	0,2	0,1	0,05	0,02	0,01
IR	Significant	Significant	Not Significant	Not Significant	Not Significant	Not Significant
ROA	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
OV	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
AGE	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

Source: Own elaboration based on data provided by the Warsaw Stock Exchange and contained in periodic reports of the companies included in the study.

In the period covered by the ROI6M model, in addition to a decline in the overall model's accuracy, the significance of the IR level also noticeably decreased. This drop in significance, combined with a reduced coefficient for this variable, suggests that in the longer term, the initial underpricing of a company's shares ceases to impact their performance, whereas in the short term, it supports price growth. This finding contradicts other studies, which indicate a negative effect of underpricing on a company's stock performance.

5. Discusion and conclusions

Underpricing of initial public offerings (IPOs) is a commonly observed phenomenon across various markets. This study applied multiple regression analysis to examine the causes of IPO underpricing on the Polish market over the period 2013-2023. The research confirmed the existence of IPO underpricing on the first day of trading, as well as after three and six months following a company's debut on the Warsaw Stock Exchange. It was also found that IPOs conducted and managed by more prominent financial institutions were characterized by levels of underpricing more closely aligned with the average for the entire period, with no significant deviations.

Given the aim of the study and the adopted hypotheses, it is worth noting that the theories best aligned with the Polish market are those related to information asymmetry, with behavioral theories, as well as ownership and control theories playing a lesser role. This implies that, in theory, the less information is available about a company, the higher the expected level of IPO underpricing. These findings are consistent with research conducted for other time periods (Sieradzki, 2019, p. 162).

The analysis is based on a limited sample of companies conducting public offerings, which may introduce a degree of bias due to the deterministic approach employed in the sample selection process.

Based on the research conducted, it is worth noting that a higher level of IPO underpricing is associated with better stock performance over three- and six-month horizons, which contradicts the findings of other researchers (Mohammed, Joyce, 2023, p. 65), who observed the opposite relationship.

Based on the conducted analysis, the adopted research hypotheses were verified, and it was concluded that:

H_1: The phenomenon of IPO underpricing is present on the Warsaw Stock Exchange. This hypothesis has been fully confirmed.

H_2: A higher level of IPO underpricing has a negative impact on stock performance over a-three-month period, but not necessarily over a six-month horizon. This hypothesis has been partially confirmed.

Knowledge about the stock price changes of companies following underpriced equity offerings is highly important for both investors and fund managers. Consequently, this understanding enables investors to make more informed investment decisions.

In examining the consequences of a high level of IPO underpricing on subsequent stock performance, the results obtained contrast with those of other researchers. It was shown that, over longer time horizons, the level of underpricing loses its significance in relation to stock returns, while in the shorter, three-month period, it even has a positive impact on performance.

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