RESEARCH ARTICLE

The aftermarket performance of initial public offerings: New evidence from an emerging market

Dilesha Nawadali Rathnayake1*, Zhixin Zhang1*, Bai Yang2*, Pierre Axel Louembé3*

1 School of Economics, Shandong University of Technology, Zibo, PR of China, 2 Business School, Shandong University of Technology, Zibo, PR of China, 3 School of Accounting, Dongbei University of Finance & Economics, Dalian, PR of China

* These authors contributed equally to this work.
* dileshausj@sdut.edu.cn

Abstract

This paper presents new updated evidence on the initial public offering (IPO) aftermarket performance for 144 public listed firms on the Colombo Stock Exchange from 1991 to 2017. We found that average aftermarket returns are always lower than 1%. On average, buy and hold abnormal returns are negative in a short period, and abnormal returns gradually become positive over a longer period (12.46% in 3 years). Further, aftermarket returns are positively related to investor sentiment and the annual volume of listings while being negatively related to initial returns, which is consistent with the divergence of opinion hypothesis. We suggest that investors should hold their subscriptions of IPO shares for a prolonged time, usually exceeding two years, as the dynamic of shares rewards the investors with positive abnormal returns in the long run.

Introduction

Share trading has been a part of Sri Lanka's history since 1896, but it is only a few years later that an official Stock exchange was created, herein Colombo Stock Exchange (CSE) which has remained the main Stock market in the country. CSE is endowed with a fully automated trading platform and 20 business sectors listed. CSE witnessed an unprecedented expansion in 2009 to become the world's best performing market of 2010, with a growth of 111.14%. Mainly due to the sound political improvements instigated since 2009 and a peaceful environment after the post-war period, CSE has considerably evolved and deserved additional attention from scholars and practitioners of finance. In fact, with a market capitalization of USD 16.07 billion in December 2018 and 202 IPOs launched between 1991 and 2017, the performance of such a developing market is worth being assessed.

Although the literature on IPO performance is rapidly growing, still there is a variety of results due to the different academic viewpoints applied, selection of determinants, measurement of performance and the contextual nature of individual firms. Despite the rather abundant empirical literature on IPO performance, the previous studies lead to a broad, diverse
and multilateral set of findings due to the theoretical perspectives being adopted (determinants, performance measures, contextual nature of individual firms). Moreover, institutional, legal frameworks in emerging economies are not advanced compared to developed nations. Also, most research stressing the IPO performance are conducted in developed economies and large stock markets when emerging economies show substantial differences regarding economic growth, business environments, income levels, and management practices. Only a few studies evaluate the behavior of IPOs in developing nations such as Sri Lanka, which operate in challenging environments (civil war, political instabilities, Asian crisis, Tsunami devastation) and so far, manage to perform strongly in the corporate sector. Especially based on the challenging economic and political atmosphere where Sri Lankan companies perform comparatively strongly, research on the capital market is expected to give exciting outcomes and fill the existing gap in knowledge of the association between IPO performance in the long run.

Initial Public Offering (IPO) aftermarket performance is broadly documented and has been a subject of attention among scholars for decades [1,2]. Peter [3] investigated aftermarket returns of Sri Lankan IPOs in terms of privatized and non-privatized offerings using the market-adjusted buy and hold returns (BHRs). IPOs are initially underpriced, and those excess returns tend to decline by the end of three years. In contrast, privatized IPOs contribute higher returns than non-privatized IPOs in the Colombo Stock Exchange (CSE). The number of IPOs examined by Peter [3] was relatively small. Ediriwickrama and Azeez [4] studied aftermarket IPO underperformance in the CSE with calendar time techniques from 2000 to 2012 and identified several factor models to describe the return variation of IPO stocks in CSE. None of the studies have considered the determinants of aftermarket performance. This is the first study considering the wider time span and twelve determinants of IPO aftermarket performance in Sri Lanka.

This study presents new findings on IPO aftermarket performance for 144 Sri Lankan IPOs that went public from January 1991 to December 2017. We measured the IPO aftermarket performance up to 36 trading months (720 trading days), including the listing day returns. Further, this study focuses on the importance of IPO issue characteristics at the time of going public to find interpretations for the IPO aftermarket performance. The key goal of this research paper is to present updated evidence by examining the amount of IPO aftermarket returns in CSE, focusing on the market-adjusted abnormal returns. This study contributes to the IPO literature by presenting new findings of IPO aftermarket performance in the CSE, using an inclusive sample and a complete analysis of IPO returns. Thus, we carry out critical analysis to determine whether our results about the IPO aftermarket performances in Sri Lanka are similar to those found in previous literature for other emerging countries. Generally, there are three ways in which the study contributes to the current literature. First, the most recent dataset is considered to uncover aftermarket performance. Previous studies have covered a shorter period and smaller samples. Second, both market-adjusted cumulative average returns (CAARs) and average market-adjusted BHRs have been employed in this study to assess the aftermarket performance of IPOs. The outcomes deliver significant information and understanding for stakeholders to invest in IPOs. Based on our results, we recommend that stakeholders should be careful while analyzing IPO returns in the long run.

This paper is ordered into six headings. Section 2 explains the literature review, and section 3 summarizes the data and research methodology. Section 4 includes the empirical results and analysis. Last, section 5 presents the conclusions of the research.

**Literature review**

The existing studies have presented numerous explanations for the behaviour of IPO aftermarket performance. However, there is a lack of observable variables that can describe aftermarket
performance. To explore the determining factors of IPO aftermarket performance, several theories are considered in this study.

The divergence of opinion hypothesis suggests that the uncertainty about an IPO can attract overvaluation on a listing day, followed by underperformance in the long run. Miller [5] proposed that at first, investors lean towards being over-optimistic about the IPO value, which causes initial under-pricing and that later, as the differences of opinions reduce when information flows increase with time, the price of IPOs diminishes to the intrinsic value, producing low aftermarket performance. Gao et al. [6] provided further evidence for Miller’s [5] argument. The study which is based on 4,057 IPOs found that divergence of opinion, proxied by short-term stock return volatility (first 25 trading days after issuance), is negatively related to IPO long-term abnormal returns. In addition, the authors highlight the effect of market regulatory settings on assets early pricing. That is, the regulatory induced pricing bias and short-selling constraints could lead to inflated initial aftermarket IPO prices that autocorrect in the long run, resulting in aftermarket underperformance. As Short-selling is typically forbidden in CSM, investment opinion divergence, proxied by market volatility (first 40 trading days after IPO) throughout this investigation, shall also bear the negative sign reported in previous works. Following previous studies [6,7], ex-ante uncertainty is used as a proxy to analyze the relationship between the divergence of opinion and IPO aftermarket performance in CSE. Greater values of ex-ante uncertainty indicate a greater divergence of opinion for the IPOs. As such, the hypothesis predicts a positive relationship between the ex-ante uncertainty and the aftermarket performance.

The impresario hypothesis asserts that the IPO market is exposed to manipulations due to the presence of the investment banks, which are comparable to the ‘impresarios’ that would voluntarily under-price the new shares with the aim of attracting more investors to the securities’ markets Shiller [8]. Interestingly, this hypothesis points out the reliance on underwriters for certifying the quality of the new issue. Similarly, the impresario hypothesis is in line with the overreaction hypothesis [9]. The deliberate under-pricing of shares generates the appearance of an excess demand, which triggers investors’ optimism and channels an overreaction toward the stock. The misevaluation of shares in initial IPO markets will autocorrect over the medium run and the long run when extra information becomes accessible to the general public [10]. Both hypotheses predict IPO aftermarket performance to be negatively associated with the initial under-pricing. Conversely, signalling theory suggests that IPO under-pricing is positively related to IPO aftermarket performance in the long run [11]. During hot issue periods, high quality firms will issue IPOs and under-price the IPO shares to pass the signal of good quality to win the confidence of investors [12]. Loughran and Ritter [1] and Ritter [2] claimed that a firm that goes public in a hot issue period usually generates a high return in the short run and low returns in the long run.

Many studies have suggested that the initial returns and aftermarket performance have a negative association, in line with the overreaction hypothesis [2,8,13]. Further, Ritter [2] found that IPO aftermarket underperformance usually continues up to 3–5 years after listing. Nevertheless, the degree of IPO aftermarket underperformance is associated with whether the IPOs are either underpriced or overpriced on the first trading day. If the IPOs are underpriced on the first trading day, then initial returns would either not be related or be positively related to IPO aftermarket performance. However, if IPOs are overpriced on the initial trading day, then the initial returns will be negatively related to aftermarket performance because the initial overpricing will be corrected gradually by the post-IPO market. Subsequently, it is expected that IPOs with greater under-pricing will perform worse in the long run [8]. Following Chi and Padgett [14] and Rathnayake et al. [15] the raw initial returns (IR) and the market-adjusted abnormal return (MAAR) for each IPO on the first day of trading are calculated as
Eqs 1 and 2, respectively.

\[ IR_{i1} = \frac{(P_{i1} - P_{i0})}{P_{i0}} \]  

(1)

\[ MAAR_{i1} = \{ \frac{(1 + IR_{i1})}{1 + Rm_{1}} - 1 \} \]  

(2)

Where \( P_{i1} \) = the closing price on the first trading day and \( P_{i0} \) = the IPO offer price of the \( i^{th} \) stock; \( IR_{i1} \) = the initial returns of the first trading day; \( Rm_{1} \) = the first trading day market return using the \( Rm_{1} = \frac{(Rm_{1} - Rm_{0})}{Rm_{0}} \) formula; \( Rm_{1} \) = the closing market index value on the first trading day of the \( i^{th} \) stock; and \( Rm_{0} \) = the closing market index value on the offering day of the stock.

Older firms perform better than are younger firms, as young firms generally have more ex-ante risk than do mature firms and mature firms have less information asymmetry with investors [2,16,17]. Thus, a positive relationship between firm age and aftermarket performance is expected. However, Brau, Couch, and Sutton [18] reported an insignificant negative relationship between issuer age and the long-term performance of IPOs. Belghitar and Dixon [16] and Ritter [2] documented a positive relationship between firm size and IPO aftermarket performance, as have other researchers who have used offer size as a proxy for ex-ante uncertainty [19–22]. Based on the divergence of opinion we expect a positive relationship between the offer size and aftermarket performance of IPOs. Board type is included in the study as a dummy variable, and we expect a positive relationship between Main Board listed companies and IPO long-term performance. Ritter [2], in the USA, and Levis [23], in the UK, for Main Board listings, found that IPOs with small size issues perform poorly in the long run. Following previous evidence, a positive coefficient is expected for Main Board listings in CSE. Following Thomadakis, Nounis and Gounopoulos [22], who found a significant negative relationship between IPO offer price and long-term market performance, we expected IPO price to be negatively related to aftermarket performance. Recently, Bhabra and Pettway [17] found a significant negative relationship, whereas while Mumtaz and Ahmed [24] found a positive but insignificant relationship, between long-term stock returns and the market volatility variable. We have computed market volatility as “the standard deviation of daily market returns over the first 40 trading days after the closing date of subscription” [25], and a negative relationship is expected.

We have included the hot dummy variable, which takes the value of 1 for the hot years, and 0 otherwise, to differentiate between hot and cold IPOs. Following the windows of opportunity hypothesis, a negative post-issue IPO performance [2,26] is expected. However, a positive relationship between the IPO volume in the market and aftermarket performance has been found by several prior studies [27,28].

Investor’s sentiment is found to be positively correlated to the IPO performance on the first trading day, and the observed share subsequently underperforms over the long run [10,29]. However, Khan, Ramakrishnan, Haq, Ahmad, and Alim [30], and Dimovski and Brooks [31] illustrated a significant positive relationship between market sentiment and aftermarket returns in a sample of Malaysian firms. Therefore, we predict that sentiment and aftermarket performance are negatively related. Nevertheless, Perotti and Oijen [32], and Rizwan and Khan [33] reported significant positive aftermarket returns of privatization IPOs in the long run. Thus, we expect a positive relationship between these two variables. IPO performance may differ significantly across the industries [2,19,27]. We include three industry dummies to control for the industry effect.
Methodology

Measures of aftermarket performance

The event–time portfolio approach method is used in this study to measure the abnormal aftermarket returns of IPO firms [14,19,34] by calculating CAARs and BHRs for 36 months following the first trading day. Initially, we calculate the daily stock returns and daily market returns. Following Allen et al. [27], the raw return for each firm, $R_i$, is calculated as

$$ R_i = \frac{P_{it} - P_{i(t-1)}}{P_{i(t-1)}} $$

where $P_{it}$ is the closing price of an IPO on a particular trading day, and $(t-1)$ is the previous trading day. Similarly, for the market return, $R_{mt}$, the return is calculated from the differences in the ASPI market index values for the same time interval as above on a firm basis.

Then, the market-adjusted return for stock $i$ in the $t^{th}$ trading day is defined as

$$ ar_t = r_t - r_{mt} $$

where $r_t$ is the return for stock, $i$ in the $t^{th}$ trading day and $r_{mt}$ is the market return index during the corresponding day.

Following Ritter [2] the aftermarket period returns for 36 months are calculated after converting daily data into monthly data by grouping 720 days into 36 months, assuming that there are 20 trading days in each trading month. The average market-adjusted return (AAR) on a sample of $n$ stocks for the $T^{th}$ event month is the equally weighted arithmetic average of the market-adjusted returns for each trading month, which is calculated as

$$ AAR_T = \frac{1}{n} \sum_{i=1}^{n} ar_t $$

The CAARs from trading month 1 to trading month $T$ is the summation of the AARs $(AAR_T)$. In particular, the CAAR from event month $q$ to event month $s$ is the summation of $AAR_T$ over various intervals during the 36-month aftermarket period:

$$ CAAR_{q,s} = \sum_{i=q}^{s} AAR_T $$

The calculation of t-statistics for the $AR_T$ series are as follows,

$$ t(AAR_T) = \frac{ARR_T \cdot \sqrt{n_T}}{sd_T} $$

where $n_T$ is the number of firms trading in event month T, and $sd_T$ is the cross-sectional Standard Deviation for event month T.

The conventional t-statistic (8) is used to test the statistical significance of the CAARs [2].

$$ t(CAAR_{it}) = \frac{CAAR_{it} \cdot \sqrt{n_T}}{\sqrt{T \cdot \text{var} + 2 \cdot (T - 1) \cdot \text{cov}}} $$

where var is the average of the cross-sectional variations over $T$ months of the AR$_{it}$, and cov is the first-order auto-covariance of the $AR_T$ series, which is calculated by the correlation coefficient $\cdot$ cross-sectional variance.

BHRs are calculated using daily returns from the beginning of the holding period until either the end of the holding period or the delisting date, whichever is earlier [1,2]. Following
Ritter [2], we excluded the initial trading day from BHR calculations

$$BHR_t = \prod_{t=1}^{T} (1 + r_{it}) - 1$$ (9)

where $T$ is the trading month, $r_{it}$ is the raw return on firm $i$ in the trading day $t$, and $T$ is the trading months (1–36).

Therefore, the market adjusted BHR [34] is defined as

$$BHR_{iT} = \left[ \prod_{t=1}^{T} (1 + r_{it}) - 1 \right] - \left[ \prod_{t=1}^{T} (1 + r_{mt}) - 1 \right]$$ (10)

where $T$ is the trading month, $r_{it}$ is the raw return for stock $i$ in the $t^{th}$ trading day, and $r_{mt}$ is the return on the market during the corresponding period.

The average BHR for the period $T$, denoted as $BHR_{iT}$, is the arithmetic mean abnormal return on all IPOs in the sample of size $n$:

$$BHR_i = \frac{1}{n} \sum_{t=1}^{n} BHR_{iT}$$ (11)

where the BHR for stock $i$ in the $t^{th}$ trading day, $n$, refers to the number of observations.

A positive value of BHR shows that IPOs outperform in the considered period, and a negative value of BHR shows that IPOs underperform in the same period.

**Empirical methodology**

The sample data for this study consist of 26 years of daily observations (total 97,125) from 1991 to 2017. Daily stock prices and market returns, were collected from the CSE data bank (https://www.cse.lk/pages/listed-company/listedcompany.component.html?status=1), after paying the subscription fees for Platinum package. While firm-level data extracted from company annual reports, and the IPO prospectus of each firm. The sample is 144 IPO issues, which is more than 70% of the total of 200 IPOs, including a total of 11 delisted firms within 36 trading months from the first trading date.

We first analyze the aftermarket returns in calendar years and on an industry basis. Then, we use cross-sectional analyses to identify the determinants of IPO aftermarket performance, followed by multiple regression analyses at the final stage. The selection of explanatory variables is based on the previous studies.

The multiple regressions used are:

$$BHR_{it} = \beta_0 + \beta_{1}IR + \beta_{2}lnAGE + \beta_{3}lnSIZE + \beta_{4}lnVOL + \beta_{5}lnPRC + \beta_{6}MVL + \beta_{7}PRIV + \beta_{8}HOT + \beta_{9}BRD + \beta_{10}IND + \epsilon_{it}$$ (12)

$$BHR_{it} = \beta_0 + \beta_{1}MAAR + \beta_{2}lnAGE + \beta_{3}lnSIZE + \beta_{4}SENT + \beta_{5}lnVOL + \beta_{6}lnPRC + \beta_{7}MVL + \beta_{8}PRIV + \beta_{9}HOT + \beta_{10}BRD + \beta_{11}IND + \epsilon_{it}$$ (13)

where the dependent variables are the BHR for 20, 60, 120, 180, 240, 480, and 720 trading days; $AGE$ denotes the firm age from its legal registration; $SIZE$ denotes the gross amount of IPO proceeds; $PRI$ represents the issue price of an IPO in Sri Lankan Rupees; $SENT$ denotes the investor sentiment; $VOL$ denotes the annual volume of IPO stock listings in the CSE; $MVL$ refers to the standard deviation of daily market returns for the first 30 trading days; $HOT$ denotes the hot-period issues; $PRV$ denotes the privatization issues; $BRD$ denotes the listed
board types; and IND indicates three dummies for the main industries. The detailed descriptions and summary of variables are shown in Table 1.

Empirical results

Aftermarket performance measured by AARs and BHRs

Table 2 shows that the AARs and CAARs are always lower than 1% for the first 36 months after the listing day. The AARs vary between -0.15% and 0.15%. The CAARs for 144 IPOs are 0.54% over 36 months after listing. Furthermore, CAARs are all negative up to the twenty-sixth trading month and subsequently show positive returns. However, the t-statistics are not statistically significant. Moreover, both BHRs and CAARs are negative up to the twelfth trading month, and after that BHRs show positive returns, whereas CAARs show positive returns at the three-year holding period only (Table 1). On a daily basis, there are many negative returns, so CAARs are lower than BHRs. BHRs are negative in the short run, and during the long run IPOs outperform them with positive BHRs. In particular, over three years, the average BHRs are 12.46% for the sample. However, skewness adjusted t-statistics are not statistically significant.

Aftermarket performance categorized by initial returns

Table 3 reveals a clear relationship between the initial returns and the aftermarket returns for both the short run and the long run. BHR20–BHR120 are negative in the short run and gradually give positive returns in the long run. Initial returns in the highest quintile (MAAR/IR ≥ 120) have the worse BHRs. Nevertheless, in the short run, BHR20–BHR120 mostly appear to be negatively related to the IPO underpricing. In contrast, in the long run, BHR240–BHR720 perform well for the lower initial return quintiles, whereas the higher initial returns quintile always has negative BHRs. When IPOs are initially either overpriced or underpriced, aftermarket IPO returns also underperform in the short run and then perform well in the market in the long run by generating positive BHRs and a similar pattern for both IR and MAAR. The results show that there is a considerable difference when initial IPOs are overpriced and that IPOs are

| Table 1. Variables in the aftermarket performance study. |
|---------------------------------------------------------|
| **Variable** | **Symbol** | **Measurement** | **Ex. sign** |
| Buy and hold return | BHR | See Eq 10 in the text | +/− |
| Raw Initial Return | IR | IR = [(P1 − P0) / (P0)] | − |
| Market Adjusted Abnormal Return | MAAR | MAAR = [(1+ IR) / (1 + Rm)] - 1 | - |
| Firm Age | AGE | The natural logarithm of the firm age from its’ incorporation | + |
| Issue Size | SIZE | The natural logarithm of gross proceeds received from the IPO issue | + |
| Board Type | BRD | A dummy variable for Main Board listed firms | - |
| Offer Price | PRI | The natural logarithm of IPO offer price | - |
| Investor Sentiment | SENT | The % change of ASPI in one month before the IPO issue | - |
| IPO Volume | VOL | The natural logarithm of the annual volume of listing | - |
| Market Volatility | MVL | The standard deviation of daily market returns for the first 40 trading days after the IPO | - |
| Privatization Issue | PRV | A dummy variable for privatization issues | + |
| Hot Issue Period | HOT | A dummy variable for hot period issues | - |
| Issuer’s Industry | HTL, PLNT, BNK | Dummy variables for hotel, plant and bank Industry’ Firms | +/− |

https://doi.org/10.1371/journal.pone.0272092.t001
more outperformed/underperformed in the aftermarket performance. However, between BHRs, only BHR720 returns have a significant difference at the 5% level.

Aftermarket performance categorized by individual measures
The complete breakdown of aftermarket returns considering different measures related to aftermarket performance are shown separately in Table 4. The IPOs of firms aged 1–4 years

Table 3. Aftermarket performance categorized by initial returns.

| Initial returns (%) | BHR20 | BHR60 | BHR120 | BHR240 | BHR480 | BHR720 |
|---------------------|-------|-------|--------|--------|--------|--------|
| Panel A             |       |       |        |        |        |        |
| IR < 0              | -1.21 | -9.42 | -13.10 | -9.48  | 15.52  | 53.07 **|
| 0 ≤ IR < 10        | -8.72 | 1.50  | -3.67  | 6.88   | 11.01  | 19.58  |
| 10 ≤ IR < 50       | -2.20 | -7.91 | -9.55  | 4.58   | 1.05   | 3.72   |
| 50 ≤ IR < 120      | 3.08  | 0.38  | 3.57   | -1.71  | -11.76 | -7.87  |
| IR ≥ 120           | -6.22 | -9.51 | -16.10 | -18.18 | -9.21  | -15.15 |
| Panel B             |       |       |        |        |        |        |
| MAAR < 0           | -5.97 | -5.52 | -8.74  | -3.53  | 9.63   | 21.55  |
| 0 ≤ MAAR < 10      | 0.62  | 5.24  | 2.40   | 6.18   | 19.30  | 53.40 ***|
| 10 ≤ MAAR < 50     | -3.53 | -9.14 | -11.74 | 4.42   | 1.05   | 10.62  |
| 50 ≤ MAAR < 120    | 0.21  | -5.67 | -5.54  | -9.50  | -14.79 | -8.61  |
| MAAR ≥ 120         | -6.04 | -6.98 | -12.69 | -15.39 | -13.89 | -22.99 |
| Panel C             |       |       |        |        |        |        |
| IR overpriced      | -1.21 | -9.42 | -13.10 | -9.48  | 15.52  | 53.07  |
| IR underpriced     | -3.57 | -3.86 | -6.28  | -0.90  | 1.45   | 2.02   |
| Negative-Positive  | 2.36  | -5.56 | -6.82  | -8.58  | 14.07  | 51.05 **|
| MAAR overpriced    | -5.97 | -5.52 | -8.74  | 3.53   | 9.63   | 21.55  |
| MAAR underpriced   | -2.24 | -4.97 | -7.54  | -0.80  | 0.13   | 10.02  |
| Negative-Positive  | -3.73 | -0.55 | -1.20  | 4.33   | 9.50   | 11.53  |

This table shows the aftermarket performance categorized by initial returns. Market-adjusted buy-and-hold returns (BHR) are calculated for six periods namely BHR20 to BHR720 considering 20, 60, 120, 240, 480 and 720 trading days respectively. IR refers to the initial returns and MAAR refers to market adjusted abnormal returns. Sample t-statistics to test the difference between categories and the overall average returns are calculated. Two-tails sample t-statistics are used to test the difference in means (assuming unequal variances). ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

https://doi.org/10.1371/journal.pone.0272092.t003

This table indicates the average monthly market-adjusted returns (AARs), and cumulative average monthly market-adjusted returns (CAARs) for the 36 trading months of IPOs. Market-adjusted buy-and-hold returns (BHR) are calculated for six periods namely BHR20 to BHR720 considering 20, 60, 120, 240, 480 and 720 trading days respectively.

https://doi.org/10.1371/journal.pone.0272092.t002
Table 4. Aftermarket performance categorized by individual measures.

| Measures               | Average Aftermarket performance (%) |
|------------------------|--------------------------------------|
|                        | BHR20  | BHR60  | BHR120 | BHR240 | BHR480 | BHR720 |
| **AGE**                |        |        |        |        |        |        |
| 1–4                    | 0.92   | 2.77   | -2.76  | -6.42  | -4.06  | 6.82   |
| 5–9                    | -1.45  | -9.94  | -11.03 | -15.70 | 0.46   | 2.44   |
| 10–19                  | -2.60  | -4.17  | -0.33  | 25.70  | 25.30  | 19.78  |
| 20<                    | -11.52 | -12.33 | -20.81 | -8.45  | -14.93 | 24.08  |
| **Young Vs. Old**      |        |        |        |        |        |        |
| Young: AGE <10         | -0.13  | -2.86  | -6.42  | -10.53 | -2.16  | 5.02   |
| Old: AGE ≥10           | -6.58  | -7.81  | -9.47  | 10.28  | 7.49   | 21.67  |
| Young-Old              | 6.45   | 4.95   | 3.04   | -20.81 | -9.65  | -16.65 |
| **SIZE (Rs. Mn.)**     |        |        |        |        |        |        |
| SIZE <100              | 5.21** | 9.87** | 8.79** | 14.38  | 21.17* | 39.79**|
| 100 ≤ SIZE <340        | -11.04** | -19.55** | -22.78** | -5.18  | 7.60   | 12.87  |
| SIZE ≥340              | -2.79  | -4.68  | -8.45  | -13.09 | -22.59 | -14.65 |
| **Small vs. Large**    |        |        |        |        |        |        |
| Small: SIZE <200       | -0.93  | 1.24   | -0.29  | 11.13  | 15.02  | 32.80  |
| Large: SIZE >200       | -5.22  | -11.61 | -15.52 | -14.07 | -10.93 | -8.50  |
| Small–large            | 4.29   | 12.85  | 15.23  | 25.21** | 25.95** | 41.30**|
| **BRD**                |        |        |        |        |        |        |
| Main                   | 0.94   | 2.43   | 3.11   | 3.40   | -1.88  | 13.28  |
| Secondary              | -8.02  | -14.50 | -21.43 | -7.48  | 7.62   | 11.29  |
| Main–Secondary         | 8.96** | 16.94** | 24.54** | 10.88  | -9.50  | 1.99   |
| **PRI (Rs.)**          |        |        |        |        |        |        |
| 1 to 11                | -0.52  | -2.41  | -2.69  | 4.19   | 4.69   | 6.56   |
| 12 to 20               | -2.86  | -5.68  | -5.58  | -9.58  | -12.13 | 10.66  |
| 21 to 300              | -5.69  | -7.16  | -14.93 | 1.25   | 14.33  | 20.82  |
| **MVL**                |        |        |        |        |        |        |
| MVL<28                 | -4.45  | -2.17  | -0.09  | 7.27   | -0.02  | 16.87  |
| 28 ≤ MVL <64           | 4.22   | 2.98   | 2.99   | 8.30   | 15.54  | 33.36  |
| 64 ≤ MVL <116          | -2.45  | -19.02** | -26.10** | -6.24  | 8.27   | 19.58  |
| MVL ≥116               | -9.49  | -2.16  | -7.98  | -14.44 | -14.93 | -19.71**|
| **VOL**                |        |        |        |        |        |        |
| 2–5                    | -7.45  | -8.75  | -13.95 | -14.44 | -5.30  | -1.59  |
| 6–10                   | 3.83   | 4.21   | 12.07** | 19.90** | 26.05** | 18.11  |
| 11–13                  | -2.18  | -7.72  | -14.64 | 11.64  | 16.80  | 49.69***|
| 14–15                  | -4.37  | -6.14  | -11.27 | -18.22 | -27.29** | -11.03 |
| **SENT**               |        |        |        |        |        |        |
| Negative SENT          | -1.31  | -1.07  | -6.95  | -1.60  | 6.22   | 15.17  |
| Positive SENT          | -5.76  | -11.42 | -9.13  | -1.04  | -4.13  | 8.43   |
| Negative–Positive      | 4.44   | 10.35  | 2.18   | -0.56  | 10.35  | 6.75   |
| **Issue type**         |        |        |        |        |        |        |
| Privatisation issues   | 8.60   | 13.72  | 21.77  | 26.79  | 10.89  | 10.51  |
| Conventional issues    | -6.50  | -10.69 | -16.59 | -9.65  | -0.53  | 13.09  |
| Difference             | 15.11** | 24.40*** | 38.36*** | 36.43*** | 11.41  | -2.59  |
| **Hot and Cold issues**|        |        |        |        |        |        |
| Cold year issues       | -8.20  | -6.96  | -9.34  | -15.59 | -2.42  | 0.28   |
| Hot year issues        | -0.84  | -4.30  | -7.14  | 4.65   | 4.09   | 17.39  |

(Continued)
have lower BHRs than returns of IPOs in 5–9 years in operation. The results specify that the aftermarket returns remain highest for the firms aged 10–19 years and tend to have positive returns with mature IPOs after one year. Firms aged more than 20 years have the worst performance in the short run, and this continues up to BHR480. Interestingly, the positive BHRs recorded by firms aged 10–19 years are significant at the 10% level. Furthermore, following Loughran et al. [1] and Rathnayake et al. [15] firms aged less than 10 years are classified as young. Young vs. old illustrates a tendency for the age to be negatively related to the BHRs, i.e., younger firms underperform for BHR20–BHR120 and then perform well for BHR240–BHR720.

SIZE reveals the aftermarket returns grouped by the size of the IPO issue, and IPOs are separated into three subgroups with nearly equivalent numbers of IPOs. Our results show that in the long run, smaller issues perform better than do larger issues. Moreover, issues up to Rs. 200 million are categorized as being small and those above that figure as being large. AGE denotes the history of the firm from its incorporation and classifies issues up to Rs. 200 million as being small and those above that figure as being large. Rs. is Sri Lankan Rupees; BRD denotes the listed board types; PRI denotes the offer price of the IPO; MVL denotes the standard deviation of the daily ASPI for the first 40 trading days prior to the IPO issue; VOL denotes the annual volume of listings in the stock market, and IPOs are categorized into four equal groups based on the number of IPOs went to the public annually; SENT is a proxy for investor sentiment; HOT denotes the hot-period issues and cold-period issues, respectively. Sample t-statistics are used to test the difference between categories, and the overall average BHRs are calculated. Two-tailed sample t-statistics are used to test the difference in mean BHRs (assuming unequal variances). ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 4. (Continued)

| Measures | Average Aftermarket performance (%) |
|----------|-------------------------------------|
|          | BHR20 | BHR60 | BHR120 | BHR240 | BHR480 | BHR720 |
| Difference | -7.36** | -2.66  | -2.19  | -20.23** | -6.51  | -17.11* |

This table shows the aftermarket performance calculations based on the individual measures. Market-adjusted buy-and-hold returns (BHRs) are calculated for six periods, namely BHR20 to BHR720, considering 20, 60, 120, 240, 480, and 720 trading days, respectively. AGE denotes the history of the firm from its incorporation and classifies issues up to Rs. 200 million as being small and those above that figure as being large; SIZE denotes the gross proceeds from the IPO and classifies up to Rs. 200 million as being small and above Rs. 200 million as being large. Rs. is Sri Lankan Rupees; BRD denotes the listed board types; PRI denotes the offer price of the IPO; MVL denotes the standard deviation of the daily ASPI for the first 40 trading days prior to the IPO issue; VOL denotes the annual volume of listings in the stock market, and IPOs are categorized into four equal groups based on the number of IPOs went to the public annually; SENT is a proxy for investor sentiment; HOT denotes the hot-period issues and cold-period issues, respectively. Sample t-statistics are used to test the difference between categories, and the overall average BHRs are calculated. Two-tailed sample t-statistics are used to test the difference in mean BHRs (assuming unequal variances). ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

https://doi.org/10.1371/journal.pone.0272092.t004

We divided the sample into equal four subgroups with an equivalent number of observations of 36 firms in each subgroup based on MVL values. When the MVL is high (MVL ≥116), BHRs are always negative. The other three subgroups tend to show lower aftermarket returns in the short run, and the returns increase gradually with the passage of trading time and end up being positive. Moreover, the results show that 28 ≤ MVL < 64 subgroup records outperformed stocks continuously throughout the three years, even though values were insignificant. VOL indicates the four equal-sized subgroups grounded on the number of IPOs that went to the public annually. The level of underperformance remains highest for the 14–15 issues that are significant at 5% and tends to decrease when the IPO volume increases. BHRs are positive when the volume is between 6–10, whereas the returns of the other three subgroups do not show a clear pattern.
Furthermore, in the short run, IPOs underperform in both negative SENT and positive SENT in the market condition. BHRs perform worse in the positive SENT than in the negative SENT. During BHR480 and BHR720, performance shows positive returns for IPOs issued at the time of negative SENT and returns show an increasing trend over the long-term for the negative SENT category. Even though the differences between mean returns in the two groups are statistically insignificant, the findings reveal a negative relationship between positive SENT and long-term IPO performance. Privatization issues are likely to perform better than conventional issues in the long run, up to two years. Privatized IPO issues show a trend of gradually increasing performance during the short time horizon and produce maximum returns during the first trading year of stocks. Conversely, conventional issues performing worse during the first year of trading and stars showing positive returns after the second year. The differences in the BHR20–BHR240 during the first trading year after the IPO issue are statistically significant at the 5% level.

Furthermore, following Rathnayake et al. [15], Table 4 shows that the BHRs are segmented by hot and cold year issues. According to the results, hot issue period IPOs perform better in the long run than do cold year IPO issues. Over the short-term, both hot issue and cold issue IPOs show negative abnormal returns, with hot issues still performing better than do cold issues. The difference between the two is significant at the 5% level in the first trading month. Long-term hot issues perform well and generate positive abnormal returns throughout BHR240–BHR720, with a positive trend of increasing returns over longer periods.

### IPO performance categorized by industry

The plantation industry has the highest returns BHR20–BHR120 in the short run, and those returns are significantly different from the overall average at the 5% level (Table 5).

| Industry                  | No. of Firms | Average Aftermarket performance (%) |
|---------------------------|--------------|-------------------------------------|
|                           | BHR20 | BHR60 | BHR120 | BHR240 | BHR480 | BHR720 |
| Banking, Finance and Insurance | 35     | -1.67 | -4.46 | -9.40  | -12.22 | -6.63  | 14.05  |
| Beverage, Food and Tobacco | 11     | -3.31 | -1.31 | -3.81  | 10.78  | 0.11   | 12.63  |
| Diversified Holdings      | 8      | 4.87  | -1.31 | -11.31 | -28.78 | -29.99 | -41.10 |
| Footwear and Textiles     | 4      | -16.01| -12.37| -38.29 | 130.19***| 139.01***| 107.83**|
| Health Care               | 5      | -2.16 | -15.21| -24.77 | -51.75* | -26.12 | -11.48 |
| Hotels and Travel         | 18     | -12.49| -9.58 | -0.17  | 12.87  | 28.09  | 55.51**|
| Information Technology    | 4      | -8.25 | -1.40 | 2.61   | 35.66  | -3.73  | -57.09 |
| Land and Property         | 3      | -6.24 | -13.45| -23.62 | -15.51 | -14.85 | 42.25  |
| Manufacturing             | 21     | -2.05 | -19.55| -25.02 | -5.41  | 16.40  | 17.75  |
| Motors                    | 1      | 7.52  | 37.94 | 30.84  | 18.95  | -17.65 | -20.06 |
| Plantation                | 18     | 11.39***| 24.77**| 28.60**| 13.05  | 7.10   | 17.69  |
| Power and Energy          | 8      | -4.33***| -11.25***| -12.55***| -27.38 | -32.64 | -33.69 |
| Services                  | 2      | -11.58| -14.30| -33.48 | -23.03 | -17.62 | -28.92 |
| Trading                   | 6      | -23.72* | -27.17 | -28.99 | -24.98 | -47.35 | -9.72  |
| Total                     | 144    | -3.04 | -5.09 | -7.80  | -1.38  | 2.14   | 12.46  |

This table gives the sample distribution by the industry; the number of firms and the average aftermarket returns. Market-adjusted buy-and-hold returns (BHRi) are calculated for six periods namely BHR20 to BHR720 considering 20, 60, 120, 240, 480 and 720 trading days respectively. Two-tails sample t-statistics are used to test the difference in the average BHRs in each industry and the overall average BHRs in the sample (assuming unequal variances). ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

https://doi.org/10.1371/journal.pone.0272092.t005
Interestingly throughout the three years, the plantation industry is the only industry that performs well and generates positive BHRs continuously. Health care, power and energy, services, and trading sector IPOs always underperform in the long run. The underperformance of the power and energy industry differs sharply from the average returns of the sample, and the difference is significant at the 1% level for less than twelve trading months. Interestingly, four industries the beverage, food and tobacco sector, the footwear and textiles sector, the hotels and travel sector, and the manufacturing sector show a similar tendency of BHRs that underperform in the short run and outperform in the long run.

Multiple regression analysis

First, the OLS assumptions are tested before running the multiple regressions. All the non-dummy variables are normally distributed (Table 6). All the non-dummy variables are stationary at the level according to the Augmented Dickey-Fuller (ADF) unit root test results, which are given in Table 7. As illustrated in the correlation matrix (Table 8), independent variables do not appear to be substitutes of each other since the correlation between variables is less than 0.5. Only IR and MAAR are 94% positively correlated, but we do not consider IR and MAAR in the same regression model.

Table 9 shows OLS results for the aftermarket returns of six dependent variables, BHR20–BHR720. We used Eqs 12 and 13 for each BHR, considering IR and MAAR, respectively. The multiple regression models explain approximately between 10%–22% of the overall variations of IPO aftermarket performance in the considered sample, which is measured by $R^2$.

| Variable | Statistic | DF | Significance |
|----------|-----------|----|--------------|
| BHR01    | 0.917     | 144 | 0.035        |
| BHR03    | 0.944     | 144 | 0.044        |
| BHR06    | 0.764     | 144 | 0.000        |
| BHR12    | 0.843     | 144 | 0.012        |
| BHR24    | 0.758     | 144 | 0.000        |
| BHR36    | 0.867     | 144 | 0.019        |
| IR       | 0.755     | 144 | 0.000        |
| MAAR     | 0.741     | 144 | 0.000        |
| AGE      | 0.875     | 144 | 0.027        |
| SIZE     | 0.727     | 144 | 0.000        |
| SENT     | 0.989     | 144 | 0.044        |
| VOL      | 0.749     | 144 | 0.000        |
| PRC      | 0.888     | 144 | 0.022        |
| MVL      | 0.861     | 144 | 0.025        |

Note: Shapiro-Wilk Normality test statistic values are recorded in the table. Market-adjusted buy-and-hold returns (BHR) are calculated for six periods namely BHR20 to BHR720 considering 20, 60, 120, 240, 480 and 720 trading days respectively. IR denotes the initial returns; MAAR denotes the market adjusted abnormal return; AGE denotes the history of the firm from its incorporation; SIZE denotes the gross proceeds from the IPO; PRC denotes the issue price of an IPO in Sri Lankan Rupees; SENT is a proxy for investor sentiment; VOL denotes the annual volume of listings in the stock market; MVL refers to the standard deviation of daily market returns for the first 30 trading days after the IPO; HOT denotes the hot-period issues; PRIV denotes the privatization issues; BRD denotes the listed board types; and HTL, PLNT, and BNK are three dummies for the hotel, plantation, and banking industries, respectively. ‘***’, ‘**’, ‘*’ denote significance at the 1%, 5%, and 10% level, respectively.

https://doi.org/10.1371/journal.pone.0272092.t006
According to our results, the \textit{BHR20}, \textit{BHR120}, \textit{BHR240}, and \textit{BHR720} regression models have significant F-statistic values. IR and MAAR have a negative relationship with \textit{BHR20–BHR720} throughout all the periods. Even the short-term relationship is insignificant, and in the long run there is a significant relationship with BHRs. Our results are in line with the divergence of opinion hypothesis [2,10,13]. In the short run, the \textit{lnAGE} coefficient has a negative sign, and it is statistically insignificant. For the \textit{BHR720} period, age and aftermarket returns have a significant positive relationship, which contradicts the previous findings [2,17,35] and the fundamentals of risk–return theory. The coefficient of the \textit{lnSIZE} has a negative relationship with BHRs, and in the long run, including the \textit{BHR480} and \textit{BHR720} relationship, is significant at the 5% level, as supported by several studies [17,27].

The signs of the two \textit{BRD} and \textit{lnPRI} variables are not constant during the sample periods. Although the estimated coefficient on \textit{BRD} has a positive sign in the short run, it is statistically significant at \textit{BHR60} and \textit{BHR120} aftermarket returns. \textit{BRD} has an insignificant negative relationship with BHRs in the long run. \textit{lnPRI} shows a significant negative relationship with BHRs in the short run and a positive relationship in the long run. \textit{MVL} coefficient values are always negative and very low. Interestingly, \textit{BHR20} and \textit{BHR720} coefficients for \textit{MVL} are statistically significant, thus supporting the hypothesis and previous studies [6,17,25]. Further, Wald test results indicate that five coefficients of ex-ante uncertainty are simultaneously equal to zero in all the models, and the results are not supported by the ex-ante uncertainty hypothesis. OLS results show an insignificant positive relationship between \textit{lnVOL} and \textit{BHR20–BHR720} throughout the all periods, which is similar to the findings of Allen et al. [27] and Hensler et al.

\begin{table}
\centering
\begin{tabular}{|c|c|c|}
\hline
Variable & Intercept & Trend and Intercept \\
\hline
\textit{BHR01} & -11.63*** & -11.93*** \\
\textit{BHR03} & -10.14*** & -10.41*** \\
\textit{BHR06} & -10.56*** & -10.69*** \\
\textit{BHR12} & -9.79*** & -9.91*** \\
\textit{BHR24} & -11.31*** & -11.28*** \\
\textit{BHR36} & -10.64*** & -10.59*** \\
\textit{IR} & -9.29*** & -9.73*** \\
\textit{MAAR} & -9.81*** & -10.23*** \\
\textit{AGE} & -10.31*** & -10.29*** \\
\textit{SIZE} & -6.01*** & -10.92*** \\
\textit{SENT} & -11.47*** & -11.67*** \\
\textit{VOL} & -2.98** & -3.54** \\
\textit{PRC} & -9.29*** & -10.99*** \\
\textit{MVL} & -12.29*** & -12.33*** \\
\hline
\end{tabular}
\end{table}

Note: Augmented Dickey-Fuller test statistic values are recorded in the table. Market-adjusted buy-and-hold returns (\textit{BHR}) are calculated for six periods namely \textit{BHR20} to \textit{BHR720} considering 20, 60, 120, 240, 480 and 720 trading days respectively. IR denotes the initial returns; MAAR denotes the market adjusted abnormal return; AGE denotes the history of the firm from its incorporation; SIZE denotes the gross proceeds from the IPO; PRC denotes the issue price of an IPO in Sri Lankan Rupees; SENT is a proxy for investor sentiment; VOL denotes the annual volume of listings in the stock market; MVL refers to the standard deviation of daily market returns for the first 30 trading days after the IPO; HOT denotes the hot-period issues; PRIV denotes the privatization issues; BRD denotes the listed board types; and HTL, PLNT, and BNK are three dummies for the hotel, plantation, and banking industries, respectively. *** *, ** denote significance at the 1%, 5%, and 10% level, respectively.

https://doi.org/10.1371/journal.pone.0272092.t007
Also, $BHR_{20}^{2} - BHR_{720}^{2}$ are positively related with $SENT$ across all regression models, which is not consistent with the investor sentiment hypothesis. However, values are not statistically significant.

Consistent with previous studies [32,33], $PRV$ record positive signs of the coefficients for the BHRs except for $BHR_{720}^{2}$ returns, and the coefficient values are significant for $BHR_{120}^{2}$ and $BHR_{240}^{2}$ at the 5% level. The $HOT$ dummy variable coefficients are negative in the short run, and the long-time horizon coefficient values are positive. Regression results indicate that $PLNT$, $HTL$, and $BNK$ industries have a positive, though not statistically significant, relationship with short-term aftermarket returns. Over the longer time horizon, $HTL$ coefficients are still positive, and the other two industry coefficients turn negative. For the $HTL$ sector, the only coefficient of $HTL$ is significant at the 5% level for $BHR_{720}^{2}$ returns. Nevertheless, we used the Wald test to test for the joint hypothesis for industry effect (Table 10) and found that the three coefficients of industries are simultaneously equal to zero.

In the final stage of multiple regression analysis, we checked for the heteroscedasticity and autocorrelation errors in the results (Table 11). Using the Breusch–Pagan, autoregressive conditional heteroscedasticity, and White’s heteroskedasticity tests, we obtained similar results showing that the model residuals do not consist of heteroscedasticity errors. Also, we conducted two autocorrelation tests, the Breusch–Godfrey and Durbin–Watson tests, and ensured that our multiple regression results were free from autocorrelation errors.

**Robustness check**

For the robustness check, we repeated our multiple regression analysis by removing 11 delisted firms which occurs during the 720 trading days from the IPO issue. Our overall results regarding the aftermarket performance of IPOs still hold, but there are very few changes (Table 12).

---

**Table 8. Pearson correlation matrix.**

| Variables | MAAR | IR  | AGE | SIZE | SENT | VOL | PRC | RISK | PRIV | HOT | BORD | BNK | PLNT | HOTL |
|-----------|------|-----|-----|------|------|-----|-----|------|------|-----|------|-----|------|------|
| MAAR      | 1    |     |     |      |      |     |     |      |      |     |      |     |      |      |
| IR        | 0.94*** | 1   |     |      |      |     |     |      |      |     |      |     |      |      |
| AGE       | 0.01  | 0.03| 1   |      |      |     |     |      |      |     |      |     |      |      |
| SIZE      | -0.29*** | -0.26*** | 0.14 | 1   |      |     |     |      |      |     |      |     |      |      |
| SENT      | 0.24*** | 0.27*** | 0.08 | -0.14 | 1   |      |     |      |      |     |      |     |      |      |
| VOL       | 0.02  | -0.01| 0.03 | -0.04 | -0.09 | 1   |      |      |      |     |      |     |      |      |
| PRC       | -0.07 | -0.07| 0.19 | 0.20 | 0.09 | 0.32 | 1   |      |      |     |      |     |      |      |
| MVL       | -0.12 | -0.09| 0.11 | 0.23*** | -0.01 | -0.09 | -0.09 | 1   |      |     |      |     |      |      |
| PRIV      | 0.21* | 0.19* | -0.07 | -0.22*** | 0.05 | 0.05 | -0.06 | -0.31*** | 1   |      |     |      |     |      |      |
| HOT       | 0.15** | 0.14** | 0.06 | 0.01 | 0.01 | -0.02 | -0.09 | 0.03 | 0.14** | 1   |      |     |      |      |
| BRD       | 0.09  | 0.10 | 0.01 | 0.11 | -0.05 | -0.01 | 0.21*** | -0.22* | 0.32*** | 0.08 | 1   |      |     |      |
| BNK       | 0.02  | 0.07 | 0.07 | 0.15** | -0.08 | -0.11 | 0.07 | -0.01 | -0.19** | -0.10 | 0.07 | 1   |      |      |
| PLNT      | 0.28*** | 0.17** | -0.12 | -0.37*** | 0.05 | -0.08 | -0.13 | -0.07 | 0.57*** | 0.19** | 0.15 | -0.20** | 1   |      |
| HTL       | -0.12 | -0.09 | -0.21** | -0.12 | 0.08 | 0.02 | 0.02 | 0.04 | -0.16* | -0.07 | -0.08 | -0.21** | -0.14* | 1   |

Note: This table presents the Pearson correlation coefficients for the variables considered in the study. IR denotes the initial returns; MAAR denotes the market adjusted abnormal return; AGE denotes the history of the firm from its incorporation; SIZE denotes the gross proceeds from the IPO; PRC denotes the issue price of an IPO in Sri Lankan Rupees; SENT is a proxy for investor sentiment; VOL denotes the annual volume of listings in the stock market; MVL refers to the standard deviation of daily market returns for the first 30 trading days after the IPO; HOT denotes the hot-period issues; PRIV denotes the privatization issues; BRD denotes the listed board types; and HTL, PLNT, and BNK are three dummies for the hotel, plantation, and banking industries, respectively. "***", "**", "*" denote significance at the 1%, 5%, and 10% level, respectively.

https://doi.org/10.1371/journal.pone.0272092.t008
considering 20, 60, 120, 240, 480 and 720 trading days respectively. Chi-square test statistics values are given in the table, and the probability of chi-squared values are recorded in parentheses.

Note: This table presents the Wald joint hypothesis test results. Market-adjusted buy-and-hold returns (BHR) are calculated for six periods namely BHR20 to BHR720 considering 20, 60, 120, 240, 480 and 720 trading days respectively. Chi-square test statistics values are given in the table, and the probability of chi-squared values are recorded in parenthesis. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

https://doi.org/10.1371/journal.pone.0272092.t009

We have found the signs of all explanatory variables to be almost identical and unchanged from the results in Table 9, except for two minor cases. First, the HOT coefficients are positive in all of BHR20–BHR720 in the new regression results. Second, HTL sector IPOs show a

Table 10. Wald test results.

| Variables | Average Aftermarket performance (%) |
|-----------|-------------------------------------|
|           | BHR20 | BHR60 | BHR120 | BHR240 | BHR480 | BHR720 |
|           | Eq (12) | Eq (13) | Eq (12) | Eq (13) | Eq (12) | Eq (13) | Eq (12) | Eq (13) |
| IR/MAAR   | -0.023 | -0.046 | -0.042 | -0.080 | -0.079* | -0.137** | -0.119** | -0.203** | -0.121** | -0.202** | -0.197*** | -0.333*** |
| AGE       | -0.009 | -0.009 | -0.003 | -0.003 | 0.033   | 0.033   | 0.089   | 0.088   | 0.040   | 0.039   | 0.141*   | 0.140**  |
| SIZE      | -0.009 | -0.008 | -0.009 | -0.011 | -0.001 | -0.002 | -0.060  | -0.063  | -0.109* | -0.111** | -0.116  | -0.120** |
| SENT      | 0.028  | 0.029  | 0.036  | 0.038  | 0.059  | 0.060   | 0.052   | 0.054   | 0.034   | 0.034   | 0.023   | 0.024    |
| VOL       | 0.059  | 0.061  | 0.098  | 0.101  | 0.133  | 0.139   | 0.142   | 0.151   | 0.029   | 0.037   | 0.198   | 0.212    |
| PRI       | -0.059** | -0.059** | -0.068* | -0.119** | -0.119** | -0.058  | -0.057  | 0.046   | 0.047   | 0.040   | 0.042    |
| MVL       | -0.002** | -0.001** | -0.001 | -0.001 | -0.001 | -0.001 | -0.001  | -0.001  | -0.001  | -0.002** | -0.002*** |
| PRV       | 0.039  | 0.040  | 0.130  | 0.131  | 0.275** | 0.274   | 0.479*** | 0.481*** | 0.168   | 0.169   | -0.180  | -0.178   |
| HOT       | -0.074 | -0.072 | -0.116 | -0.113 | -0.088 | -0.084 | -0.018  | -0.015  | 0.043   | 0.046   | 0.171   | 0.176    |
| BRD       | 0.069  | 0.069  | 0.173* | 0.172* | 0.231** | 0.229** | 0.087   | 0.083   | -0.100  | -0.104  | -0.004  | -0.014   |
| BANK      | 0.043  | 0.045  | 0.101  | 0.103  | 0.147  | 0.147   | -0.007  | -0.005  | -0.104  | -0.103  | -0.041  | -0.043   |
| PLNT      | 0.135  | 0.150  | 0.255  | 0.281  | 0.274  | 0.318  | -0.250  | -0.187  | -0.193  | -0.131  | -0.164  | -0.267   |
| HTL       | 0.077  | 0.082  | 0.013  | 0.005  | 0.221  | 0.209   | 0.207   | 0.192   | 0.195   | 0.180   | 0.543** | 0.524**  |
| C         | -0.092 | -0.062 | 0.008  | 0.051  | -0.282 | -0.238 | 0.752   | 0.810   | 1.965* | 2.015*  | 1.653   | 1.746    |
| R²        | 0.155  | 0.162  | 0.119  | 0.126  | 0.167  | 0.176   | 0.147   | 0.162   | 0.109   | 0.119   | 0.195   | 0.215    |
| Prob(F-stat) | 0.347 | 0.031** | 0.189  | 0.150  | 0.024** | 0.015** | 0.071* | 0.038** | 0.320   | 0.234   | 0.013** | 0.005*** |

Observations 144 144 144 144 144 144 144 144 141 137 137 132 132

Ex-ante uncertainty

| Eq (12) IR | BHR01 | BHR03 | BHR06 | BHR12 | BHR24 | BHR36 |
|-----------|-------|-------|-------|-------|-------|-------|
|           | Eq (13) MAAR | 1.145 (0.338) | 1.787 (0.135) | 1.193 (0.317) | 1.271 (0.285) | 1.614 (0.175) |
|           | Eq (13) MAAR | 1.371 (0.247) | 1.168 (0.326) | 1.787 (0.135) | 1.238 (0.293) | 1.340 (0.259) | 1.708 (0.153) |

Industry Effect

| Eq (12) IR | BHR01 | BHR03 | BHR06 | BHR12 | BHR24 | BHR36 |
|-----------|-------|-------|-------|-------|-------|-------|
|           | Eq (13) MAAR | 1.146 (0.232) | 1.036 (0.379) | 1.354 (0.259) | 0.993 (0.398) | 0.777 (0.509) | 1.426 (0.239) |
|           | Eq (13) MAAR | 1.663 (0.178) | 1.203 (0.311) | 1.504 (0.217) | 0.706 (0.551) | 0.597 (0.618) | 1.447 (0.233) |

Note: This table presents the Wald joint hypothesis test results. Market-adjusted buy-and-hold returns (BHRI) are calculated for six periods namely BHR20 to BHR720 considering 20, 60, 120, 240, 480 and 720 trading days respectively. Chi-square test statistics values are given in the table, and the probability of chi-squared values are recorded in parenthesis. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

https://doi.org/10.1371/journal.pone.0272092.t010
negative relationship in the BHR20 and BHR60 periods and later all show positive aftermarket returns. However, the new results have created some variations in the significance of the variables. Interestingly, all $R^2$ values are increased, and the significance of the F-statistic remains the same in the new results. Thus, we conclude that our results are robust.

**Conclusion**

This study focused on the evaluation of the performance of initial price offerings (IPOs) price performance up to 36 months including the listing day in terms of market-adjusted buy and hold returns (BHRs) and market-adjusted cumulative average returns (CAARs) and the practicality determinants at the time of IPO issues to find explanations for the IPO aftermarket performance. Average market-adjusted returns and CAARs are always lower than 1%. Averagely abnormal returns are negative in the short run, and abnormal returns gradually become positive in the long run. Over the three years, IPOs outperform with positive 12.46% BHRs. We found that initial returns have a long-term significant negative relationship with all BHRs and that the outcomes are consistent with the
divergence of opinion hypothesis. Market volatility and aftermarket returns are negatively related throughout the all considered periods. Privatized IPOs show a significant positive relationship with one-year aftermarket returns. Hot issue period IPOs are positively related with first trading month aftermarket returns, while other periods are not significant. Similarly, plantation sector IPOs show a positive and significant relationship in short run BHRs. We do not accept the ex-ante hypothesis in aftermarket performance as five variables age of the firm, issue size, listed board effect, market volatility, and the IPO price are jointly not significant. Aftermarket returns are positively related with investor sentiment, and the annual volume of listings are based on the firm went to the public. For the robustness check, we re-estimated the multiple regressions by using the sample of 133 firms after removing delisted companies from the original sample. We found that the signs of most of the explanatory variables are unchanged and remained the same as the full sample results.

Consequently, we suggest that investors should hold their subscriptions of IPO shares for a prolonged time frame, usually exceeding two years, as the dynamic of shares rewards the investors with positive abnormal returns in the long run. Though intrinsic characteristics of IPO firms may constitute a bias to this pattern, it is still worthwhile for investors in emerging stock exchanges to monitor the performance of IPO firms over the long-run.

Table 12. Robustness check- multiple regression results.

| Variables | BHR20 Eq (12) | BHR60 Eq (13) | BHR120 Eq (12) | BHR240 Eq (13) | BHR480 Eq (12) | BHR720 Eq (13) |
|-----------|---------------|---------------|----------------|----------------|----------------|----------------|
| IR/ MAAR  | -0.039**      | -0.067**      | -0.050**       | -0.088**       | -0.073**       | -0.128**       |
| AGE       | -0.017        | -0.016        | 0.004          | 0.005          | 0.034          | 0.035          |
| SIZE      | -0.009        | -0.007        | -0.018         | -0.020         | -0.001         | -0.004         |
| SENT      | 0.037         | 0.039         | 0.014          | 0.012          | 0.026          | 0.029          |
| VOL       | 0.025         | 0.025         | 0.043          | 0.044          | 0.104          | 0.105          |
| PRI       | -0.058**      | -0.058**      | -0.001         | -0.001         | -0.058         | -0.058         |
| MVL       | -0.001**      | -0.001**      | -0.001         | -0.001         | -0.001         | -0.001         |
| PRV       | 0.036         | 0.038         | 0.093          | 0.096          | 0.202          | 0.205          |
| HOT       | 0.167**       | 0.172**       | 0.105          | 0.111          | 0.062          | 0.071          |
| BRD       | 0.039         | 0.038         | 0.044          | 0.042          | 0.120          | 0.117          |
| BANK      | 0.076         | 0.077         | 0.063          | 0.065          | 0.063          | 0.066          |
| PLNT      | 0.189*        | 0.210**       | 0.278**        | 0.307**        | 0.290**        | 0.331**        |
| HTL       | -0.107        | -0.109        | -0.025         | -0.027         | 0.139          | 0.135          |
| C         | -0.052        | -0.025        | 0.070          | 0.111          | -0.314         | -0.258         |
| R2        | 0.202         | 0.212         | 0.128          | 0.139          | 0.161          | 0.167          |
| Prob(F-stat) | 0.009***    | 0.005***      | 0.195          | 0.137          | 0.059*         | 0.033**        |

This table presents the robustness regression results after excluding 11 delisted firms from the sample. Market-adjusted buy-and-hold returns (BHR) are calculated for six periods namely BHR20 to BHR720 considering 20, 60, 120, 240, 480 and 720 trading days respectively. IR denotes the initial returns; MAAR denotes the market adjusted abnormal return; AGE denotes the history of the firm from its incorporation; SIZE denotes the gross proceeds from the IPO; PRC denotes the issue price of an IPO in Sri Lankan Rupees; SENT is a proxy for investor sentiment; VOL denotes the annual volume of listings in the stock market; MVL refers to the standard deviation of daily market returns for the first 30 trading days after the IPO; HOT denotes the hot-period issues; PRIV denotes the privatization issues; BRD denotes the listed board types; and HTL, PLNT, and BNK are three dummies for the hotel, plantation, and banking industries, respectively. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

https://doi.org/10.1371/journal.pone.0272092.t012
Supporting information

S1 Data.
(XLSX)

Acknowledgments

We greatly appreciate the comments and suggestions given by the Journal Editor and anonymous referees.

Author Contributions

Conceptualization: Dilesha Nawadali Rathnayake.
Data curation: Pierre Axel Louembé.
Formal analysis: Dilesha Nawadali Rathnayake, Pierre Axel Louembé.
Funding acquisition: Bai Yang.
Investigation: Dilesha Nawadali Rathnayake, Zhixin Zhang, Bai Yang.
Methodology: Dilesha Nawadali Rathnayake, Pierre Axel Louembé.
Software: Pierre Axel Louembé.
Supervision: Zhixin Zhang.
Validation: Bai Yang.
Visualization: Pierre Axel Louembé.
Writing – original draft: Pierre Axel Louembé.
Writing – review & editing: Dilesha Nawadali Rathnayake, Zhixin Zhang, Bai Yang.

References

1. Loughran T, Ritter JR. The new issues puzzle. The Journal of Finance. 1995 Mar; 50(1):23–51. https://doi.org/10.1111/j.1540-6261.1995.tb05166.x.
2. Ritter JR. The long-run performance of initial public offerings. The journal of finance. 1991 Mar; 46(1):3–27. https://doi.org/10.1111/j.1540-6261.1991.tb03743.x.
3. Peter S. Performance of initial public offerings and privatized offers: Evidence from a developing country. Managerial Finance. 2007 Sep; 33(10):798–809. https://doi.org/10.1108/03074350710779241.
4. Ediriwickrama TC, Azeez AA. Multi factor explanation to IPO long run underperformance anomaly: Sri Lankan evidence. The International Journal of Accounting and Business Society. 2016 Dec 16; 23(2):15–27. Retrieved from https://ijabs.ub.ac.id/index.php/ijabs/article/view/271.
5. Miller EM. Risk, uncertainty, and divergence of opinion. The Journal of Finance. 1977 Sep 1; 32(4):1151–68. https://doi.org/10.2307/2326520.
6. Gao Y, Mao CX, Zhong R. Divergence of opinion and long-term performance of initial public offerings. Journal of Financial Research. 2006 Mar; 29(1):113–29. https://doi.org/10.1111/j.1475-6803.2006.00169.x
7. Houge T, Loughran T, Suchanek G, Yan X. Divergence of opinion, uncertainty, and the quality of initial public offerings. Financial management. 2001 Dec 1:5–23. https://doi.org/10.2307/3666256.
8. Shiller RJ. Speculative prices and popular models. Journal of Economic perspectives. 1990 Jun; 4(2):55–65. https://doi.org/10.1257/jep.4.2.55
9. De Bondt WF, Thaler R. Does the stock market overreact? The journal of finance. 1985 Jul; 40(3):793–805. https://doi.org/10.1111/j.1540-6261.1985.tb05004.x.
10. Aggarwal R, Rivoli P. Fads in the initial public offering market?. Financial management. 1990 Dec 1:45–57. https://doi.org/10.2307/366669.
11. Su D, Fleisher BM. An empirical investigation of underpricing in Chinese IPOs. Pacific-Basin Finance Journal. 1999 May 1; 7(2):173–202. https://doi.org/10.1016/S0927-538X(99)00005-0.
12. Ting YU, Tse YK. An empirical examination of IPO underpricing in the Chinese A-share market. China economic review. 2006 Jan 1; 17(4):363–82. https://doi.org/10.1016/j.chieco.2005.07.001.
13. Ritter JR, Welch I. A review of IPO activity, pricing, and allocations. The journal of finance. 2002 Aug; 57(4):1795–828. https://doi.org/10.1111/1540-6261.00478.
14. Chi J, Padgett C. The performance and long-run characteristics of the Chinese IPO market. Pacific Economic Review. 2005 Dec; 10(4):451–69. https://doi.org/10.1111/j.1468-0106.2005.00285.x.
15. Rathnayake DN, Loumbeé PA, Kassi DF, Sun G, Ning D. Are IPOs underpriced or overpriced? Evidence from an emerging market. Research in International Business and Finance. 2019 Dec 1; 50:171–90. https://doi.org/10.1016/j.ribaf.2019.04.013.
16. Belghitar Y, Dixon R. Do venture capitalists reduce underpricing and underperformance of IPOs?. Applied Financial Economics. 2012 Jan 1; 22(1):33–44. https://doi.org/10.1080/09603107.2011.597720.
17. Bhabra HS, Pettway RH. IPO prospectus information and subsequent performance. Financial Review. 2003 Aug; 38(3):369–97. https://doi.org/10.1111/1540-6288.00051.
18. Brau JC, Couch RB, Sutton NK. The desire to acquire and IPO long-run underperformance. Journal of Financial and Quantitative Analysis. 2012 Jun; 47(3):493–510. https://doi.org/10.1017/S0022109012000233.
19. Agatheee US, Sannasee RV, Brooks C. The long-run performance of IPOs: the case of the Stock Exchange of Mauritius. Applied Financial Economics. 2014 Sep 2; 24(17):1123–45. https://doi.org/10.1080/09603107.2014.924294.
20. Alanazi AS, Al-Zoubi HA. Extreme IPO underpricing and the legal environment in wealthy emerging economies. Journal of Multinational Financial Management. 2015 Apr 1; 31:83–103. https://doi.org/10.1016/j.jmufn.2015.05.004.
21. Durukan MB. The relationship between IPO returns and factors influencing IPO performance: case of Istanbul Stock Exchange. Managerial Finance. 2002 Feb 1; 28(2):18–38. https://doi.org/10.1108/03074350210767672.
22. Thomadakis S, Nounis C, Gounopoulos D. Long-term performance of Greek IPOs. European financial management. 2012 Jan; 18(1):117–41. https://doi.org/10.1111/j.1468-036X.2010.00546.x.
23. Levis M. The long-run performance of initial public offerings: The UK experience 1980–1988. Financial Management. 1993 Apr 1; 28:41. https://doi.org/10.2307/365963.
24. Mumtaz MZ, Ahmed AM. Long-run pricing performance of initial public offerings (IPOs) in Pakistan. Nust Journal of Social Science and Humanities. 2016; 2(2):97–140. https://doi.org/10.51732/njssh.v2i2.14.
25. AI-Hassan A, Delgado F, Omran M. The under-pricing of IPOs in the Gulf cooperation council countries. Research in International Business and Finance. 2010 Sep 1; 24(3):344–60. https://doi.org/10.1016/j.ribaf.2010.03.002.
26. Loughran T, Ritter JR, Rydqvist K. Initial public offerings: International insights. Pacific-Basin Finance Journal. 1994 May 1; 2(2–3):165–99. https://doi.org/10.1016/09603107.1994.90016-7.
27. Allen DE, Morkel-Kingsbury NJ, Piboonthanakiat W. The long-run performance of initial public offerings in Thailand. Applied Financial Economics. 1999 Jun 1; 9(3):215–32. https://doi.org/10.1080/0960310993232294.
28. Hensler DA, Rutherford RC, Springer TM. The survival of initial public offerings in the aftermarket. Journal of Financial Research. 1997 Mar; 20(1):93–110. https://doi.org/10.1111/j.1540-6803.1997.tb00238.x.
29. Ljungqvist A, Nanda V, Singh R. Hot markets, investor sentiment, and IPO pricing. the Journal of Business. 2006 Jul; 79(4):1667–702. https://doi.org/10.1086/503644.
30. Khan S, Ramakrishnan S, Haq ZU, Ahmad M, Alim K. Determinants of IPO’s Long-run Performance: Case of Pakistan Stock Exchange. Journal of Managerial Sciences -Economic, Business and Management. 2018; XI(03):13–45. Retrieved from https://www.qurtuba.edu.pk/jms/EBM.htm.
31. Dimovski W, Brooks R. Initial public offerings in Australia 1994 to 1999, recent evidence of underpricing and underperformance. Review of Quantitative Finance and Accounting. 2004 May; 22(3):179–98. https://doi.org/10.1023/B:REQU.0000025759.39918.89.
32. Rizwan MF, Khan SU. Long-run performance of public vs. private sector initial public offerings in Pakistan. The Pakistan Development Review. 2007 Dec 1:421–33. https://www.jsstor.org/stable/41261174.
33. Kooli M, Suret JM. The aftermarket performance of initial public offerings in Canada. Journal of multinational financial management. 2004 Feb 1; 14(1):47–66. https://doi.org/10.1016/S1042-444X(03)00038-0.
34. Lyn EO, Zychowicz EJ. The performance of new equity offerings in Hungary and Poland, Global Finance Journal. 2003 Jul 1; 14(2):181–95. https://doi.org/10.1016/S1044-0283(03)00011-5.