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IPOs performance evaluation: Which methodology to opt for?

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ABSTRACT: Each corporate event of interest could be analyzed through several approaches. In the recent finance literature, there are common methods emanating from two notorious approaches, that are: the CAR and BHAR methods belonging to the event study approach, and those that fall into the second approach of calendar time, namely the CTAR, and the asset pricing models; starting with the Fama and French's three-factor model to the refined multi-factor models.

The Initial Public Offering (IPO) is a corporate event that consists of the operation to open up the capital to investors, it is a strategic decision where companies make that step toward the capital market, especially the stock exchange market, and go from private to public. This event can be analyzed and studied through the approaches named above, based on the computation of abnormal returns around the IPO event, which, in turn, could be calculated through the statistical models (Constant Mean Return Model, Adjusted Market Return, Market Model) and economic ones (Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory (APT)).

Both approaches (the event study, and the calendar time) have been and still are under criticism, according to many researchers the outcomes and findings depend on the methodology used to evaluate the performance of IPOs from the first step of defining abnormal returns, to the application of methods assembling them, till the test of the null hypothesis.

The following paper is a kind of literature review where we tried to assemble a number of theoretical and empirical papers and works containing the pieces of information we need to aid in answering this question of evaluating the IPO's performance through different methods and arbitrating between them.

KEYWORDS: Ipos performance, abnormal returns, event-study approach, calendar time approach.

1 INTRODUCTION

It is conventional that each corporate event of interest could be analyzed through two common approaches in the recent finance literature, we are talking about the methods of the event study approach, and those of the calendar time approach. The first one is defined as an empirical analysis that seeks to ascertain the existence or the absence of an abnormal return earned by a firm after a corporate event in a timeline window and interpret it as the assessment and computation of the impact had an exogenous event on the value of stocks under the security's market value variations, this approach is containing different methodologies (CAR and BHAR) that calculate the abnormal return for every event firm in a sample. The second one which is the calendar time approach, poles apart in terms of forming a portfolio in each calendar month containing companies that had experienced the same event during a specific time period, and in turn have distinct methods (including CTAR, and the asset pricing models; starting with the Fama and French's three-factor model to the refined multi-factor models) we will see their details in the present paper.

While defining the approaches we find persistently a substantial element that is the abnormal return which is computed first using different methods; statistical (Constant Mean Return Model, Adjusted Market Return, Market Model) and economic (Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory (APT)). While processing with the methodologies of the first approach, authors can use benchmark methods while calculating the benchmark return used to form the abnormal return after subtracting it from the actual return, these benchmark methods following several authors including Barber and Lyon [1] are based on reference portfolios (Size decile portfolios; Book-to-market decile portfolios (BTM=Equity/market capitalization); Fifty size/book-to-market portfolios; Equally weighted market index), or three Control firm methods (Size-matched; Book-to-market matched; Size/book-to-market matched) and the Fama French three-factor model based on a regression intercept.

However, the process doesn't end here, after choosing the method to compute abnormal returns, it is crucial to then test statistically the null hypothesis of zero abnormal return, which can be based on parametric or nonparametric tests. The methodologies of the second approach aim to test the null hypothesis that the intercept is a cipher in the regression of monthly calendar-time portfolio returns against the factors, in a choosing asset-pricing model among those that exist as the commonly used; the three-factor model of Fama and French [2] and its add-on four-factor which is the momentum-related factor put forward by Carhart [3], or the refined multi-factor models developed afterward, then it is

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important to select between the estimation techniques; the ordinary least squares (OLS), the weighted least squares (WLS), that are appropriate to the pricing model chosen.

The Initial public offering (IPO) is a corporate event that consists of the operation to open up the capital to investors, it is a strategic decision where companies make that step toward the capital market, especially the stock exchange market, and go from private to public, this event can be analyzed and studied through the above-named approaches, and many researchers and authors have analyzed the abnormal returns emanating from the impact of the IPO event in different markets around the world, the instance of Ritter [4] in the USA; Levis [5] in the UK; Chen, Firth, and Jeong-Bon [6] in China; Stehle et al. [7] in Germany; Kooli and Suret [8] in Canada; Erdogan [9] in turkey; A. Dutta and P. Dutta [10] in South Africa; Alami Talbi [11] in Morocco, and others, we will see afterward in details.

This topic is very important and appealing in its context, as much as the IPO is a corporate event that always remains a concern to managers, investors, and capital market specialists.

Each person who is interested in computing the abnormal returns that earn companies after going public wonders which methodology and techniques to choose for a robust and efficient process of IPOs performance evaluation; our case. This leads us to make a review of the most common approaches with their methods and the limits of each one to be able to decide and arbitrate between them.

Both approaches could not escape criticism by facing problems of being the bad model as stated by Fama [12], and yielding wrong results or different outcomes while using one method instead of another ([13] and [1]), that's why choosing the methodology is important, and testing statistically the findings is more crucial to give more appealing and founded interpretations.

The following paper is a kind of literature review where we tried to assemble a number of theoretical and empirical papers and works containing the pieces of information we need to aid in answering this question of evaluating the IPO's performance through different methods.

The paper's outline then consists of a first part related to our methodology for collecting scientific articles and work that flow into our subject, followed by a second part that is our theoretical framework of analysis; a sort of critique of the empirical literature containing accurately more details about existing approaches; including methods; their way of computation, a sample of empirical studies method, and their limits.

2 METHODOLOGY FOR COLLECTING SCIENTIFIC ARTICLES

Our literature search is performed to gather as much information as relevant from previous studies and works to answer our queries. This is crucial for providing evidence on our topic which is about choosing the adequate methodology to evaluate IPO performance and help validate our research afterward. This is going to help every future research aiming to evaluate the performance of IPOs and then arbitrate between the trails at one's disposal and provided by the literature.

We accomplished this step of collecting the relevant scientific works before going to the phase of analysis and critique, using keywords and phrases to search relevant databases.

We were then based on especially controlled databases, namely: Science Direct, Elsevier, Scopus, Jstor, and Cairn. By seeking the following keywords: IPOs performance, abnormal returns, event-study approach, calendar time approach, etc. We've got the scientific articles intersection between the approaches and methods of evaluating the performance of corporate events and the IPO's performances as our event of interest.

The works we chose at the final stage were of three types; the first group was quite defining the approaches and their methods including the way of computations of abnormal returns, included for theoretical and conceptual enrichment of the study. The second group was about different empirical papers using one or a combination of the methods we will expose in the subsections of the next part of our article to show the inferences and results adopted in diverse markets opting for different methods and approaches. Then, the third group which is about papers criticizing and exposing the limits of each technique apart and presenting its remedy.

In what follows, our theoretical framework for qualitative analysis emanating from the results of these studies and works selected.

3 THEORETICAL FRAMEWORK OF ANALYSIS: CRITIQUE OF THE EMPIRICAL LITERATURE

3.1 THE EVENT-STUDY APPROACH

The event study is an empirical analysis that involves the examination of the behavior around the time of an information announcement or event, it reveals the impact of a significant catalyst occurrence or contingent event on the value of a security, such as company stock, and is one of the most important methodological approaches to market-based empirical research in finance and accounting [14], in other words by MacKinlay [15] this approach measures the impact on the value of a company of a specific event using financial market data, it can be used to inspect the financial performance of a security such as a company stock following many events, among others; the announcements of annual accounting earnings, accounting principal changes, large block trades, and corporate mergers and acquisitions.

In accordance with MacKinlay [15], the long story of event studies started with the study by Dolley in 1933, until the late 1960s characterized by the contributions of Myers and Bakay (1948), Barker (1956, 1957, 1958), and Ashley (1962) and then comes the seminal studies by Ball and

Brown (1968), and Fama et al. (1969), these were the pioneering studies that opened up the venues of development and adjustment to this methodology.

In the literature four types of event study were evoked and developed; the first one is "Information content" by Ball and Brown [16] which demonstrated the practical use and the purpose of accounting information in the context of annual earnings announcement; one of the events that this approach has been used for its study, then "the market efficiency" of Fama, Fisher, Jensen and Roll [17] from where came the Theory of Efficient Markets of Fama [18] which underlies that the markets are impacted by the public information so that the stocks prices are reflected. The two types that are left are derived from the first types and defined as follows. The "Model evaluation" which is conducted to evaluate alternative models of investors because the measurement of excess return is affected by the efficacity and validity of the expectations model, Beaver and Dukes [19] were the first who made this study for this purpose to rank measures adopted and give inferences regarding the models used to drive the information content, this approach is an ex-ante specification of models of expected security price reaction. The "Metric explanation" is a simple approach that its center of interest is to identify variables chosen to account for the excess return metric in the context of information content or market efficiency test, which means the study of the factors associated with the metric and an explanation ex-post of it.

In general, regardless of the type adopted, while conducting an event study one can utilize statistical or economic methods, or models using the dependent variable which is time to find out the variables justifying and determining the abnormal stock price that resort in the duration of a specific occurred event.

The techniques used then in event studies are diverse, numerous researchers have summarized them in a set of steps and tasks called the procedure to conduct an event study, so the first thing to do is obviously to define the event of interest and identify the event window Fig.1 which means the period over which for example stock prices typically respond to the specific event that is the IPO in our case. Then it is crucial to specify the selection criteria for the inclusion or exclusion of a given company in the study in terms of information and data availability also its added value to the study, which forms the sample characteristics. From there, we have to determine the normal return and abnormal return, measure and analyze them using one or multiple models among those various ones that exist. Following MacKinlay [15], these models for measuring normal performance can be loosely grouped into two categories; statistical and economic: "Models in the first category follow from statistical assumptions concerning the behavior of asset returns and do not depend on any economic arguments. In contrast, models in the second category rely on assumptions concerning investors' behavior and are not based solely on statistical assumptions." (p.17)

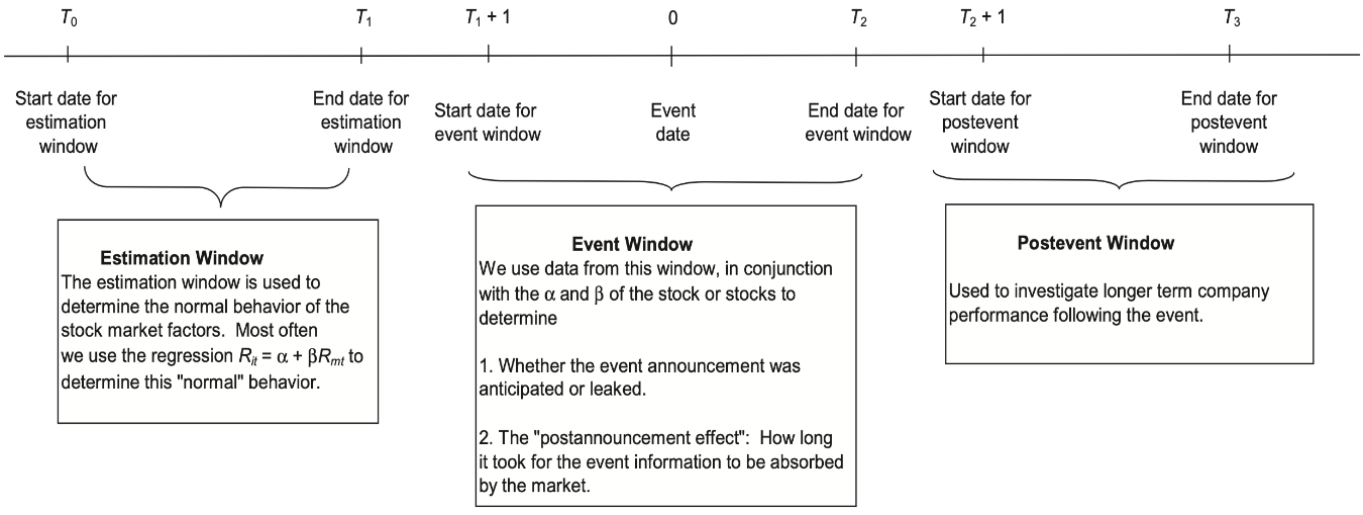

Fig. 1. The Event-Study TimeLine [20]

STATISTICAL MODELS:

In the first group, we choose to introduce the Constant Mean Return Model, the Market Model, and The Market-Adjusted Return Model.

Constant Mean Return Model

Is the simplest model referring to Brown and Warner ([20], [21]) that affirmed having similar results using the Constant Mean Return Model and other sophisticated ones. Per them, it's a crude method but robust.

The normal return is defined here by a facile average of the real return in the estimated window, and suppose that the mean return of a security remains the same and occurs continuously over a period of time.

$$AR_{i,t} = R_{i,t} - \overline{R}_i$$

With i: firm, t: trading day

Although, this model is subject to several criticisms relating to the constant character of the return over the passing of time that cannot be guaranteed when the volatility is high.

Adjusted Market Return

This is another method that requires a new database and relates the normal return to the return of the market portfolio (Rm).

$$AR_{i,t} = R_{i,t} - Rm_t$$

With i: firm, t: trading day

Market Model

The Market Model is an overtaking and upgrade of the previous models based on statistics, it differs in terms of using an abroad-based stock index that changes from one region to another instead of setting as default a market portfolio, also by supposing that there is a stable linear interaction between both the market and security returns.

$$AR_{i,t} = R_{i,t} - \alpha_i - \beta_i Rm_t$$

With i: firm, t: trading day, $AR_{i,t}$ is the abnormal return, $R_{i,t}$: the real return of the asset in t, Alpha and beta: are the parameters of the market model.

"The systematic risk parameter (beta) is equal to the slope coefficient in a time series regression of individual firm returns on the return on a market index." ([14], p.568)

Through this model, we can reduce the variance of the abnormal return that is estimated by linear regression in the estimation window increasing the ability to detect event impact, this linear regression depends on R^2 which when it is high, the variance is reduced more, and therefore the gain is important.

ECONOMIC MODELS:

To estimate the stock's future return, based on economic models we can calculate the normal returns using two common methodologies namely: the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT).

Capital Asset Pricing Model (CAPM):

Developed by Sharpe [23], Lintner [24], and Mossin [25], this model brings a methodology to calculate the abnormal return using the real and the estimated return, taking the sensibility of the asset and market return Rm in addition to the free risk assets returns Rf into consideration, the expected returns of risky assets are bent on the covariance between both returns of assets and market portfolio. Per Sharpe [23] "Capital asset prices" is a theory of market equilibrium under conditions of risk. In other words, in equilibrium, the investor who follows rational procedures like diversification can reach any desired point along a capital market line; among other objectives attain a higher rate of return by incurring the additional risk, because in the market exists the price of time or the pure interest rate and the price of risk. This theory then supposes the market efficiency from the moment that securities and prices mirror every piece of information obtainable on the market at any time.

$$AR_{i,t} = R_{i,t} - Rf_t - \beta\,(Rm_t - Rf_t)$$

With i: firm, t: trading day, Rf: free risk assets return

This model has been used in many studies, but some researchers judge it as unsuitable when facing certain market anomalies such as market inefficiency and asset-pricing model inadequacies [26], it has been deemed insufficient even if it was the first model that determines the relationship between average return and market beta, the reason why this model has been refined to multi-factor models we will see them in a proximate section.

Arbitrage Pricing Theory (APT):

Developed by Ross [27], it provides an alternative to the mean-variance approach and is used to control different factors, which means that we have different risk prizes associated with different factors that in turn are linked to their specific sensibility beta. Each beta can be calculated through a linear regression between factors and assets.

$$AR_{i,t} = R_i - Rf + \beta_1 R_1 + \beta_2 R_2 + \beta_n R_n$$

With i: firm, t: trading day.

A head back on the objective of the event study that is known also by other names such as; residual analysis and abnormal performance index tests, and research to date [14]. A Return event study quantifies an event's economic impact in so-called abnormal returns. Following many researchers, an aggregation of the abnormal return observations must be done to be able to draw overall inferences for the event object of the study. This aggregation occurs along two dimensions; over time and across securities. From where does the need to evoke the concept of the called in the financial economics literature the Cumulative Abnormal Return (CAR) that is the equation of summing daily or monthly abnormal returns.

"In some cases, we sum the abnormal returns to arrive at the cumulative abnormal return (CAR), which measures the total impact of an event through a particular time period, also called the event window." ([20], p. 371)

In what follows more details about the cumulative abnormal returns method (CAR) that accommodates a multiple-period event window.

3.1.1 THE CUMULATIVE ABNORMAL RETURNS (CAR) METHOD

As already stated, the choice for the Cumulative Abnormal Returns CAR, means that the excess return has been calculated and must be organized and grouped to be ready for analysis. The CAR method is then an arithmetic procedure where the variable CAR_t is the sum of the total abnormal returns from the start of the event window t=1 till a particular period of time T in the same window:

$$CAR_T = \sum_{t=1}^{T} AR_t$$

With AR is the stock's abnormal return, defined by the actual stock return in event window day t minus the Return predicted, for example, by the stock's alpha and beta and market return or other prementioned models.

Based on benchmark models: the CARs could represent the sum of the actual returns less the return benchmark that estimates the return would earn a company without the impact of the event or supposing that the event doesn't happen, which can be developed through many benchmark methods already showed in previous parts of the present section. The formula of CARs is then the following:

$$CAR_{i,T} = \sum_{t=1}^{T} AR_{i,t}$$

With:

$$AR_{i,t} = R_{i,t} - E(R_{i,t})$$

Then the average cumulative abnormal return between event periods; 1 and t is calculated as follows:

$$\overline{CAR}_T = \sum_{i=1}^{nT} w_{i,T} CAR_{i,T}$$

$w_{i,t}$: is the weight, and equals to $\frac{1}{\text{nt}}$ when returns are equally weighted and $\frac{\text{MVi}}{\sum \text{MV}_i}$ when abnormal returns are pre-weighted by market capitalization MVi of newly listed securities.

The advantages of this method are around the fact that the CAR surrounds the event even if its precise day of occurrence is unrecognized, in this vein Kolari and Pynnönen [28] affirm that: "Most event studies examine CAR behavior over multiple days around the event date. CARs allow for the possibility that the event date is not exactly known and capture post-event market reaction." (p.4017)

The concept is unchangeable according to the type of event. Staying in our field of interest and the topic of our paper, even for the capital markets especially: "In a stock market event study, cumulative abnormal returns (CARs) are estimated by summing estimated abnormal returns (ARs) over an event window" Dixit Salinger ([29], p.39).

The following table is a sample of empirical studies having used the CAR method while determining IPOs performances before and after the event of opening up capital to investors:

Tableau 1. Sample of empirical studies having used the CAR method in computing IPO performance.

Country	Authors	Study period	Sample size	Study window	Inferences
Germany	Wittleder [30]	1961-1987	67	1 year	Underperformance in long run
Germany	Sapusek [31]	1983- 1993	142	3 years	Underperformance in long run
China	Chan, Wei and Wang [32]	1993- 1998	570	3 years	Super performance of A-share in long run
Korea	Lee and Lim [33]	1980- 1994	331	3 years	Underperformance in long run
United states	Ritter [4]	1975- 1984	1512	3 years	Underperformance in long run
France	Leleux and Muzyka [34]	1987- 1991	56	3 years	Underperformance in long run
France	Brounen and Eichholtz [35]	1984- 1999	17	1 year	Underperformance in long run
Portugal	Duque and Almeida [36]	1992- 1998	21	1 year	Underperformance in long run
United Kingdom	Leleux and Muzyka [34]	1987- 1991	22	3 years	Underperformance in long run
United Kingdom	Levis [5]	1980- 1988	712	3 years	Underperformance in long run
Tunisia	Cherrak, Sahut and Rajhi [37]	1995- 2002	26	3 years	Underperformance in long run
Turkey	Ozden [38]	1990-1997	134	3 years	Underperformance in long run

Source: Summary of empirical works on the long-term performance of IPOs from the literature on the issue (elaborated by authors).

Various studies have been made in order to test statistically the hypothesis related to the power of event study methodology and the limits of its different methods while determining the average or cumulative average abnormal returns and estimating their magnitude.

When measuring the abnormal returns, that are considered residuals and prediction errors from the benchmark models of normal returns among others the market model, in accordance with Salinger [29], the source of standard errors in event study, especially when using the CAR method, is ignoring the intertemporal and contemporaneous correlation of these estimated residuals, because per him, that serial correlation of estimated errors causes a significant understatement of the standard errors (the problem with time-series dependence). Even if emanating from the efficient market hypothesis the fact that estimated ARs are intertemporally uncorrelated can be easily justified, but based on estimated market model parameters, this can be a forecast error, that the ARs are actually correlated with each other when the calculation of each estimated AR is based on same estimated market parameters. So, to take into consideration the intertemporal and contemporaneous correlation of estimated residuals, the joint estimation between firms or portfolios is crucial. Moreover, the approximate equivalence between the sum of ARs and the CARs should be verified, because if it's not the case we can get an equivocal interpretation. Salinger [29], gives an easier procedure by a simple formula using a variant of the dummy variable procedure for the variance of estimated cumulative abnormal returns also to estimate the appropriate standard errors, this dummy variable approach is computational ease, also the variance of CARs here is not the sum of the variances of the individual ARs.

These hassles were also evoked by Binder [39], when talking about several statistical issues in hypothesis testing; the problems with heteroskedasticity and dependence that are related to the fact that the abnormal return estimators are ofttimes dependent or haven't matched variances, which means that the abnormal return estimators visualized in 4 examples by the author: "1) are cross-sectionally (in event time) correlated, 2) have different variances across firms, 3) are not independent across time for a given firm or 4) have greater variance during the event period than in the surrounding periods." (p. 114). Many problems per Binder [39] can be ignored and easily solvable because they are quite minor as cross-sectional dependence; because it doesn't represent a problem when the event periods are haphazardly distributed over calendar time.

On the report of several authors including Kolari and Pynnönen [28], event studies are subject to a cross-sectional correlation between abnormal returns when the day of the event is the same for the companies in the sample, this is why the impossibility of supposing the independence of ARs by test statistics is a fact within the scope of knowledge. Other evidence supports the view that the common methods used to determine the long-run abnormal returns are misspecified, conceptually deficient, and can conduct to biases in statistical results and statistical tests directed. According to Barber and Lyon [1] who documented the biases that are induced by the CAR method, the latter is subject to three biases that are: measurement bias, a new listing bias, and a skewness bias. Knowing that the measurement bias is a hassle linked to the inappropriate method to detect long-run abnormal stock returns. Per the prementioned authors, the CAR method is a biased predictor when the time horizon is large, especially on the conceptual ground this method doesn't take into account the investment strategy of Buy-and-Hold which will be explained in the next section. Regarding the new listing bias, it is related to the fact that by conducting the event study of long-run abnormal returns we have to select while making our sample, companies that have a long post-event history of returns to analyze and interpret the impact the event had on the market value of the security in the long-run period of time, while when counting the index or reference portfolio we include even the new companies that started been traded in the event month which distort the results, because per the aforementioned authors: "The population mean CAR will be positive if newly listed firms underperform market averages, while it will be negative if newly listed firms outperform market averages." (p.346) Referring to Ritter [4] who confirmed that in an equally weighted market, those companies who made the decision to go public and opening up capital to investors are actually underperforming the market index. Concerning skewness bias, it occurs seeing that abnormal returns are positively asymmetric in the long run.

Based on the approach of reference portfolios while estimating the expected return, these biases can't be excluded and avoided, whereas by using the control firm approach where sample firms are matched to a control firm considering specified firm characteristics as revealed by Barber and Lyon: "We evaluate three methods of identifying a control firm: (1) matching a sample firm to a control firm closest in size […], (2) matching a sample firm to a control firm with most similar book-to-market ratio, and (3) matching a sample firm to a control firm of similar size and book-to-market ratio." ([1], p.355). The new listing bias and skewness issue can be eliminated, from the moment that both the sample and control firms have to be listed in the identified event month and are equally foreseeably to meet very important returns.

As we have already seen, the CAR method was used in different time horizons, whereas many researchers consider it as not appropriate for long-run studies. It is advocated for measuring the short-term abnormal returns only ([40], [1], [41]), in other cases, the use of additional methods is required. In what follows details about the BHAR method that is the best long-run event study.

3.1.2 THE BUY-AND-HOLD ABNORMAL RETURN METHOD (BHAR)

The buy-and-hold abnormal return approach as the name implies, assumes that the long-run abnormal returns have to be determined by the calculation of the buy-and-hold abnormal return, that is; the long-run buy-and-hold return of a sample firm minus the long-run return of an appropriate benchmark. Based on the principle of buy and hold which is a strategy that investors adopt by buying stocks and holding them for a long period of time. It is also the compound return on a sample firm less the compound return on a reference portfolio [1].

The main steps to obtain the BHAR are as expressed next:

The long-run return of a sample firm i of the event during the number of months T is written:

$$BHR_{i,t} = \prod_{t=1}^{T}(1 + Ri,t) - 1$$

This may help us to have the global return yielded by the so-called "buy-hold" strategy from the first day of trading and held until the period *T,* after the IPO event.

After we calculate the average buy-hold return where there is no rebalancing as we've seen in the CAR method, it assumes the average returns of each firm over the same time horizon *T* months (1, 6, 60…). We can then define the buy-and-hold abnormal return adjusted using the normal return $R_{Benchmark}$ for correction.

$$BHAR_{i,T} = \left[\prod_{t=1}^{T}(1 + Ri,t) - 1\right] - \left[\prod_{t=1}^{T}(1 + Rmt) - 1\right]$$

The return benchmark can be developed according to Barber and Lyon [1] through two benchmark methods including; Reference portfolios and Control firms. Fama French three-factor model is not applicable to the BHAR method but as we've seen it's useful while calculating CARs. Because per the above mentioned authors it has two drawbacks: the first one is related to the survivor bias that occurs due to the obligation of making at least five observations of monthly returns post-event disposed to the four parameters in the regression, and the second one is associated with the issue of stability of long-run returns over the estimation period that is assumed by the regression approach, which means that a firm's market, size, and book-to-market characteristics are supposed unchangeable over time. Whereas, following the size/book-to-market portfolios, the firm's portfolio assignment is able to vary once a year.

From where we got the adjusted average abnormal returns for period T:

$$\overline{BHAR}_T = \sum_{i=1}^{nt} w_{i,T} BHAR_{i,T}$$

The pre-weighting $w_{i\,t}$ corresponds to $\frac{1}{\mathrm{nt}}$ in the case of equally-weighted abnormal returns and is tantamount to $\frac{\mathrm{MVi}}{\sum \mathrm{MV_i}}$ if they are pre-weighted by their weighted value in the month of the event. With MV denotes the market capitalization and n_t is the number of companies over the matching period.

Recalled by Barber and Lyon [1], Lyon et al. [41] this method is conceptually favorable, because it measures the long-run performance of the common stock of sample firms in proportion to a proper group of comparison, so it detects and ascertains the underlying parameter of interest. Also, because we can't rely on the CAR method where cumulative abnormal returns represent a biased predictor of buy-and-hold abnormal returns as we've seen previously.

The following table is a sample of empirical studies having used the BHAR method while determining IPOs performances before and after the event of opening up capital to investors:

Tableau 2. Sample of empirical studies having used the BHAR method in computing IPO performance.

Country	Authors	Study period	Sample size	Study window	Inferences
Germany	Jaskiewicz, González, Menéndez and Schiereck [42]	1990-2000	153	3 years	Underperformance in long run
Germany	Schmidt et al. [43]	1984- 1985	32	1 year	Underperformance in long run
Germany	Uhlir [44]	1977- 1986	70	15 months	Underperformance in long run
Germany	Ehrhardt [45]	1960- 1990	160	3 years	Underperformance in long run
Germany	Ljungqvist [46]	1970-1993	145	3 years	Underperformance in long run
Germany	Stehle et al. [7]	1960- 1992	187	3 years	Underperformance in long run
Austria	Aussenegg [47]	1984- 1993 1984- 1996	57 51	3 years 5 years	Underperformance in long run
China	Chen, Firth and Jeong-Bon [48]	1992- 1995	342	3 years	Underperformance of B-share in long run
Spain		1987- 1997	56	3 years	Underperformance in long run
Spain	Álvarez, González [49]	1990-2000	43	3 years	Underperformance in long run
United states	Jaskiewicz, González, Menéndez and Schiereck [42]	1970- 1990	4753	3 and 5 years	Underperformance in long run
Finland	Loughran and Ritter [50]	1984- 1989	79	3 years	Underperformance in long run
France	Keloharju [51]	1996- 1998	168	2 years	Underperformance in long run
Italy	Chahine [52]	1985- 1998	110	3 years	Underperformance in long run
Italy	Giudici and Paleari [53]	1985- 1996	97	3 years	Underperformance in long run
Poland	Arosio, Giudici and Paleari [54]	1991- 1996	57	3 years	Underperformance in long run
Poland	Aussenegg [47]	1991- 1997	45	1 year	Underperformance in long run
United Kingdom	Aussenegg [55]	1991-1995	240	3 years	Underperformance in long run
Sweden	Loughran et al. [57]	1980- 1990	162	3 years	Superperformance in long run

Source: Summary of empirical works on the long-term performance of IPOs from the literature on the issue.

A Head back on the boundaries of the event study, by testing its different methods, we can evoke in the context of the buy-and-hold abnormal return method (BHAR), the serial correlation of estimated errors that causes a significant understatement of the standard errors (including the problem with time-series dependence and cross-correlation problem) already mentioned in the part reserved to the CAR method, and the need to determine the model while calculating the ARs, that impacts the interpretation of the results and depends even on the structure of the firms studied. In this vein, as affirmed by Roll [40], the common stock data have serial dependence, he also stated that: "There is a potentially serious problem in estimating expected return differences between small and large firms. Even with exactly the same sample observations, the method used to compute sample mean returns can have a substantial effect on the estimates." (p. 371)

In this sense, the methods are of different kinds; arithmetic and rebalanced are the most used by researchers in empirical studies since they are easier to compute. In addition to the buy and hold method, the latter is for the aforementioned author, the one that best imitates the real investment experience. As for the arithmetic calculation methods, an average daily return of an equally weighted portfolio is obtained by first calculating the average of the daily returns of the individual stocks by days and companies. From this moment they can be composed to bring out the long-term estimate of the expected return. Unlike the buy and hold method, the average income of an equally weighted portfolio is the last thing to be calculated and is determined after the average individual stock returns, which emerge by linking the individual daily returns over a long-time horizon, and then applying an average. For Roll [40], the serial dependence differs systematically according to the element studied, which makes the choice of the method arbitrary in certain cases. In terms of the serial dependence between individual assets and portfolios, it has a heavy effect on stocks with low trading volume, i.e. less synchronous trades and with larger bid/ask spreads, its impact on results obtained differs according to the method followed, because by using BH method, it is clear that its averages will be affected by the serial dependence of the individual assets, whereas, for the arithmetic and rebalanced methods, the averages obtained will be rather affected by the serial dependence of the portfolio and which will tend to increase with the test of time, unlike the averages of the first method which will decrease over the years. This is to conclude that the average emanating from the calculations of the buy-and-hold method gives an unbiased estimate of the return of the holding period of a realistic portfolio, which means that it measures the changes in investor's wealth as in a real investment situation, while the rebalanced average gives an unbiased estimate of the return of its strategy, but is not realistic in a short time horizon since rebalancing is so expensive, as for the arithmetic means for the author it gives biased estimates and does not reflect a realistic investment experience.

Back to the article by Barber and Lyon [1], where they argued problems that conduct to biases in the computation of test statistics elected to resort to the long-run abnormal stock returns. While documenting the calculation of BHAR using a reference portfolio or a control firm or

even the three-factor model of Fama and French [2] as the expected return for each sample firm, they discussed the drawbacks of what suffer the Buy-and-hold abnormal returns, which are; new listing bias since the new IPOs underperform market averages based on the inferences of Ritter [4], a skewness bias, and a rebalancing bias. The two first were already explained in the section about CAR method, the last one is related to the compound returns of a reference portfolio, which means that in an equally weighted market index for example in calculations we suppose a periodic rebalancing whereas the returns of companies in the sample are compounded without rebalancing. From where came the dissimilarities between the CAR and BHAR methods which are about compounding, the CARs neglect the effect of monthly compounding, while the BHARs never overlook it. So, the positive skewness is not that important in CARs for the same reason that the monthly returns of sample companies are rather summed than compounded. Barber and Lyon [1], advocated in this case the control firm approach to the detriment of reference portfolios, because in addition to the elimination of the new listing and the skewness biases as we've aforementioned, it moreover gets rid of or in a realistic point of view lightens and alleviates the rebalancing bias because both the sample and control firm returns are elaborated without re-balancing. Also following Eckbo, Masulis, and Norli [58], the BHAR methodology can't be a feasible portfolio strategy due to the unrecognized beforehand global number of stocks. In addition to this, many authors have evoked the cross-correlation problem that emerges because of the unsuccessful operation of matching on firm-specific characteristics that were supposed to utterly eliminate the correlation between firms' returns following the event.

In the lineage, a flowering of scientific works on the question of developing test statistics that solve the biases of the CAR and BHAR method like cross-sectional correlation in event studies, especially event-date clustering issues, among others; the nonparametric rank test of Corrado and Zivney [59] that showed in terms of the ADJ-BMP test statistic related to variance changes and cross-correlation, that this test is robust and powerful when calculating single-day AR and CARs in the short-run horizon, where does the inspiration came from for the complementary results in this direction obtained by Kolari and Pynnönen [28] while demonstrating the strength of their ADJ-BMP test in adjusting for cross-correlation and variance inflation and volatility in different time windows, from single to multiple days, in concurrence with other approaches like the portfolio approach and many tests statistics, this test is performant per its proposer and goes beyond the t-statistic of Boehmer, Musumeci, and Poulsen [60]. In this vein, Ang and Zhang [61] documented that the sign test and the most correlated single firm benchmark were implemented as techniques to verify and test the null hypothesis following the buy-and-hold benchmark approach, are powerful and reasonably performant when the sample size is large and the event study is conducted in the long run. The authors prementioned added that: "For long-horizon event studies with a large sample, it is likely to be more fruitful to spend efforts on understanding the characteristics of the sample firms, than on implementing various sophisticated testing procedures." (p.404). About the sign test, they affirmed that it's misspecified when brought with reference portfolio benchmarks unless it's applied with a single firm benchmark in that case it becomes well specified, so the sign test per them is the most powerful test in their simulations, and performs better than any other kind of test when the sample is about small firms, the condition to get this power and performance is to choose the combination of the test and the benchmark with the single most correlated firm.

As we've seen, the BHAR method like its previous one; the CAR method, is facing several anomalies and biases preventing it from being a performant and robust approach in detecting the abnormal return and testing the null hypothesis that there is no abnormal performance following a corporate event in the process conducting an event study. According to Fama [12], these anomalies enter into the picture due to the misspecification of models and the statistical tests applied; which leads to the called "bad model problems" experienced by the BHAR method. However, this is a query that many authors have tried to deal with by using nonparametric and bootstrap tests that are according to Kothari and Warner [13] promising to reduce misspecification, it can be also solved with other hassles including the cross-correlation problem, and the skewness bias, by the use of other methodologies that are following Fama [12], Mitchell and Stafford [62], and Lyon et al. [41] falling within the scope of the calendar time approach.

In what follows more details about the calendar methods.

3.2 THE CALENDAR-TIME PORTFOLIO APPROACH (CTIME)

The calendar-time portfolio approach (CTIME) also called Jensen's alpha approach, is another way to determine the abnormal return of a portfolio composed of several companies encountering the same event of interest (that is the IPO in our case). It is evolved by Jaffe [63] and Mandelker [64] and is defined by Dutta ([65], p.2) as a methodology that: " […], is based on the mean abnormal time-series returns to monthly portfolios of event firms." The author in line with other researchers such as Fama [12], Mitchell and Stafford [62], and Lyon et al. [41] affirms that the calendar time method performs better than other methods especially the BHAR when return calculations do overlap, and is more powerful in detecting the long-run abnormal returns. The abnormal return calculated by the CTIME approach is then the intercept in regression, the residue return that isn't revealed by the expected return models we saw in the previous section. The idea of this approach is resumed by Czapiewski and Lizińska ([66], p.3) as: "First, portfolios consisting of IPO firms are formed for each calendar month in a sample period. These portfolios consist of all IPO companies that went public within a specified period of time. For each calendar month, calendar portfolios are rebalanced as new IPO companies enter and some firms drop out. Then, a mean monthly portfolio abnormal return is estimated by regressing excess returns using models such as CAPM or multifactor models. The intercept proxies for the abnormal monthly return."

The procedure of this technique that analyses the risk-adjusted return of firms is different and considered statistically robust; starting by calculating the average excess returns of our sample companies' period-by-period, and then regressing these period-by-period averages on

definite market factors. This method is a strong alternative in the case of cross-sectional dependence because it combines the returns of a whole cross-section into a sole portfolio ([12], [62]).

Based on several authors, the calendar methods are of two types; the first type is based on the monthly average of Calendar-Time Abnormal Returns (CTAR), and the second one is founded on the use of three-factor models developed by Fama and French [2] as an asset pricing model which necessitates after determining the abnormal returns, a statistic test to check on the null hypothesis supposing that the intercept is null in the regression of monthly calendar-time portfolio returns. For this purpose, two estimation techniques were proposed by researchers who judged them appropriate for pricing models; the ordinary least squares (OLS), and the weighted least squares (WLS).

The ordinary least squares (OLS):

According to the encyclopedia: "Ordinary least squares (OLS) regression is a statistical method of analysis that estimates the relationship between one or more independent variables and a dependent variable; the method estimates the relationship by minimizing the sum of the squares in the difference between the observed and predicted values of the dependent variable configured as a straight line... The error term indicates that the relationship predicted in the equation is not perfect. That is, the straight line does not perfectly predict Y."

The objective of this regression is to arrive at a better estimation of the population parameters by using the sample data on Y and X.

The weighted least squares (WLS):

WLS is an extension and enhancement of Ordinary least squares regression. Where non-negative constants or weights are linked to data points, and it estimates the relationship by reducing the weighted sum of squares rather than minimizing the residual sum of squares as done by the ordinary least squares.

It is considered a solution to many problems that OLS can't handle, such as the violation of homoscedasticity assumption by data when the latter don't have tantamount variances. Also, to avoid heteroscedastic error terms when having a logic regression or other nonlinear function.

In what follows, more details about the calendar methods, the empirical studies that have used it, and its limits.

3.2.1 THE CUMULATIVE AVERAGE CALENDAR ABNORMAL RETURNS METHOD (CTAR)

The cumulative average calendar abnormal returns method (CTAR) is the calendar version of the cumulative average of abnormal returns following a specific event (the CAR method we saw previously), it is characterized by classifying the $AR_{i,t}$ by calendar month, which is the R_{it} return on event firm i in the calendar month t, subtracting the expected return on the event portfolio E (R_{it}). This means that we compute at first the abnormal return ($AR_{i,t}$) for each security i using the returns of the reference portfolios (R_{pt}) over the same interval:

$$AR_{i,t} = R_{i,t} - Rp_t$$

The typical formula for computing the mean abnormal returns for each calendar month is then below:

$$MAR_t = \sum_{i=1}^{nt} w_{i,t} AR_{i,t}$$

With n_t denotes the number of listed companies in month t.

w_{it} is tantamount to $\frac{1}{nt}$ when the ARs are equally weighted and corresponds to $\frac{MVi}{\sum MV_i}$ when they are value-weighted.

From where we obtain the mean monthly calendar time abnormal return ($\overline{CTAR}_T$) of period T which is the total number of months in the sample period.

$$MMAR = \frac{\sum_{t=1}^{T} MARt}{T}$$

The following table is a sample of empirical studies having implemented the CTAR method while determining IPOs performances before and after the event of opening up capital to investors:

Tableau 3. Sample of empirical studies having used the CTAR method in computing IPO performance.

Country	Authors	Study period	Sample size	Study window	Inferences
United States	Brav and Gompers [67]	1972-1992	934 venture-backed IPOs and 3,407 non-venture-backed IPOs	5 years	Venture-backed IPOs outperform non-venture-backed IPOs using equal-weighted returns. Value weighting significantly reduces performance differences and substantially reduces underperformance for non-venture-backed IPOs.
United States	Mitchell and Stafford [62]	1963–1993	1,000	3 years	The EW portfolio experiences abnormally low returns
Canada	Kooli et al. [68]	1986-2000	141	3 years	On an EWbasis, issuing firms have significantly positive abnormal returns in the three years following the IPO, on a VWbasis, there is no evidence of significant AR.
Spain	Alvarez and González [69]	1987-1997	56	3-5 years	Non-existence of long-run underperformance
Canada	Dutta [65]	1978-2007	130 IPOs – 200 firms	5 years	The market period (i.e. the hot and cold period markets) does not have any significant impact on calendar time abnormal returns based on SCTA.
South Africa	A. Dutta and P. Dutta [10]	1996-2006	225	5 years	Underperformance in long run
UK	Gregory, Guermat and Al-Shawawreh [70]	1975-2004	2,499	5 years	Underperformance in long run
Canada	Kooli and Suret [8]	1991-1998	445	5 years	Underperformance in long run
Turkey	Erdogan [9]	1995-2000	126	3-5 years	Not significantly underperform or overperform the ISE 100 in the long run
EuroNM (European markets: Germany, Belgium, France, Italy, Netherlands)	Miloud [71]	1997-1999	277	3 years	On the Calendar-Time basis; IPOs seem neither to perform very well nor perform very badly

Source: Authors.

The CTAR method was first implemented by Jaffe [63] and Mandelker [64], it's a method that considers the dependence between IPO firm returns, it moreover permits factor loadings to vary over time, contrary to the three-factor model of Fama-French we will see after.

According to Kooli et al. ([68], p.52): "Calendar-time portfolios represent an important improvement over the traditional event methodology, which assumes independence of individual-firm abnormal returns. Returns are once more equally- and value-weighted."

Even though several researchers advocated the CTAR method after detecting many biases and anomalies related to the CAR and BHAR methods that the methods of calendar approach alleviate, as being in random samples, in samples with small firms, and with calendar clustering well-specified, other authors, criticize it as non-powerful to detect the abnormal returns, their anomalies, and to test the null hypothesis ([72], [73], [74]), the reason why the arithmetic and rebalanced methods still the most used by researchers in empirical studies as we've seen in previous tables dedicated to showing a number of studies using the methods presented so far, many authors choose solely the methods of event study approach since they are easier to compute, or apply them beside the CTAR method that is one of the calendar-time portfolio approach method, in order to compare results resorted from each one, also as we stated before when talking about the dissimilarities between the CAR and BHAR methods, we recall following Roll [40], that the buy and hold method, is the one that best imitates the real investment experience and commonly used.

In this sense, Dutta [74] proposed through its study the use of the standardized abnormal returns of the event firms forming the monthly portfolios to refine the mean monthly calendar time abnormal return methodology, the Standardized Calendar Time Approach (SCTA) is an improving approach where there is a standardization of event firms' abnormal returns and a weighting of the monthly portfolios, the first refinement aims to minimize the volatility of future returns resorting from the impact of the corporate event, and the second one tend to receive weight in each monthly portfolio containing more event firms, it is involving in term of the size and power properties related to the statistical tests used in long-run event studies, and lighten the issue linked to varying portfolio composition called heteroscedasticity problem. Nevertheless, according to the authors, there is one potential limitation that is current in other long-run event studies, which is about nonrandom samples, this refined method is misspecified in all types of non-arbitrary samples.

3.2.2 THE FAMA-FRENCH CALENDAR-TIME APPROACH

The Fama-French calendar-time approach in relation to our event of interest is Fama-French's three-factor model commonly used for examining the returns on the Calendar-Time Portfolios of companies that issue shares in the context of IPO, this method has been used by many authors among others: Loughran and Ritter [50] and Brav and Gompers [67], and compute the event portfolio's monthly return as the equally-weighted average of monthly returns of all firms in the portfolio to resort the abnormal return through a regression on three factors developed by Fama and French [2].

This model reminds us of the famous Capital Asset Pricing Model (CAPM) evoked in previous parts, it is concretely the capital asset model adjusted by adding the factor (SMB) to neutralize the size effect estimated by the free-float market capitalization and the second factor (HML) to neutralize investor confidence in the published accounts by companies.

The factor (SMB): Stands for Small Minus Big, which means the gap in returns for each month t of every year of the period between the three portfolios with small free-float market capitalization and those with large capitalization. Presented as below:

$$SMB_t = \tfrac{1}{3}\,(Small/High + Small/Medium + Small/Low) - \tfrac{1}{3}(Big/High + Big/Medium + Big/Low)$$

The factor (HML): Stands for High Minus Low, which indicates the difference in returns for each month t every year of the period between the two portfolios with high Book-to-Market and those with low Book-to-Market. And is expressed by the next formula:

$$HML_t = \tfrac{1}{2}\,(Small/High + Big/High) - \tfrac{1}{2}\,(Small/Low + Big/Low)$$

So that the residuals of the event portfolio are regressed on the Fama-French three factors as in the following model:

$$Rp_{,t} - Rf_{,t} = \alpha + \beta\,(Rm_t - Rf_{,t}) + s\,SMB_t + h\,HML_t + \varepsilon_t$$

Where R_{pt} denotes equally weighted return on the portfolio of the companies studied in month t, R_{ft} is the return on the risk-free asset in month t, be tantamount to the 1-month Treasury bill rate, observed at the beginning of the month. Rmt is the monthly market index return, from where we got β ($R_{mt} - R_{ft}$): monthly risk premium and ($R_{mt} - R_{ft}$): monthly residuum of the market return over the risk-free return.

SMBt is the zero-investment portfolio monthly return for the common size factor in stock returns, and HMLt is the zero-investment portfolio monthly return for the book-to-market common equity factor in stock returns. α: Jensen's α, is the intercept that is able to detect the abnormal return of the portfolio analyzed and should be equal to zero under the null hypothesis of the absence of abnormal returns after the event, supposed by the fact that the Fama-French three-factor model yields an entire description of expected stock returns. And β, s, and h are pre-event correlation coefficients and sensitivities of the event portfolio to the three factors and are according to Ang and Zhang [61] helping to eliminate the effect of other incorrigible and out-of-control factors such as industry factor, seasonal factor, momentum factor, and other factors shared by only firms of the same characteristics, such as geographical location, ownership, and governance structures that can influence on the event firm's long-term stock return.

Regarding the techniques used to test the null hypothesis, Ang and Zhang [73] documented that the use of the WLS while conducting the Fama-French calendar-time approach enhances the performance and strength of the calendar-time portfolio approach in detecting the abnormal returns, and advocates it over the OLS technique mainly for long event horizons. Otherwise, this power diminishes clearly over time when the event horizon expands.

Regarding the sample of empirical studies having used the Fama-French calendar-time approach while determining IPOs performances before and after the event of opening up capital to investors, we can give the instance of Czapiewski and Lizińska [66], Ewen [75], Fu [76], Ali et al. [77], Shen et al. [78], Brav et al. [79], and others that choose to opt for the Fama-French calendar-time approach to compare the outcomes of it with other methods and get inferences regarding the interpretations of each one.

Although, many authors have doubted the power of this method and reproach it as weak. In accordance with some of them including Loughran and Ritter, this anomaly resorts to the use of returns on infected portfolios as regression factors, due to the view of weighting equally each month, and considering the value-weighted returns of the calendar-time portfolios. Nevertheless, after computing abnormal returns and testing the null hypothesis through the calendar methods, Ang and Zhang [61] affirmed basing themselves on the previous findings, that the Fama-French calendar-time approach implemented with the WLS technique performs better with a sample size of 1000, and still has a reasonably high power even for the long 5-year holding period. And look at the empirical evidence of Loughran and Ritter as non-conclusive, they added that the ordinary least squares (OLS) estimation technique may go through a potential heteroskedasticity problem caused by an uneven and irregular number of companies forming the calendar-time portfolios, for that reason the weighted least squares (WLS) technique is considered a panacea in addressing this problem of changing portfolio's size composition: "When applying WLS, we use the monthly number of firms in the event portfolio as weights." ([61], p.396)

Brown and Warner [22] shed light on the relation between non-synchronous trading and market model parameter estimation, when having distinct trading intervals while computing a security's return and the market index's return using the OLS technique it leads to biased and incoherent estimations of market model parameters, that becomes more intense and harsher with daily data.

In the lineage, following Rasheed et al. [80], the ordinary least squares (OLS) technique is the best to assess the parameters in a linear regression model, this can be confirmed under the condition of data satisfying the underlying hypothesis. Otherwise, the findings could be equivocal and fallacious. The presence of outliers and heteroscedasticity in the data are the causes that bring about this violation of the constant variance presumption (homoscedasticity) using the OLS method. For that reason, the authors tried to use the weighted least squares (WLS) to deal with the problem of outliers in the data, but according to them, this technique is also affected by outliers which leads them to redress their study by the use of the iterative reweighted least-squares (IRWLS) of Huber [81] and Tukey which helped them to prove that the M-estimation technique (based on Huber weighted function and tukey bisquare function) and the least trimmed squares method (LTS) could be considered as robust and more powerful against the OLS in solving the problem of heteroscedasticity and outliers.

In the same vein, Dutta [65] affirmed that the Standardized Calendar Time Approach (SCTA) which is the refined version of the CTAR, is still the best in the context of detecting IPOs' performances to the detriment of the BHAR method and the Fama-French's three-factor model, especially in the long run, the author also proved while applying the SCTA method on the long-term performance of Canadian initial public offerings, that the specification of the market period; being cold or hot, doesn't affect the calendar time abnormal returns.

In line with limits related to this method, Fama and French [82] perceive that the Fama-French three-factor model fails to capture the momentum effects of Jegadeesh and Titman's model [83], this latter emphasizes the implications of Returns to Buying Winners and Selling Losers for Stock Market Efficiency, Jagadeesh and Titman [83] through their empirical study document trading strategies that buy past winners and sell past losers and prove that it reifies significant abnormal returns over the 1965 to 1989 period of their sample. Eventually, appeared the Carhart four-factor model developed by Carhart [3] to rectify the Fama-French three-factor model with a momentum factor WML_t computed as the difference between the returns of winners' and losers' portfolios. Whose winners and losers are arranged on the basis of returns over the previous year, unless the previous month.

The factor WML: the momentum factor is in other words the rapidity or velocity of a stock's or security's price variation.

It is estimated as:

$$WMLt = ½\ (Small\ Up_t + Big\ Up_t) - ½\ (Small\ Down_t + Big\ Down_t)$$

The Carhart four-factor model is then the regression:

$$R_t^P - R_t^F = \alpha + \beta_{RM}\left(R_t^M - R_t^F\right) + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \beta_{WML}WML_t$$

The latest innovation in capital asset pricing models, is the Fama-French 5-factor model ([84], [85]) which draws risk along with investment and profitability in addition to size and value while determining average stock returns.

The factor RMW: is the mean return of the two portfolios with high (robust) operating profitability minus the mean return of the two portfolios with low (weak) operating profitability

$$RMWt = ½\ (Small\ Robust_t + Big\ Robust_t) - ½(Small\ Weak_t + Big\ Weak_t)$$

The factor CMA: is the mean return on the two conservative investment portfolios minus the mean return on the two aggressive investment portfolios.

$$CMAt = ½\ (Small\ Conservative_t + Big\ Conservative_t) - ½(Small\ Aggressive_t + Big\ Aggressive_t)$$

The regression on the Fama-French five-factor model is finally:

$$R_t^P - R_t^F = \left(\alpha + \beta_{RM}\left(R_t^M - R_t^F\right) + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \beta_{RMW}RMW_t + \beta_{CMA}CMA_t\right)$$

4 CONCLUSION

To conclude, following these different and sometimes reverse currents of thoughts, we can only agree with the idea of Kothari and Warner [86] regarding the methodology for evaluating long-term market performance after a specific corporate event that is going to stay outstanding, because it's considered a real practical and theoretical issue that created many debates and still a subject of discussion in the literature.

Considering the time horizon of the event study, and the sample size, is very important to know the performance and power of the tests and techniques implemented while using a certain method or approach. According to Ang and Zhang [61], the combination of long-horizon event studies and a small sample size should be carefully studied by using an ample range of tests and interpreted neatly.

Apart from the biases and judgments linked to the CAR method, considered not appropriate for long-run studies, and advocated for measuring short-term abnormal returns only. The buy-and-hold benchmark being the second method of the event study approach, in accordance with Ang and Zhang ([61], p.390): "is susceptible to biases associated with cross-sectional correlation, insufficient matching criteria, new equity issues, periodic balancing, and skewed distribution of long-term abnormal returns, while the calendar-time portfolio approach may suffer from an improper asset-pricing model and heteroskedasticity in portfolio returns."

In terms of CTA methods, Dutta [65] confirmed that the recently introduced calendar time methodology namely the Standardized Calendar Time Approach (SCTA) is better and more powerful than the BHAR methodology and the Fama–French three-factor model while detecting the long-run abnormal stock returns, it gives a practical solution to the heteroscedasticity problem which occurs in calendar time methodology due to varying portfolio compositions. In contradiction to Loughran and Ritter [72], Ang and Zhang [73] and others that have affirmed that the CTP approach is not that robust and powerful, and is deemed deficient in determining abnormal performance. Despite the limits of each methodology of both approaches, many authors prefer to opt for the CAR and BHAR methods because they are easy to use and because the methods of CTIME are also far from being totally perfect.

As we've seen through the present paper, each approach with its methodologies has its proper pitfalls and biases, seeing the various points of view and criticisms related to each technique conducted to calculate the abnormal return in the context of IPO, we advocate the use of as many different and diverse methods as possible and compare their results to avoid getting mitigated and limited findings.

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