International Review of Business Research Papers
Vol. 12. No. 2. September 2016 Issue. Pp. 88 – 107

The Impact of the Civil War on IPO Stocks in Sri Lanka: Regression and Event Based Analysis

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Sri Lanka suffered from a civil war for three decades and this conflict ended in 2009. This study examines the impact of 20 war related incidents on Sri Lankan Initial Public Offering (IPO) stocks from 2000 to 2009. The broad methodologies used were event study analysis, Ordinary least square regression analysis (OLS) and the generalized autoregressive conditional heteroscedasticity (GARCH (1,1)) model. Under regression, the main techniques used were the Chow breakpoint test (CBT) and dummy variable analysis. OLS dummy variable analysis and the ordinary GARCH model appeared to be the best estimators in measuring the impact of war, while 50% of events selected had a negative impact on IPO stock returns. The ordinary GARCH model is recommended for use in assessing the impact of war on specific security classes or industries.

Field of Research: Finance

1. Introduction

Sri Lanka's capital market was seriously affected due to the three decade long ethnic conflict and therefore foreign investor participation was low during this period. With the end of the armed conflict in 2009, Colombo Stock Exchange (CSE) indices rose rapidly, creating new records. The All Share Price Index (ASPI) moved from 3,300 levels in 2009 to 7,000 levels in March 2011 which resulted in a 112% increase. Currently (August 31st 2016), the ASPI is at 6528.21 levels. Initial Public Offerings (IPOs) emerged as the fastest and easiest mechanism for both foreign and local investors to participate in the growing Sri Lankan capital market.

This paper aims to fulfill two purposes. The first is to measure the impact of the civil war on IPO stocks during the intra war period. Even though there are numerous studies which focus on the impact of terrorism and civil wars on financial markets, the authors were unable to find a study that measures the specific impact of war on IPO stocks to their knowledge and to date. The second purpose of the paper is to identify the methodology that works best to depict the worsened picture of IPO stocks due to war in the Sri Lankan context[i]. The study findings indicate that the Ordinary Least Square (OLS) and ordinary GARCH model is more suitable in measuring the impact of war on Sri Lankan IPO stocks. Section 2 of the paper describes the prior literature related to the study and sections 3 and 4 discuss the data and methodology used in the paper respectively. Finally, section 5 discusses the results before the conclusion is presented.

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2. Literature Review

2.1 Basic Concepts

Incidents related to terrorism or war can take different forms such as assassinations, bombings, suicide attacks, armed assaults and attacks on infrastructure. Such incidents tend to cause economic consequences such as diminished economic growth, capital market downturns, diverting foreign direct investments, surge in defense expenditure in national accounts and restricted trade, to name but a few. This paper focuses on the impact of war on capital markets, especially IPO stocks. Many studies such as those by (Aslam and Kang 2013) have shown that terror events will result negative stock market returns. Further some studies including (Essaddam and Karagianis 2014) have found that terrorist attacks make stock markets highly volatile. (Chambers 2007), (Ritter and Welch 2002) and many others found that IPO stocks are highly risky and therefore those should be compensated with a higher return in the stock market. These empirical findings lead to the acceptance by the United States Security and Exchange Commission (2013) that IPOs are risky and speculative by nature in one of their investor bulletins. Therefore this paper's logic is that if stock markets are highly volatile and generate negative returns due to terrorist events, IPO stocks will be much more volatile and result in more negative returns due to such events than the market index, since it is proven that IPOs are more risky and uncertain by nature. This is the main hypothesis of this paper. Further (Thomadakis, Gounopoulos, Nounis and Riginos 2014) found that there was a visible shift from IPO overpricing to underpricing in war periods based on a study conducted on the Athens Stock Exchange, Greece.

(Sandler and Enders 2008) concluded that the size and diversity of the economy will be a vital factor in absorbing the negative impact of terrorist events and will hence minimize the impact on capital markets. This is why the US economy is so resilient and the US stock markets came back strongly after the 9/11 attack. However Sri Lanka is a small and less diversified economy and the terrorist impact will be larger and more difficult to absorb than in a more developed economy. That is another reason why Sri Lanka's capital market and IPO activity was quite low in the war- ridden years of 2001, 2007 and 2008. In contrast, IPO activity is now booming after the war ended in May of 2009.

Before moving in to the literature on methodology, it is necessary to distinguish between the two concepts of civil war and terror events. (Sandler and Enders 2008) defined civil war as an event that involves a minimum of 1000 deaths and may result in 10,000 casualties while a terrorist incident will result, on an average in a single death. So civil war is a much broader phenomenon than terrorist incidents. Sri Lanka's conflict can be judged as a civil war since it involved more than 50,000 deaths on both sides stretching over three decades (from the Government of Sri Lanka and from the Liberation Tigers of Tamil Ealam (LTTE)). Further, Sri Lanka's conflict should be defined as domestic terrorism rather than transnational terrorism.

2.2 Literature on Methodology

The event study method is the most popular and widely used methodology in analyzing the impact of war on financial markets. However, it involves several weaknesses and the most prominent ones are heavy reliance on efficient market assumptions, biased towards short run impact only and hyper sensitive to even small changes in research design. Further, (Basdas and Oran 2014) pointed out that event study suffers from a clustering problem which means restricting the same event date for all securities in the market. (Sandler and Enders 2008) compared cross sectional panel and time series regressions as alternative methodologies. The advantages of the cross sectional panel regression method are large variations in key variables and a large number of degrees of freedom. However, the disadvantages are that data problems may arise due to diverse sources, cross borders are difficult to identify and the poor display of the dynamic effect of terrorism on key variables. Alternatively, the time series regression methodology has many advantages such as the fact that the dynamic effect of terrorism can be identified, the ability to provide forecasts, the ability to identify the microeconomic impact and the ability to estimate cross border spill overs. However, the time series regression is also not free of disadvantages and some of them are the inability to generate a generalized picture and a large number of data requirements. After considering these facts, the authors of this paper chose the time series regression methodology since the aforementioned disadvantages of the time series method are not applicable to the present study.[ii] Further, the authors of this paper have opted to use both the ordinary least squares (OLS) model and the Generalized Autoregressive Conditional Heteroscedasticity model (GARCH (1,1)). The latter is used mainly to remove possible heteroscedasticity and serial correlation problems. (Chesney, Reshetar and Karaman 2010) can be presented as a prior study in methodology relevant to this paper.

To conclude the literature review, it should be noted that there are two approaches available to assess the economic consequences of war or terrorism. (Sandler and Enders 2008) identified them as macroeconomic and microeconomic consequences of terrorism. Macroeconomic consequences involve the impact of war on the economy as a whole. Microeconomic consequences involve the impact of terrorism on a particular aspect of the economy or on a particular industry. (Enders and Sandler 1996) studied the impact of terrorism on net foreign direct investments in Greece and Spain and this is an example of the microeconomic consequences of terrorism involved with an important aspect of the economy but not affecting the whole economy. Examples for a particular industry's vulnerability to terrorism are the studies of (Drakos and Kutan 2003) where the authors analyzed the relationship between terrorism and tourism in Greece, Turkey and Israel. The present paper also falls into the category of studies on microeconomic consequences since this study focuses only on the impact of war on IPO stocks in Sri Lanka.

3. Data

The data used in this study consist of 23 initial public offerings issued in the Colombo Stock Exchange (CSE) between 2000 and 2009. This time period was selected since Sri Lanka's armed conflict ended in May 2009 and the objective of the study is to measure the impact of war on IPO stocks in conflict ridden years. The data was collected from a variety of sources. The issue dates and offering prices of IPOs were taken from the CSE web site and listing prospectuses. Daily stock prices were taken from the CSE and adjusted by the authors to represent dividends and other corporate actions. The All Share Price Index (ASPI) was taken as the market index and data was obtained from the CSE.

Event information was collected from www.lankaweb.com which is an online news provider about Sri Lanka. Detailed descriptions are available on the events which were analyzed in the following table. However, the authors did not attempt to classify these events as positive or negative events when considering peace, since an event can be interpreted differently depending on the intentions or interpretations of either party involved in the conflict, whether the Government of Sri Lanka or the LTTE. The authors believe that such a classification would create a bias towards either party.

Table 1: Selected list of war related events in Sri Lanka from 2000 to 2009

Event No	Event Date[iii]	Event Description
1	2000/02/01	The Norwegian Government decided to play an intermediary role in presenting a new peace package to Tamil Tiger rebels.
2	2000/05/04	The Sri Lankan Government assumed new powers and puts the country on a war footing.
3	2000/12/05	Interpol sent a worldwide notice for the arrest of LTTE chief, Velupillai Pirabakaran.
4	2001/02/28	LTTE banned in the UK.
5	2001/07/24	Tiger rebels attacked main airbase and the only international airport in Sri Lanka, destroying 13 aircraft and leaving at least 12 people dead.
6	2002/02/21	Government and Tamil Tiger rebels agreed to a permanent ceasefire.
7	2002/09/16	First round of Peace talks commenced in Thailand between the government and the LTTE.
8	2003/04/21	LTTE pulled out of peace talks.
9	2004/03/03	Renegade Tamil Tiger commander, known as Karuna, led split in rebel movement.
10	2005/08/12	Foreign minister Lakshman Kadiragamar, a Tamil himself, assassinated by LTTE.
11	2005/11/18	Mahinda Rajapakse elected president of Sri Lanka. LTTE prevents people in their controlled areas from voting.
12	2006/04/25	LTTE suicide bomber acting as a pregnant woman launched an unsuccessful assassination attempt against Army Commander Lt General Sarath Fonseka
13	2006/07/26	LTTE Blocked Mavil Aru sluice gates. Army launched operation 'Watershed' to take control of the gates. This incident is regarded as the beginning of the Army's military operation to oust the LTTE.
14	2006/10/16	LTTE suicide attack blasted buses carrying sailors who were going on leave. Over 100 sailors died in this incident.
15	2006/12/01	LTTE suicide bomber launched an unsuccessful assassination attempt against Defence Secretary Gotabaya Rajapakse
16	2007/03/26	LTTE Air Wing, for the first time launched an air raid and dropped bombs over Katunayake Air Base causing minor damages.
17	2007/07/11	Military liberated the Eastern Province from LTTE with the capture of Toppigala
18	2008/01/02	Sri Lanka government withdrew from ceasefire agreement.
19	2009/01/02	Army liberated Killinochchi town, the rebel administration headquarters
20	2009/05/19	President Mahinda Rajapaksha officially declared the war to be over.

Source: www.lankaweb.com, Authors' construction

There are four models described in table 2 to adjust the daily IPO returns for the level of systematic risk as well as factors such as size, book to market and momentum. Factor data were obtained mainly from individual company annual reports and the CSE web site. The risk free rate is taken as the 3 month Treasury bill rate published by the Central Bank of Sri Lanka (CBSL).

Table 2: Four models used for the assessment

Model	Source
Simple market model (SMM)	Ross (1976), Merton (1987)
Sharpe-Lintner CAPM (Basic CAPM)	Sharpe (1964), Lintner (1965)
Fama & French 3 factor model (FF3 model)	Fama & French (1993; 1996)
Carhart's 4 Factor model (C4F model)	Jagadeesh & Titman (1993), Carhart (1997)

Source: Authors' construction

4. Methodology

4.1 Construction of Cumulative Market Return & Cumulative IPO Portfolio Return

4.1.1 Construction of Cumulative Market Return

Even though this paper focuses mainly on time series regression analysis, the authors wish to present some statistics from traditional event study analysis. Therefore the study needs to calculate cumulative returns for both market and IPO portfolios. Simple market return (R_{mt}) refers to the daily natural logarithm of the ASPI return of CSE. It is calculated as follows.

$$R_{mt} = Ln\left[\frac{P_{mct}}{P_{mct-1}}\right] \quad \text{--►} \quad (1)$$

Where R_{mt} is the simple market return, P_{mct} is the closing value of ASPI on day *t*, and P_{mct-1} is the closing ASPI value of day *t*-1.

The abnormal daily market return (AR) is calculated according to the method suggested by (Brown and Warner 1985).

$$AR_{mt} = R_{mt} - \overline{R_m} \quad \text{--►} \quad (2)$$

Where AR_{mt} is the abnormal daily market return and $\overline{R_m}$ is the average of ASPI daily returns in the estimation period. (Armitage 1995) suggested that the average range of the estimation period is 100 days to 300 days to a daily returns study. Therefore the authors preferred to use a 100 days estimation period to estimate $\overline{R_m}$. Further, the event window and post event window was decided as 1 day (t) and 5 days (t+5) respectively. $\overline{R_m}$ Is calculated as follows.

$$\overline{R_m} = \frac{1}{100}\sum_{-105}^{-5} R_{mt} \quad \text{--►} \quad (3)$$

Finally the cumulative abnormal return (CAR_{mt}) of the market index (ASPI) is calculated as follows.

$$CAR_{mt} = \sum_{t}^{t+5} AR_{mt} \dashrightarrow \quad (4)$$

4.1.2 Construction of Cumulative IPO Portfolio Return

The single IPO firm daily portfolio return for day t is calculated as follows. It is the daily natural logarithm of a single IPO firm return.

$$R_{it} = Ln \left[\frac{P_{icpt}}{P_{icpt-1}} \right] \dashrightarrow \quad (5)$$

Where R_{it} is the single IPO firm daily return for day *t*, P_{icpt} is the closing price of the IPO firm for day t and P_{icpt-1} is the closing price of the IPO firm for day *t*-1.
Next step is to calculate the value weighted IPO portfolio return. Weights were calculated according to 31st December market capitalization of each firm. IPO companies were included to construct the IPO portfolio return from listing to five years or delisting, where the earlier of the two situations is taken. When there are missing prices (when there is no trading) for IPO firms, the last traded price was taken to compute the return.[iv] (Fama 1998) proved that equal weighted scenarios are poor approximations while value weighted scenarios are more suitable for performance evaluation purposes. The value weighted IPO portfolio return is calculated as follows.

$$R_{IPOt} = \sum WR_{it} \dashrightarrow \quad (6)$$

Where R_{IPOt} is the value weighted return of an IPO portfolio for day t and *W* is the weight based on the 31st December market capitalization of IPO firms. The next step is to compute the daily abnormal return of the IPO portfolio according to the methodology followed by (Ritter 1991).

$$AR_{IPOt} = R_{IPOt} - R_{mt} \dashrightarrow$$

(7)

Where AR_{IPOt} is the abnormal return of the IPO portfolio and R_{mt} is the value which was calculated in equation 1. As the final step, the cumulative abnormal return for the IPO portfolio is calculated as below.

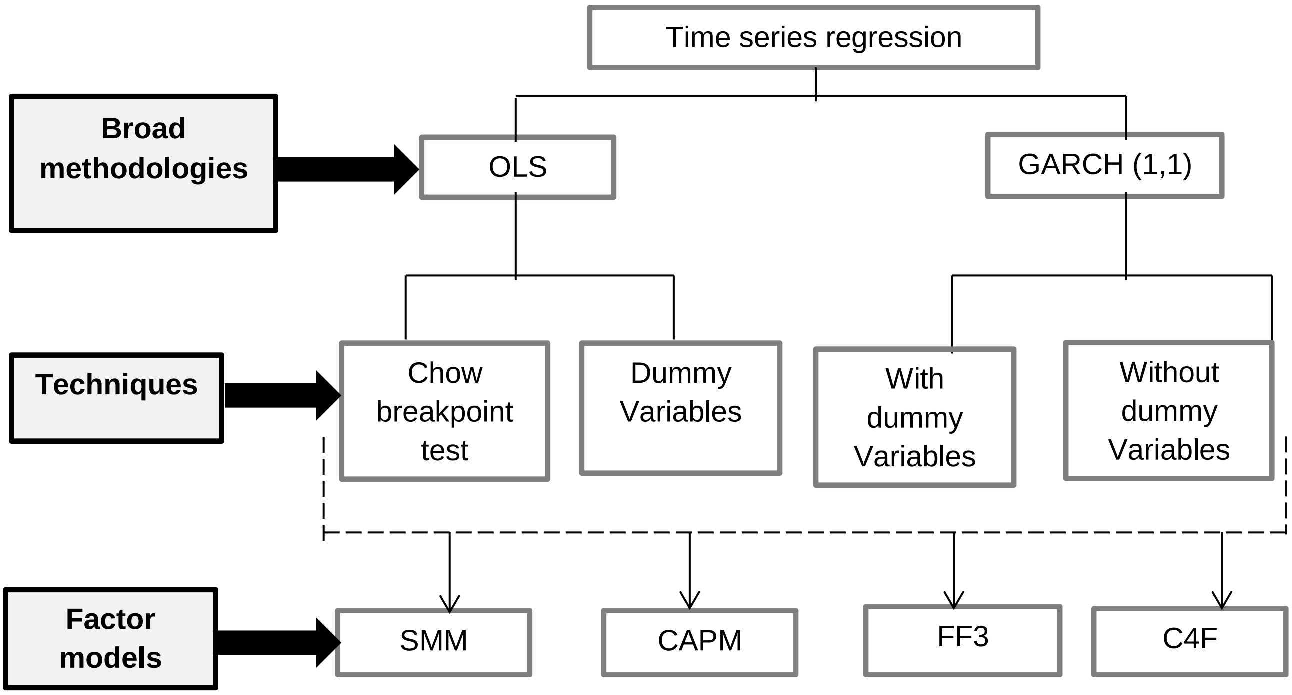
$$CAR_{IPOt} = \sum_{t}^{t+5} AR_{IPOt} \dashrightarrow \quad (8)$$

Where CAR_{IPOt} is the cumulative abnormal return for the IPO portfolio.

4.2 Overview of the Proposed Time Series Regression Methodology

As mentioned in the section 4.1, the key objective of this paper is to employ a time series regression methodology to explain the impact of war on IPO stocks. The two broad methodologies used in this paper are the OLS methodology and GARCH (1,1) methodology under time series regressions. ARCH (Autoregressive conditional heterokedasticity) effects have been used in event studies by (Cable and Holland, 2000). Two main techniques utilized to analyze the impact of war events are the Chow breakpoint test and dummy variable analysis. These two techniques are employed under both broad methodologies. Finally four asset pricing models are tested under each of these techniques and these are the simple market model (SMM), the Capital asset pricing model (CAPM), the Fama & French 3 factor model (FF3) and the Carhart 4 factor model (C4F). The proposed methodology is outlined in the figure below.

Figure 1: Proposed time series regression methodology



Source: Authors' construction

4.3 Techniques Followed

4.3.1 Chow Breakpoint Test (CBT)

The F statistic under CBT is calculated as follows. A structural break will be recognized at the 5% significance level.

$$F = \frac{RSS_c - (RSS_1 + RSS_2)/k}{RSS_1 + RSS_2 / n - 2k} \qquad (9)$$

RSS_c, RSS_1 and RSS_2 are the combined residual sum of squared, residual sum of squared of 1st group and residual sum of squared of 2nd group respectively. *K* is number of parameters and *n* is number of observations.

4.3.2 Dummy Variable Regression Analysis

Here the dummy variable takes the value 1 if the particular day has fallen within the post event window of five days or a value of 0 otherwise. (Karafaith 1988) was a pioneer who used dummy variable regression in event study analysis.

4.4 Factor Models Followed in OLS Regression

4.4.1 Simple Market Model (SMM) Under OLS Regression

SMM can be regarded as one of the earliest version of factor models. However, it is rarely used in IPO studies. (Drobetz, Kammermann and Walchili 2005) used it to measure the IPO long run anomaly in the Swiss market. The general SMM which is used for the Chow breakpoint test is represented as follows.

$$R_{IPOt} = \alpha + \beta R_{mt} + \beta Lag1R_{IPOt} + \beta Lag2R_{IPOt} + \varepsilon \dashrightarrow \quad (10)$$

Where R_{IPOt} is the daily IPO portfolio return at day *t*, R_{mt} is the daily return of the market index return (ASPI) at day *t*, $\beta Lag1R_{IPOt}$ is the first lag variable of R_{IPOt} and $\beta Lag2R_{IPOt}$ is the second lag variable of R_{IPOt}. ε denotes the random error term. Lags are introduced to deal with serial correlation in OLS regression.

The adjusted SMM for dummy variable regression analysis is given below. Here, the dummy variable represents the days war related events happened. It takes a value of 1 if the particular day has fallen within the post event window of five days of war related events or a value of 0 otherwise. ε denotes the random error term.

$$R_{IPOt} = \alpha + \beta R_{mt} + \beta Lag1R_{IPOt} + \beta Lag2R_{IPOt} + \gamma_t\, Dummy + \varepsilon \dashrightarrow \quad (11)$$

4.4.2 Sharpe-Lintner CAPM (Basic CAPM) Under OLS Regression

A CAPM describes the relationship between risk and expected return and this is used in the pricing of risky securities. (Gompers and Lerner 2003) used CAPM to evaluate IPO long run performance. This is calculated by taking a risk measure (beta) that compares the returns of the asset (here the IPO portfolio) to the market over a period of time and to the market premium (*Rm-Rf*). The general CAPM which is used for the Chow breakpoint test is represented as follows.

$$R_{IPOt} - R_{ft} = \alpha + \beta\,(R_{mt} - R_{ft}) + \beta\, Lag(R_{IPOt} - R_{ft}) + \varepsilon \dashrightarrow \quad (12)$$

Where R_{ft} denotes the risk free return at time *t*, R_{mt} is the monthly return of ASPI at time *t* and $Lag(R_{IPOt} - R_{ft})$ is the lag variable of the dependent variable. ε denotes the random error term.
The Adjusted CAPM formula for dummy variable regression analysis is given below.

$$R_{IPOt} - R_{ft} = \alpha + \beta\,(R_{mt} - R_{ft}) + \beta\,Lag(R_{IPOt} - R_{ft}) + \gamma_t\,Dummy + \varepsilon \quad (13)$$

Where the dummy variable represents the days of terrorist incidents occurred.

4.4.3 Fama and French Three Factor Model (FF3 model) Under OLS Regression

The Fama and French three factor model (FF3) is an extension of the original CAPM style approach. (Gompers and Lerner, 2003) is one of the early studies that used FF3 to assess IPO long run performance. The general FF3 which is used for the Chow breakpoint test is represented as follows.

$$R_{IPOt} - R_{ft} = \alpha + \beta\,(R_{mt} - R_{ft}) + \beta\,Lag(R_{IPOt} - R_{ft}) + s\,SMB_t + h\,HML_t + \varepsilon \quad (14)$$

Where SMB_t denotes the return difference between small and big stocks for the period *t*, HML_t denotes the return difference between high book to market firms and low book to market firms for period *t*.
SMB_t (small minus big) is the average return on the three small portfolios minus the average return on the three big portfolios for the period *t*.

$$SMB_t = 1/3\,(\text{small value} + \text{small neutral} + \text{small growth}) - 1/3\,(\text{big value} + \text{big neutral} + \text{Big growth}) \quad (15)$$

HML_t (high minus low) is the average return on two value portfolios minus the average return on the two growth portfolios for the period *t*.

$$HML_t = 1/2\,(\text{small value} + \text{big value}) - 1/2\,(\text{small growth} + \text{big growth}) \quad (16)$$

Adjusted FF3 formula for the dummy variable regression analysis is given below.

$$R_{IPOt} - R_{ft} = \alpha + \beta\,(R_{mt} - R_{ft}) + \beta\,Lag(R_{IPOt} - R_{ft}) + s\,SMB_t + h\,HML_t + \gamma_t\,Dummy + \varepsilon \quad (17)$$

4.4.4 Carhart Four Factor Model (C4F model) under OLS Regression

(Carhart 1997) developed a further extension to the FF3 model by adding the momentum factor (winners minus losers – WML) and this is known as the four factor model. (Eckbo and Norli 2005) added momentum to their study of the IPO long run price performance. The general C4F model which is used for the Chow breakpoint test is represented as follows.

$$R_{IPOt} - R_{ft} = \alpha + \beta\,(R_{mt} - R_{ft}) + \beta\,Lag(R_{IPOt} - R_{ft}) + s\,SMB_t + h\,HML_t + w\,WML_t + \varepsilon \quad (18)$$

Where WML_t is the return difference between winner and loser stock portfolios for period *t*. WML_t is estimated as follows.

$$WML_t = 1/2\,(\text{small winners} + \text{big winners}) - 1/2\,(\text{small losers} + \text{big losers}) \quad (19)$$

Adjusted C4F formula for the dummy variable regression analysis is given below.

$$R_{IPOt} - R_{ft} = \alpha + \beta\,(R_{mt} - R_{ft}) + \beta\,Lag(R_{IPOt} - R_{ft}) + s\,SMB_t + h\,HML_t + w\,WML_t + \gamma_t\,Dummy + \varepsilon \quad (20)$$

The results of these OLS models were tested for serial correlation using the Breusch Godfrey Serial Correlation LM (BGSCLM) test and heteroscedasticity using the Breusch Pagan Godfrey Heteroscedasticity (BPGH) test. It is proven that all OLS models are free from serial correlation and heteroscedasticity.

4.5 Factor Models Followed under the GARCH (1,1) Model

4.5.1 SMM under the GARCH (1,1) Model

The mean equation for the SMM which used for regression analysis without dummy variables under the GARCH (1,1) model is similar to equation 10. Its variance equation is as follows.

$$\sigma_t^2 = \varpi_0 + \varphi_1\, e_{t-1}^2 + \eta\sigma_{t-1}^2 + \beta R_{mt} + \beta Lag1R_{IPOt} + \beta Lag2R_{IPOt} \quad (21)$$

Where σ_t^2 is the variance of the residual derived from the mean equation, e_{t-1}^2 is the previous periods' squared residual derived from the mean equation (ARCH term) and σ_{t-1}^2 is the previous day's residual variance (GARCH term).

Further the mean equation for SMM which is used for dummy variable regression analysis under the GARCH (1,1) model is similar to equation 11. Its variance equation is given as follows.

$$\sigma_t^2 = \varpi_0 + \varphi_1\, e_{t-1}^2 + \eta\sigma_{t-1}^2 + \beta R_{mt} + \beta Lag1R_{IPOt} + \beta Lag2R_{IPOt} + \gamma_t\,Dummy \quad (22)$$

4.5.2 CAPM under the GARCH (1,1) Model

The mean equation for the CAPM which is used for regression analysis without dummy variables under the GARCH (1,1) model is similar to equation 12. Further, the mean equation for CAPM which is used for dummy variable regression analysis under the

GARCH (1,1) model is similar to equation 13. Their variance equations are given as follows respectively.

$$\sigma_t^2 = \varpi_0 + \varphi_1 e_{t-1}^2 + \eta\sigma_{t-1}^2 + \beta(R_{mt} - R_{ft}) + \beta Lag(R_{IPOt} - R_{ft}) \quad (23)$$

$$\sigma_t^2 = \varpi_0 + \varphi_1 e_{t-1}^2 + \eta\sigma_{t-1}^2 + \beta(R_{mt} - R_{ft}) + \beta Lag(R_{IPOt} - R_{ft}) + \gamma_t Dummy \quad (24)$$

4.5.3 FF3 under the GARCH (1,1) Model

The mean equation for the FF3 which used for regression analysis without dummy variables under the GARCH (1,1) model is similar to equation 14. Further, the mean equation for FF3 which is used for dummy variable regression analysis under the GARCH (1,1) model is similar to equation 17. Their variance equations are as follows respectively.

$$\sigma_t^2 = \varpi_0 + \varphi_1 e_{t-1}^2 + \eta\sigma_{t-1}^2 + \beta(R_{mt} - R_{ft}) + \beta Lag(R_{IPOt} - R_{ft}) + s\,SMB_t + h\,HML_t \quad (25)$$

$$\sigma_t^2 = \varpi_0 + \varphi_1 e_{t-1}^2 + \eta\sigma_{t-1}^2 + \beta(R_{mt} - R_{ft}) + \beta Lag(R_{IPOt} - R_{ft}) + s\,SMB_t + h\,HML_t + \gamma_t Dummy \quad (26)$$

4.5.4 C4F under the GARCH (1,1) Model

The mean equation for the C4F which is used for regression analysis without dummy variables under the GARCH (1,1) model is similar to equation 18. Further, the mean equation for C4F which is used for dummy variable regression analysis under the GARCH (1,1) model is similar to equation 20. Their variance equations are given as follows respectively.

$$\sigma_t^2 = \varpi_0 + \varphi_1 e_{t-1}^2 + \eta\sigma_{t-1}^2 + \beta(R_{mt} - R_{ft}) + \beta Lag(R_{IPOt} - R_{ft}) + s\,SMB_t + h\,HML_t + w\,WML_t \quad (27)$$

$$\sigma_t^2 = \varpi_0 + \varphi_1 e_{t-1}^2 + \eta\sigma_{t-1}^2 + \beta(R_{mt} - R_{ft}) + \beta Lag(R_{IPOt} - R_{ft}) + s\,SMB_t + h\,HML_t + w\,WML_t + \gamma_t Dummy \quad (28)$$

All GARCH models were tested for serial correlation using a correlogram of standardized residuals squared and for heteroscedasticity using the Auto Regressive Conditional Heteroscedasticity (ARCH) test. It is proven that all GARCH models are free from serial correlation and heteroscedasticity.

5. Results

5.1 Descriptive Statistics

Descriptive statistics of variables are given in table 3. According to the risk return theory, higher risks should be compensated by higher returns. Therefore the stock market index should produce a higher return compared to treasury bills. However, the descriptive statistics given below reveal that the mean and median three month Treasury bill rate is approximately 12% higher than the stock market index indicating a negative equity premium. The standard deviation of the market rate of return is lower than the standard deviation of the risk free rate. The IPO portfolio mean and median returns are almost zero. Further, the mean and median SMB is a negative figure, which implies a reverse size premium contrary to (Fama and French 1993). However, HML and WML factors are positive according to the original findings.

Table 3: Descriptive Statistics

	R_m	R_f	R_{IPO}	*SMB*	*HML*	*WML*
Mean	0.07%	12.31%	0.00%	-2.41%	3.21%	0.10%
Median	0.00%	11.53%	0.00%	-3.28%	0.36%	0.23%
Maximum	18.29%	21.30%	15.67%	13.51%	17.61%	9.86%
Minimum	-13.89%	7.00%	-21.01%	-15.44%	-5.48%	-11.70%
Std. Dev.	1.29%	3.95%	1.75%	7.23%	7.18%	6.87%
No of Obs	2606	2606	2606	2434[v]	2434	2434

Source: Authors' construction using E-views 6.0 software

5.2 Brief Event Study Analysis

Table 4: Cumulative abnormal returns in post event scenarios

Event No	1 day CAR		3 day CAR		5 day CAR	
	ASPI	IPO	ASPI	IPO	ASPI	IPO
1	1.49%	-0.33%	1.38%	0.36%	1.22%	-0.60%
2	-1.53%	0.82%	-2.78%	8.50%	-1.49%	5.13%
3	-0.30%	0.50%	0.26%	-2.61%	1.34%	-7.09%
4	-0.82%	0.99%	-0.90%	1.40%	-0.75%	1.58%
5	0.06%	-1.18%	0.29%	-0.12%	0.50%	0.23%
6	2.86%	-3.24%	2.38%	-5.65%	1.63%	-7.88%
7	1.09%	-0.16%	3.01%	-0.75%	3.49%	-4.73%
8	-1.07%	-0.42%	0.06%	-2.92%	1.05%	-5.46%
9	-0.92%	-0.47%	-0.26%	-2.57%	1.64%	-3.56%
10	-1.03%	-0.08%	-0.75%	1.35%	-0.89%	1.69%
11	-7.73%	0.03%	-4.42%	1.35%	-6.36%	2.39%
12	-4.22%	0.04%	1.18%	1.29%	1.18%	0.31%
13	0.38%	0.15%	-0.66%	0.60%	-0.86%	1.69%
14	-0.72%	-0.51%	-0.94%	0.13%	0.86%	-1.20%
15	-1.31%	0.40%	-1.27%	0.39%	-2.66%	0.01%
16	-0.54%	0.21%	-1.53%	0.81%	-1.35%	0.72%
17	0.30%	0.27%	-1.31%	-0.21%	-3.91%	-1.31%
18	-1.24%	-0.18%	-3.01%	0.21%	-6.60%	-0.18%
19	-0.67%	-3.55%	-0.48%	0.15%	-0.74%	-4.85%
20	4.84%	-4.36%	3.26%	-4.23%	4.37%	-5.28%

Source: Authors' construction

This event study analysis presents mixed results. When the above table was analyzed, it was possible to identify events which give lower CAR to IPO stocks than ASPI and these were shaded. The authors identified those events as the events which influenced the IPO stock returns negatively. There are 8, 8 and 11 such events respectively for CARs of day

1, day 3 and day 5. Therefore on an approximation, 50% of events have an impact on IPO stocks and 50% don't.

5.3 OLS Regression Results

5.3.1 Chow Breakpoint Test Results under OLS Regression

The Chow breakpoint test will be used to find out whether structural breaks are associated with terror events and it will be based solely on OLS regression results without using dummy variables.

Table 5: OLS regression results without dummy variables[vi]

	SMM (Eq 10)	CAPM (Eq 12)	FF3 (Eq 14)	C4F (Eq 18)
α	-0.001*** (-2.682)	-0.002*** (-2.951)	-0.002*** (-2.891)	-0.002*** (-2.890)
R_m	0.949*** (49.383)			
$Lag1R_{IPO}$	-0.067*** (-4.767)			
$Lag2R_{IPO}$	-0.034*** (-2.385)			
R_m - R_f		1.021*** (81.047)	1.017*** (79.670)	1.017*** (79.132)
$Lag1(R_{IPO} - R_f)$		-0.034*** (-2.762)	-0.033*** (-2.636)	-0.032** (-2.561)
SMB			0.008** (2.017)	0.008* (1.896)
HML			-0.001 (-0.178)	0.001 (0.139)
WML				0.002 (0.384)
Adj.R^2	0.486	0.917	0.922	0.922
F Stat.	821.57***	14418.96***	7280.88***	5777.37***

Source: Authors' construction using E-views 6.0 software
Note 1: Comments marked with *, ** and *** indicate significance at the 10%, 5% and 1% level. Note 2: t statistics are reported in parentheses.

When analyzing the results of the above table, it is evident that the IPO portfolio is underperforming and the market beta is positively significant at the 1% level in all 4 models. Lag variables of the dependent variables are also highly significant at the 1% and 5% levels which indicate that there is a previous day effect. However other factors except SMB are not statistically significant, which means they don't have an impact on the dependent variable $(R_{IPO} - R_f)$. However, the F statistic is highly significant and therefore it can be concluded that all factors jointly explain the variation of the dependent variable. The adjusted R^2 is very high except in the SMM and therefore the models are good for prediction purposes.

Table 6: Results of the Chow breakpoint test

Event No	Presence of a structural Break (Yes/No)			
	F Statistic			
	SMM		CAPM	
1	No	1.43	No	2.17
2	No	0.89	No	0.88
3	Yes	3.99***	No	2.06
4	Yes	2.59**	No	0.94
5	Yes	2.39**	No	0.79
6	Yes	6.61***	No	1.17
7	Yes	11.16***	Yes	3.61**
8	Yes	7.92***	Yes	2.63**
9	No	1.59	No	1.14
10	Yes	2.70**	No	2.30
11	No	1.12	No	1.22
12	No	1.51	No	2.16
13	No	1.54	No	2.22
14	No	1.24	No	2.09
15	No	0.96	No	2.16
16	No	0.79	No	2.21
17	No	0.83	No	2.14
18	No	0.80	No	1.31
19	Yes	5.39***	Yes	7.42***
20	No	0.38	No	0.51

Source: Authors' construction using E-views 6.0 software
Note 1: Comments marked with ** and *** indicate significance at the 5% and 1% level.

Even though it has been intended to use the Chow breakpoint test (CBT) for all 4 models, a problem of exact collinearity arises in the last 2 models (FF3 and C4F). Suggested remedial action for the problem of exact collinearity is dropping a constant or some variables. However when a constant or variables like SMB, HML and WML are dropped, the models will lose their identity. Therefore the authors decided not to carry out CBT for FF3 and C4F. The results for CBT for the SMM and CAPM are given in the above table. In the SMM, it has been revealed that 8 events had a structural break out of 20 events. However in CAPM, only 3 events had a structural break out of 20. This indicates that the impact of terror events is less when the performance of IPO stocks are evaluated using CAPM rather than SMM.

5.3.2 Dummy Variable Regression Analysis under OLS Regression

Table 7: OLS regression results with a dummy variable

	SMM (Eq 11)	CAPM (Eq 13)	FF3 (Eq 17)	C4F (Eq 20)
α	-0.001** (-2.223)	-0.002*** (-2.917)	-0.002*** (-2.888)	-0.002*** (-2.890)
R_m	0.948*** (49.373)			
$Lag1R_{IPO}$	-0.068*** (-4.839)			
$Lag2R_{IPO}$	-0.035** (-2.470)			
$R_m - R_f$		1.021*** (81.095)	1.018*** (79.786)	1.017*** (79.250)
$Lag1(R_{IPO} - R_f)$		-0.034*** (-2.816)	-0.034*** (-2.752)	-0.033*** (-2.677)
SMB			0.009** (2.170)	0.009** (2.033)
HML			-0.001 (-0.146)	0.001 (0.214)
WML				0.003 (0.464)
Dummy	-0.003** (-2.072)	-0.002* (-1.896)	-0.003*** (-2.590)	-0.004*** (-2.588)
Adj.R^2	0.487	0.917	0.922	0.923
F Stat.	618.03***	9623.43***	5839.49***	4826.89***

Source: Authors' construction using E-views 6.0 software
Note 1: Comments marked with *, ** and *** indicate significance at the 10%, 5% and 1% level. Note 2: t statistics are reported in parentheses.

The results of Table 7 are very similar to those of table 5 except for the introduction of the dummy variable. The dummy variable had a statistically significant relationship with the dependent variable in all 4 models which means that terror events had a significant negative impact on IPO returns. When these results are compared with CBT results, dummy variable analysis reflects the impact of war on IPO stocks more than the CBT in all 4 models.

5.4 GARCH (1,1) Model Regression Results

5.4.1 GARCH (1,1) Model Results Without a Dummy Variable

Table 8: GARCH (1,1) model results without dummy variables (variance equations)

	SMM (Eq 21)	CAPM (Eq 23)	FF3 (Eq 25)	C4F (Eq 27)
ϖ (Intercept)	0.000*** (10.509)	0.000*** (6.361)	0.000*** (4.975)	0.000*** (9.034)
ARCH	0.119*** (21.141)	0.099*** (20.623)	0.097*** (18.909)	0.121*** (15.805)
GARCH	0.874*** (167.414)	0.894*** (206.04)	0.887*** (183.334)	0.843*** (96.903)
R_m	0.000*** (4.808)			
$Lag1R_{IPO}$	0.000 (0.096)			
$Lag2R_{IPO}$	-0.001*** (-4.448)			
$R_m - R_f$		0.000*** (5.534)	0.000*** (4.385)	0.000*** (5.466)
$Lag1(R_{IPO} - R_f)$		-0.000*** (-5.462)	-0.000*** (-4.417)	-0.000*** (-5.230)
SMB			-0.000 (-1.139)	0.000*** (5.132)
HML			0.000*** (8.889)	-0.000*** (-5.604)
WML				-0.000*** (-9.038)
Adj.R^2	0.483	0.917	0.921	0.922
F Stat.	268.96***	4092.13***	2625.49***	2198.73***

Source: Authors’ construction using E-views 6.0 software
Note 1: Comments marked with *, ** and *** indicate significance at 10%, 5% and 1% level. Note 2: z statistics are reported in parentheses.

The above table analyzes the results of the GARCH (1,1) model variance equation without dummy variables. It should be noted that this GARCH (1,1) model is tested for a normal Guassian distribution and controlled for the ARCH effect and serial correlation. The positive intercept (ϖ) shows the presence of significant volatility of residuals of IPO returns derived from the mean equation. ARCH and GARCH terms are positive and statistically significant and can be used to explain the volatility of Sri Lankan IPO returns. Further it can be seen that both ARCH and GARCH terms have an ‘internal’ or ‘family’ shock with which to explain the volatility of Sri Lankan IPO returns. This finding is common to all 4 models. Market beta and lag variables (except lag 1 in the SMM) are also positive and highly significant and can be used to explain the volatility of residuals of the mean equations. Other exogenous variables like SMB, HML and WML are also highly significant except in one situation. That is the SMB in FF3 (Eq 25) which is negative and insignificant. However F statistics in all 4 models are highly significant at the 1% level which result explains that all factors, whether they are internal or external jointly explain the volatility of residuals derived from mean equations. Further, except for the SMM, the other 3 models show a very high adjusted R^2, indicating they are good approximations.

5.4.2 GARCH (1,1) Model Results With a Dummy Variable

Table 9: GARCH (1,1) model results with dummy variables (variance equations)

	SMM (Eq 22)	CAPM (Eq 24)	FF3 (Eq 26)	C4F (Eq 28)
ϖ (Intercept)	0.000*** (10.135)	0.000*** (6.084)	0.000*** (4.710)	0.000*** (8.939)
ARCH	0.119*** (20.579)	0.100*** (20.200)	0.097*** (18.658)	0.123*** (15.743)
GARCH	0.873*** (156.978)	0.892*** (189.844)	0.887*** (165.516)	0.840*** (93.871)
R_m	0.000*** (4.871)			
$Lag1R_{IPO}$	-0.000 (-0.060)			
$Lag2R_{IPO}$	-0.000*** (-4.091)			
R_m - R_f		0.000*** (5.255)	0.000*** (4.457)	0.000*** (5.531)
$Lag1(R_{IPO} - R_f)$		-0.000*** (-5.162)	-0.000*** (-4.497)	-0.000*** (-5.320)
SMB			-0.000 (-0.847)	0.000*** (5.239)
HML			0.000*** (8.261)	-0.000*** (-5.555)
WML				-0.000*** (-9.017)
Dummy	0.000* (1.666)	0.000 (1.010)	-0.000 (-0.720)	-0.000 (-1.141)
Adj.R^2	0.483	0.917	0.921	0.922
F Stat.	220.26***	3182.31***	2223.39***	1906.36***

Source: Authors' construction using E-views 6.0 software
Note 1: Comments marked with *, ** and *** indicate significance at the 10%, 5% and 1% level. Note 2: z statistics are reported in parentheses.

When the GARCH (1,1) model variance equation is analyzed with the dummy variable, all variables other than the dummy depict a very similar behaviors to the GARCH models without a dummy. The dummy which represents terror events in the SMM shows a 10% level of positive significance. However, the dummy is not significant in the other 3 models indicating that terror events did not have a significant impact on the volatility of the residuals of Sri Lankan IPO return mean equations.

6. Conclusion

The purposes of this paper are to measure the impact of war on IPO stocks and to discover the best methodology for doing so. Event study analysis reveals that 50% of events have a material impact on IPO stocks while 50% do not. Under the OLS methodology rather than the CBT, dummy variable analysis clearly shows the significant impact of terror events on IPO stocks. It is possible to come to such a conclusion because the coefficient of the dummy variable in OLS is statistically significant and negative. This finding has been confirmed by many previous research works including those of (Aslam and Kang 2013); (Chesney, Reshetar and Karaman 2010); (Chen and Siems 2004) and (Abadie and Gardeazabal 2003). When GARCH models are considered, both with and without dummy, these versions result in highly significant ARCH and GARCH terms which provide evidence of a solid internal shock. However in the dummy version of the GARCH model, the dummy does not result in any statistical significance except for the SMM. Therefore it is possible to conclude that in the OLS methodology, dummy variable analysis is preferred over CBT. However, in the GARCH models, it is immaterial whether a dummy is used or not. So the ordinary GARCH model will be a good approximation in measuring the impact of war on IPO stock returns. GARCH models remove statistical problems such as serial correlation and heteoskedasticity according to (Cable and Holland 2000) and (Mills, Coutts and Roberts 1996). On the other hand (Campbell, Lo and Mackinlay 1997) explain that multifactor models lower the variance of abnormal returns while showing the variation of normal returns better. This study combined the GARCH (1,1) model and multifactor models to correctly identify the impact of war on IPO stocks. Overall, only 50% of the events selected had an impact on IPO stock returns. This study provides a guideline in selecting a methodology to assess the impact of war on specific security classes such as IPO stocks or specific industries such as defence and air lines, and this study therefore will be important to investment professionals, academics and policy makers.

Endnotes

[i] The ''methodology'' phrase used here is limited to regression based techniques and the 4 key factor models used to evaluate the impact of war, namely the simple market model, Capital asset pricing model, Fama and French 3 factor model and Carhart 4 factor model. For more details, refer the methodology section.

[ii] Disadvantage of the inability to generate a generalized picture across countries is not applicable to the present study since this study focuses only on Sri Lanka. Another disadvantage in the requirement of a large volume of data could be overcome by using more than 2,606 observations.

[iii] When an event date is a holiday for CSE operations, the next available trading day will be taken as the event day for calculation purposes. However Table 1 discloses the original event date where such a situation is applicable.

[iv] This practice of taking last traded prices to deal with the missing values will result in 0% returns which do not cause any bias to the ultimate IPO portfolio return.

[v] Numbers of observations are less for three variables (SMB, HML and WML). The reason for this is that only one stock remained in the IPO portfolio before July, 2000 and these factors cannot be constructed for single stocks.

[vi] These regression results reported in Table 5 were used for the Chow breakpoint test subsequently as shown in Table 6.

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