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Changes in equity returns and volatility across different Australian industries following the recent terrorist attacks

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ABSTRACT

We investigate the impact of five recent terrorist attacks on equities listed on the Australian Stock Exchange. Following the Global Industry Classification Standard, we analyse how these events affect the different sectors in Australia. Using parametric and non-parametric tests, we investigate the relationship between stock returns for equities listed in these sectors and terrorist attacks. We report significant short term negative abnormal returns around the September 11 attacks and to a lesser extent, the Madrid and London bombings. Our evidence shows a weak positive equity response to the Bali bombing, and no response from the Mumbai attack in the Australian market. We also document negative industry abnormal returns as high as 37.30% on the day in the Utilities sector. Our findings show that systematic risk of certain sectors increased after the events of September 11 but remained unchanged for the other attacks.

1. Introduction

Chan and Wei (1996) postulates that political risks affect the risk and return of capital markets and in this paper we investigate whether political events like terrorism activities affect foreign capital markets. Cam (2006) provides a detailed analysis of the impact of the September 11, Bali and Madrid bombings on 135 industry equity indexes in the United States. The empirical evidence shows that September 11 had the most influence on the US market with airline, hotel and leisure industries recording strong negative abnormal returns while water, defence and telecommunications industries showing strong positive abnormal returns. More recently, Nikkinen et al. (2008) show that the response of international markets to September 11, 2001

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terrorist attack differs according to the degree of integration of each region with the international market. In our paper we adopt and augment the approach used by Cam (2006), and look at the impact of five recent terrorist attacks on the Australian Equity Market.

Following Cam (2006), we do not assume that investors necessarily react negatively to terrorist attacks. Equity holders tend to respond negatively to such events only when they perceive an increase in the expected costs of terrorist activities. We argue that market players may well not react if they do not perceive that the attack has an impact on expected returns. It is possible that stock markets do not react negatively on days surrounding a major terrorist attack. We believe that markets can respond differently to the different attacks and that the variability in risk and returns differs significantly across different sectors within an economy. Our industry analysis on how terrorism affects returns of industrial portfolios contributes to the debate of Yao, Gao and Alles (2005) who only limited their model to financial and economic factors.

Kim and In (2002) demonstrated that the Australian market is sensitive to international events. As such, the Australian Stock Exchange provides an ideal testing ground for our arguments. On the one hand, Australia's geographic isolation may project the image of an investment haven. Yet, Australia's strong ties with the United States and the 'war on terror' may attract terrorist activity. Furthermore the Australian Stock Exchange was among the first markets to open immediately following 9/11. Chen and Siems (2004), Ito and Lee (2005), Richman et al. (2005) and Worthington and Valadkhani (2005) showed that the Australian market reacted negatively to the September 11 terrorist attack. Using a long term regression analysis and assessing the industry effects, Worthington and Valadkhani (2005) argue that only the Financial sector was negatively affected. Richman et al. (2005) showed a negative long term effect on the overall Australian market. On the short term analysis of the impact of September 11, Chen and Siems (2004) and Richman et al. (2005) argue that the entire equity market fell. Our results support these two studies in that we do observe a negative impact on the Australian market following 9/11.

Our contributions are as follows. Firstly, we identify precisely which industries in Australia were affected. Secondly, we look at how subsequent attacks impacted on these industries. Thirdly we modified the methodologies used in the existing literature by excluding firm specific information and using regression analysis to reinforce our findings. Most of the existing literatures fail to exclude firm specific information and thus report results which contain both the impact of terrorist attacks and other non terrorist components. For instance, Ito and Lee (2005) studied the impact of 9/11 and Bali bombings on both the domestic and international airline demand. They do not observe any immediate downward spike but instead an ongoing downshift in the Australian domestic and international airline demand, following September 11. They explained that their results contain both the impact of 9/11 and the collapse of Ansett Australia. As for Bali bombings, they document a decrease in the international demand only. Drakos (2004) argue that systematic risk of major airline[1] companies increased post 9/11 but fails to demonstrate the same increment on the Australian airline company (Qantas). Our conclusions support Drakos (2004) as the majority of the Australian industries studied did not result in an increase in their systematic risk. However, we identified certain sectors with an increase in their systematic risk. We thus argue that one must be careful in generalising the findings of Drakos (2004) as there are variations in systematic risk changes across industries. To the best of our knowledge there is no current study that looks at the short term impact of 9/11 on other Australian industries. Hence the first objective of this paper is to bridge the gap between the current short term literatures on the effects of September 11 on the Australian sectors. Furthermore, investors can use this as a guide to make their investment decision in Australia in the event of another terrorist attack. Such analysis will be beneficial to portfolio managers that use the top–down investment process. The second stage of this process is to deal with the factors influencing the industry and we contribute to this debate by adding the terrorist impact on the different industries. We also observe that the Water sector is very sensitive to international terrorist attacks and this may have some serious implications for Australian security.

Furthermore, most of the above literature may lead one to believe that terrorist attacks result in an increase in terrorist risk, and therefore reflect a negative sentiment. We argue that such conclusions should not be drawn until one considers the industry effects of terrorist attacks post September 11. To support our hypothesis, we study the impact of the subsequent four terrorist attacks that occurred in Bali, Madrid, London and Mumbai on the Australian Stock Exchange. By observing the industry effects in Australia, we can

[1] Carter and Simkins (2004) provide further evidence on the effects of September 11 attacks on a set of international airline stocks and find a negative reaction of both domestic and international airlines.

determine how Australian investors' reacted to the recent major terrorist attacks. This study is unique in the sense that it is the first study that looks at the short term effects of the five recent attacks on the different Australian industries. Most of the current literature attempt to study the impact of one attack on the world capital markets where we study how the major international terrorist attacks had an impact on one single country. Our results are consistent with the prior literature, in that September 11 did, indeed, have a negative impact on the Australian Market. Furthermore, we find that, the market as a whole is fairly insensitive to the major terrorist attacks post September 2001. Our contribution to this debate is that while we show that the major terrorist attacks following September 11 did not affect the Australian equity market as a whole, certain industries were more severely affected. In Section 2, we present the data and methods used in this paper. Section 3 presents the empirical findings and Section 4 provides some concluding remarks.

2. Data and methods

2.1. Data

We use daily stock returns indexes, returns calculated from the All Ordinaries share price index, and the 10-year bond rate for the period, August 1999 to August 2006, obtained from Datastream. We have a total of 1191 stocks in our sample. We construct industry portfolios based on the Global Industry Classification Standards (GICS). One of the practical issues that we face in this process is the small number of firms within some industry sectors. To overcome this issue, we study 13 out of the 14 industries described by GICS. The number of firms in each of these industry sectors is shown in Table 1. Table 1 reports the descriptive statistics for each of the different industries. The average daily return for the Computer, Health, Defence, Water, and Retail sectors are negative. The banking sector shows a positive return while the remaining sectors exhibit close to zero returns for the period. Further, we fail to reject the null hypothesis that the returns for the Capital Goods, Insurance, Defence, Water, Banks and Utilities industries are normally distributed. Table 1 also includes the standard deviation, skewness, excess kurtosis, range of returns, and number of shares for each of the industry classifications. Details of the five terrorist attacks that occurred in the United States, Bali, Madrid, London and Mumbai, are summarised in Table 2.

2.2. Methodology

We define daily return as:

$$DR_i = ln\left(\frac{SRI_{it}}{SRI_{it-1}}\right) \tag{1}$$

Table 1
Descriptive statistics of daily returns, for sectors in Australia from August 1999 to August 2006.

	Mean	Stdev	Skewness	Excess Kurt	Range	Count	*T*-test statistic*	JB-statistic
Return								
Materials	0.053%	0.011	16.158	272.702	0.185	300	0.879	942631
Diversified Financials	0.007%	0.001	−0.488	15.040	0.015	106	0.534	1003
Energy	0.016%	0.003	2.859	22.627	0.032	156	0.619	3540
Real Estate	0.003%	0.002	−3.574	15.349	0.001	108	0.190	1290
Capital Goods	0.019%	0.001	0.247	0.819	0.006	55	1.119	2.097
Computers	−0.101%	0.002	−0.894	7.790	0.015	112	−5.927	298
Pharmaceuticals	−0.076%	0.004	2.517	13.123	0.026	50	−1.436	412
Health	−0.156%	0.004	−3.860	19.241	0.023	39	−2.614	698
Insurance	0.058%	0.001	−0.455	−1.615	0.002	5	1.495	.716
Defence	−0.117%	0.001	−1.016	1.007	0.005	15	−3.580	3.217
Water	−0.384%	0.004	−0.667	−2.475	0.008	5	−2.306	1.647
Retail	−0.048%	0.002	−1.484	18.649	0.030	221	−2.963	3284
Banks	0.074%	0.001	−0.785	2.140	0.003	8	2.539	2.348
Utilities	0.015%	0.003	0.606	3.643	0.014	11	0.152	6.754
All	−0.012%	0.006	25.568	796.013	0.199	1191	−0.700	31574016

Table 2
The five major terrorist attacks and their consequences.
Source: Adapted and adjusted from CAM 2006.

Terrorist attack	Date	Event	Injuries	Fatalities
September 11 — United States	11/09/2001	Four commercial aircrafts were hijacked. Two were deliberately crashed into the World Trade Centre, and another one into the Pentagon. Passengers forced the crash of one plane into Pennsylvania.	5000	3025
Bali bombing — Indonesia	12/10/2002	A car bomb exploded outside the crowded Sari Club and inside the Padi's Bar.	300	202
Madrid — Spain	11/03/2004	Planted bombs detonated on commuter trains.	1800	191
London — United Kingdom	7/07/2005	Suicide bombings of the London subway and bus system.	700	55
Mumbai — India	11/07/2006	Explosive devices tore through several commuter trains	714	207

where

DR_i is the daily return for stock i,
SRI_{it} is the stock return index for stock i at time t.
SRI_{it-1} is the stock return index for stock i at time $t-1$.

Ex-post abnormal returns are estimated following Cam (2006) and Brown and Warner (1985). *Ex-post* abnormal returns for each firm (AR_{it}) are calculated as the difference between observed returns of firm i at event day t and the expected return, $E(R_{it})$.

$$AR_{it} = R_{it} - E(R_{it}) \tag{2}$$

The daily expected return, $E(R_{it})$, is estimated using an excess return CAPM over the last 260 observed daily returns:

$$E(R_{it}) = \beta_0 + \beta_1\left(\tilde{r}_{mt} - \tilde{r}_{ft}\right) \tag{3}$$

The abnormal return for industry I, AR_{It} at time t is then obtained by averaging the abnormal return of each firm within the industry.

$$AR_{It} = \frac{1}{N}\sum_{i=1}^{N} AR_{it} \tag{4}$$

We exclude all firms with firm specific information 15 days on either side of the event day from the industry portfolio, where firm specific information is defined as any announcement made on the Australian Stock Exchange. This enables the model to capture only the impact of the terrorist attacks and to be free from other firm specific information.

2.3. Parametric tests

The parametric tests used in this study rely on the important assumption that the industry abnormal returns and cumulative abnormal returns are normally distributed. The standard t-statistic for the abnormal return is:

$$t_{AR_{It}} = \frac{AR_{It}}{SD(AR_{It})} \tag{5}$$

where AR_{It} is defined as above and $SD(AR_{It})$ is an estimate of the standard deviation of the abnormal returns. By cumulating the periodic abnormal return for each industry over five days, we obtain the five day cumulative abnormal return, $CAR5_{It}$.

$$CAR5_{It} = \sum_{t=1}^{5} AR_{It} \tag{6}$$

The *t*-statistic for the five day cumulative abnormal return (CAR5) is obtained by dividing $CAR5_{It}$ by the standard deviation of the five day cumulative abnormal return, $SD(CAR5_{It})$.

$$t_{CAR5_{It}} = \frac{CAR5_{It}}{SD(CAR5_{It})} \tag{7}$$

2.4. Non-parametric tests

The literature dealing with abnormal returns show that they are not normally distributed. In particular, the distribution of the abnormal returns tends to exhibit fat tails and positive skewness. Under these circumstances, parametric tests tend to reject the null too often when testing for positive abnormal performance and too seldom when testing for negative abnormal returns. Corrado and Truong (2008) highlighted the need for a robustness test in event studies in Asia-Pacific financial markets and as a result we turn to an alternative ranking test developed by Corrado (1989). This non-parametric test is more powerful at detecting the false null hypothesis of no abnormal returns.

We transform each firm's abnormal returns, AR_{it} into ranks, K_i over the combined period, T_i of 260 days and are denoted as:

$$K_i = \text{rank}(AR_{it}) \tag{8}$$

Following Cam (2006), the period is broken up into the 244 days prior to the event, the event day and 15 days after the event. The ranks in the event period for each firm are then compared with the expected average rank ($\bar{K}_i$) under the null hypothesis of no abnormal returns. The expected average rank ($\bar{K}_i$) is given by

$$\overline{K}_i = 0.5 + \frac{T_i}{2} \tag{9}$$

As such, the non-parametric *t*-statistic, t_{np}, for the null hypothesis of no abnormal returns for each industry is therefore given by:

$$t_{np} = \frac{\frac{1}{N}\sum_{i=1}^{N}(K_i - \overline{K}_i)}{SD(\overline{K})} \tag{10}$$

where $SD(\bar{K})$ is the standard deviation of the average rank and is denoted by:

$$SD(\overline{K}) = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\frac{1}{N^2}\sum(K_{it} - \overline{K}_i)^2} \tag{11}$$

2.5. Regression analysis

Using the CAPM, we then test if terrorist attacks have had an impact on the systematic risk of Australian industries on the days of the attack. We include a multiplicative dummy variable in the standard CAPM to test this possibility:

$$\tilde{r}_{It} - \tilde{r}_{ft} = \phi_I + \beta_I^1\left[\tilde{r}_{mt} - \tilde{r}_{ft}\right] + \beta_I^2\left[\tilde{r}_{mt} - \tilde{r}_{ft}\right]{}^*D + \tilde{\varepsilon}_{it} \tag{12}$$

where

$\tilde{r}_{It}$	is the industry *i*'s return at time *t*
$\tilde{r}_{ft}$	is the risk free return at time *t*
$\tilde{r}_{mt}$	is the return on the market at time *t*
D	is a dummy variable that takes the value of 1 on the day of the event, and 0 otherwise. This variable is meant to capture the effect of terrorist attacks on the systematic risk.
$\tilde{\varepsilon}_{it}$	is the error term

Table 3
Abnormal returns on Australian industry indices following five terrorist attacks.

Industry	Sep-11		Bali		Madrid		London		Mumbai	
	AR	*T*-stat	AR	*T*-stat	AR	*T*-stat	AR	*T*-stat	AR	*T*-stat
Banks	−3.40%	−1.91	0.07%	0.06	−0.96%	−0.67	0.50%	0.56	0.01%	0.00
Pharmaceutical	−4.31%	−3.50	1.86%	0.90	−1.72%	−1.35	−1.42%	−1.24	0.24%	0.15
Materials	−4.35%	−4.59	−0.56%	−1.09	−0.77%	−0.87	−0.23%	−1.44	−0.68%	−0.52
Water	−11.14%	−3.05	5.34%	7.34	−0.93%	0.79	−1.44%	−5.85	0.38%	0.07
Defence	−8.11%	−3.15	1.42%	0.77	1.54%	1.32	−3.65%	−1.11	0.25%	0.06
Insurance	−1.76%	−0.94	−0.01%	−0.01	−2.87%	−2.15	−0.06%	−0.19	−0.10%	−0.10
Health	−0.07%	−2.24	−0.34%	−0.23	−1.30%	−1.35	1.77%	1.30	0.04%	0.02
Capital Goods	−6.95%	−3.76	0.68%	0.62	−0.23%	−0.42	0.97%	1.35	−0.03%	−0.02
Real Estate	−3.48%	−4.92	0.12%	0.24	4.14%	0.22	−0.05%	−0.70	−0.05%	−0.21
Group Retailing	−4.01%	−4.37	0.07%	0.14	0.37%	0.40	−0.25%	−0.66	0.04%	0.09
Utilities	−37.30%	−3.62	−4.24%	−0.45	−18.74%	−1.72	8.75%	1.58	0.24%	0.07
Energy	−0.77%	−0.64	−0.33%	−0.89	−1.83%	−1.44	0.43%	0.19	−0.01%	−0.01
Diversified Financials	−0.74%	−1.21	−0.51%	−0.46	−0.37%	−0.69	−0.57%	−0.54	−0.17%	−0.28

This table presents abnormal returns and the parametric *t*-test results for 13 Australian Industries after September 11, Bali, Madrid, London and Mumbai terrorist attacks.

ϕ_i is the intercept of the regression equation ($E(\phi_i) = 0$)
β_I^1 is the CAPM beta
β_I^2 is the coefficient of the dummy variable.

The inclusion of an additive dummy variable in the above Eq. (12) results in a near singular, variance–covariance matrix. As a result we estimate a separate equation to test if the intercept was affected by the attacks;

$$\tilde{r}_{It} - \tilde{r}_{ft} = \varphi_I + \alpha_I^1\left[\tilde{r}_{mt} - \tilde{r}_{ft}\right] + \alpha_I^2 D + \tilde{\varepsilon}_{it} \tag{13}$$

We gathered the returns for each industry 244 days prior to the event, and 15 days after the event. Standard tests and residual diagnostics revealed no major concerns with the above two econometric models. We also test if these dummy variables were redundant in the above equations using a Wald test for restrictions.

Using the terrorist event date as the breakpoint, we apply the Chow test to test if the CAPM has changed after each terrorist attack. Further, we consider how specifically the terrorist attacks impacted on the long term systematic risk. The test determines whether the level of risk, particularly captured by structural changes, is altered after the event day:

$$\tilde{r}_{it} = \varphi_I + \delta_I^1\left[\tilde{r}_{mt} - \tilde{r}_{ft}\right] + \delta_I^2\left[\tilde{r}_{mt} - \tilde{r}_{ft}\right]{}^{*}SD + \delta_I^3 SD + \tilde{\varepsilon}_{it} \tag{14}$$

where *SD* is a structural dummy variable that takes the value of 0 prior to the event, and 1 after the day of the event. This variable captures the structural changes and influence of terrorist attacks on the systematic risk over a long term horizon.

3. Empirical findings

This section reports the results of five different terrorist attacks on the Australian Stock Exchange. Using parametric tests and a non-parametric test we test whether the returns and systematic risk of 13 Australian industries were affected by these five events. We confirm that there is a strong negative impact on returns for most of the industries and a general increase in systematic risk of some industries during the US attack. Interestingly, we do not find similar evidence for the subsequent attacks. Surprisingly, the attack on a neighbouring country, Indonesia, had a positive impact in some Australian sectors.

Table 4
Cumulative abnormal returns on Australian industry indices following five terrorist attacks.

Industry	Sep-11		Bali		Madrid		London		Mumbai	
	CAR5	*T*-stat	CAR5	*T*-stat	CAR5	*T*-stat	CAR5	*T*-stat	CAR5	*T*-stat
Banks	−5.92%	−1.23	−2.96%	−1.32	−0.94%	−0.66	0.24%	0.68	0.12%	0.17
Pharmaceutical	−7.23%	−2.76	2.21%	1.12	−2.21%	−1.41	0.05%	0.01	−2.85%	−1.31
Materials	−10.71%	−3.84	−0.76%	−0.03	−0.91%	−0.32	1.97%	1.24	−2.16%	−0.68
Water	14.33%	0.89	13.24%	0.94	−9.54%	−1.69	−6.12%	−1.43	0.46%	0.23
Defence	−9.47%	−1.84	0.79%	0.10	−2.38%	−0.79	−3.21%	−1.12	−0.06%	−0.01
Insurance	0.18%	0.08	−1.17%	−0.06	3.35%	1.34	2.96%	1.02	−1.10%	−0.54
Health	−3.95%	0.07	−0.93%	−0.06	−0.49%	−0.10	3.01%	1.43	2.87%	1.22
Capital Goods	−5.46%	−2.43	0.24%	0.45	−3.91%	−1.54	3.48%	2.42	−1.88%	−0.99
Real Estate	−3.94%	−2.72	0.25%	0.05	1.95%	1.44	0.33%	0.09	−0.88%	−0.82
Group Retailing	−7.99%	−3.92	2.13%	1.52	0.43%	0.06	0.59%	0.45	−0.34%	−0.09
Utilities	−23.76%	−1.62	13.10%	1.00	−3.43%	−1.13	−23.55%	−1.15	0.19%	0.04
Energy	−1.32%	−0.99	−1.24%	−0.68	−2.98%	−1.22	5.75%	1.84	0.19%	0.03
Diversified Financials	−1.29%	−0.79	0.98%	0.17	−2.44%	−1.32	−1.13%	−0.61	−1.05%	−1.13

This table presents five day cumulative abnormal returns and the parametric *t*-test results for 13 Australian industries after September 11, Bali, Madrid, London and Mumbai terrorist attacks.

3.1. United States — September 11

Tables 3 and 4 summarise the parametric empirical results for September 11 for the different sectors. Following Cam (2006), we report the abnormal return on the day, and the five day cumulative abnormal return as well as their respective *t*-statistics for the 13 different industries. It should be noted that, unlike the US market that opened 6 days after the attack, the Australian market opened the day after the attack. In other words, we are assessing the performance of the Australian stock market on the 12th of September of 2001. The results reported in Tables 3 and 4 show a consistent negative effect on equities listed in the Australian Stock Exchange following the September 11 attack. Fig. 1 supports this hypothesis, except for the Water and the Insurance sectors; all the other industries illustrate both a negative abnormal return and a negative five day cumulative abnormal return.

Columns 2 and 3 of Table 3 report the abnormal returns and the parametric *t*-statistics for the various sectors. Table 3 shows that the returns in the Materials sector fell by 4.35% after the September 11 attack, and the *t*-statistic shows that this value is statistically different from zero. With the exception[2] of Banks, Insurance, Energy and Diversified Financials, all the other industries exhibited a negative and significant abnormal return. In other words nine out of thirteen sectors were affected by the event. The sector that was affected the most was the Utilities sector, which fell by 37.30%. Such a large percentage fall is not unusual, given Cam (2006), reports a 35% fall in the returns of Airline and Airport industry and after the September 11 attacks in the US. While Cam (2006) US industry classification differs from the GICS classification that we use, some similarities can be observed in the Materials and Real Estate industries. These two industries suffered on September 11 in both the US and Australia though the magnitude of the impact is moderately higher in the United States. Surprisingly, we observe a decrease in the Defence and Water industries in Australia. Such result is inconsistent with Cam (2006) who shows a positive return in these two sectors in the US.

Worthington and Valadkhani (2005) also use time series analysis of Australian equity markets and concluded that the Financial sector was the only sector affected negatively by September 11. While industry classification is different, our analysis shows no evidence of statistical fall in the Diversified Financials (see Tables 3 and 4). Thus, our findings are inconsistent with Worthington and Valadkhani (2005). A direct comparison of their study, however, is not possible given that they use a different model. In their model specification, they include other catastrophic and natural events, like Sydney hail storm, Canberra bushfire, Victorian gas supply crisis, HIH collapse, September 11 and Bali bombings. In addition

[2] Note that the exclusion of firms with firm specific information surrounding the events may account for these unexpected results in these sectors.

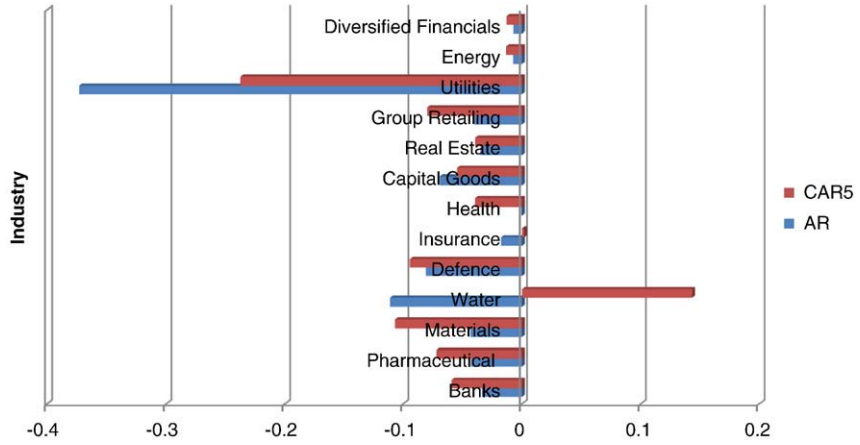

Fig. 1. AR and CAR5 on Australian industry indices following September 11.

their analysis is of a long term nature while ours is on a short term basis. Chen and Siems (2004) assess the short term effect of September 11 on the global capital market. Using a major market index, they showed that the Australian equity market fell by 4.19%. Using an international capital asset pricing model, Richman et al. (2005) document a negative impact of about 4.6% on the All Ordinaries index. Our findings are thus consistent with Chen and Siems (2004) and Richman et al. (2005) as we show a clear and consistent fall in various industries in Australia. Whilst our analysis does not specifically look at the airline industry, we are consistent with Ito and Lee (2005) in terms of negative sentiment surrounding the event. Fig. 1 shows the ranking of the abnormal returns. From the Fig. 1, we can observe that Health, Energy, Diversified Financials, and Insurance sectors are the least affected by the September 11 terrorist attack.

Except for the Water and Insurance sectors, all other sectors exhibit a negative cumulative abnormal return over the following five days. Note that our approach is consistent with most studies as this methodology supports the hypothesis of negative sentiment after the September 11 attack. The second column of Table 4 shows that the Utilities sector was the worst performing sector with −23.76% as CAR over the next five days (see Fig. 1) though the *t*-statistic implies that this is not statistically different from zero. The sectors that recorded statistically significant drop were Pharmaceutical (−7.23%), Materials (−10.71%), Capital Goods (−5.46%), Real Estate (−3.94%) and Group Retailing (−7.99%). Note that all these sectors also exhibit a negative abnormal return on the day following the attack. From Fig. 1, we observe a positive five day CAR for Water but a quick look at the *t*-statistic in Table 4 (column 3) reveals that this is not statistically significant. It is noticeable from Fig. 1 that the CAR5 is marginally higher than the event day AR for most industries, implying that the market continued to plummet over the following five days. Our findings are consistent with Chen and Siems (2004) who showed that cumulative abnormal return is around −6.81% six days after the event and −8.60% eleven days after the attack. This result is inconsistent with the Cam (2006) who found that the CAR over the following six days is lower than the abnormal return for US firms.

As a robustness test, we consider the non-parametric[3] results in Table 5 in our discussion. The negative impact of the 9/11 event on Australian industries was also detected by the non-parametric tests. The results in Table 5 show that except for Water and Group Retailing, all the other industries have a negative non-parametric *t*-statistic. For instance, column 2 of Table 5 shows that the non-parametric *t*-statistic is −3.09 for the Material industry. This reflects the negative abnormal returns identified earlier in the parametric tests. Generally speaking the results of the non-parametric tests supports the results observed in the parametric analysis.

[3] Generally speaking, when the reported non-parametric *t*-statistics is less (greater) than negative two (positive two), we conclude that the abnormal returns were negative (positive) on the day of the event.

Table 5
The impact of five terrorist attacks on Australian industry indices — non-parametric results.

Industry	Sep-11	Bali	Madrid	London	Mumbai
Banks	−3.02	1.40	−0.94	0.93	0.35
Pharmaceutical	−0.22	2.10	−0.90	0.18	0.88
Materials	−3.09	1.25	−1.42	−0.44	−0.87
Water	1.83	20.33	−2.22	−5.24	0.23
Defence	−2.64	1.34	−0.08	−1.67	0.57
Insurance	−0.39	1.00	−1.12	0.11	−0.45
Health	−0.54	−0.35	1.13	1.44	0.07
Capital Goods	−3.35	−0.27	−1.64	−1.28	−1.29
Real Estate	−0.42	1.42	−1.33	−0.95	−1.10
Group Retailing	0.96	0.11	−1.69	−0.65	−1.63
Utilities	−2.84	0.63	−0.47	0.33	0.13
Energy	−0.28	0.23	−2.49	0.48	−1.78
Diversified Financials	−0.22	0.27	−0.99	0.43	−0.86

This table presents the non-parametric t-test results for 13 Australian Industries after September 11, Bali, Madrid, London and Mumbai terrorist attacks.

Based on the above discussion, we can conclude that Pharmaceutical, Material, Water, Defence, Health, Capital Goods, Real Estate, Group Retailing and Utilities industries were strongly negatively affected on the day following the September 11 attack and these findings are consistent with Chan and Wei (1996) who reported that unfavourable political news are associated with negative returns. It is generally assumed that following a terrorist attack, returns of equities fall as a result of an increase in systematic risk. Our next objective will be to test if the industries negatively affected by 9/11 experienced a general increase in their systematic risk. The multiplicative regression analysis (see Eq. (12)) attempts to test this hypothesis immediately after the attack. Columns 2 to 4 of Table 6 report the results of the multiplicative dummy variable model (Eq. (12)). A positive (negative) coefficient of the multiplicative dummy variable (β_I^2) reflects an increase (decrease) in systematic risk. The sign of the coefficient (β_I^2) appears to be positive in seven out of the nine industries discussed above. When the coefficient of the multiplicative dummy variable is statistically different from zero, it implies a significant statistical change in the systematic risk of the industry. The *t*-statistics results from column 4 of Table 6 show that systematic risk statistically increased in only four sectors namely Capital Goods, Defence, Health and Water sectors out of the nine sectors that recorded a statistical dropped in their abnormal return. For example the systematic risk of Capital Goods was 0.130932 (see column 3 of Table 6) prior to the attack and increased by 0.780447 (see column 4 of Table 6) after the attack. The systematic risk increased from 0.130932 to 0.911379 after the attack. The Wald test[4] reveals that for this industry (and for Defence, Health and Water sectors), that the dummy variable is not a redundant variable. The general increase in systematic risk after political news was also documented by Chan and Wei (1996). On the other hand, there is no statistical evidence of an increase in systematic risk in the remaining five industries. Another key finding of this study is that terrorist attacks do not always lead to an increase in systematic risk and that terrorist risk varies significantly across industries. These results are consistent with Drakos (2004) who finds no evidence of an increase in the systematic risk of a major Australian airline company (Qantas). The general observation of Drakos (2004) on the other hand is that systematic risk generally increased for all the major international airline companies except for Qantas and KLM.

On the other hand the additive dummy variable Eq. (13) shows the impact of September 11 on the intercept of the CAPM. Once more we focus the industries stated in the previous paragraph. Columns 5 to 7 of Table 6 present the findings of the regression. As from Column 7, we can observe that the intercept was statistically decreased only in case of the Materials and Group Retailing sector and did not change for the remaining ones.

In estimating Eqs. (12) and (13), we only show the short term impact of the September 11 attacks on the Australian industrial sectors. We applied the Chow breakpoint test to the standard CAPM to determine whether the model has changed after the terrorist attack. The results are consistent with a change in the model for most of the sectors but fail to explain whether the intercept or the slope (long term systematic risk) of the model has changed. By applying Eq. (14), we can establish the direction of change in the long term systematic risk. That is, we test if the increase in systematic risk observed on the first trading day after

[4] Note that we do not report the results of the Wald Test in this paper.

Table 6
The impact of September 11 attack on Australian industry indices — regression analysis.

	$\tilde{r}_{It}-\tilde{r}_{ft}=\phi_I+\beta_I^1[\tilde{r}_{mt}-\tilde{r}_{ft}]+\beta_I^2[\tilde{r}_{mt}-\tilde{r}_{ft}]*D+\tilde{\varepsilon}_{it}$			$\tilde{r}_{It}-\tilde{r}_{ft}=\varphi_I+\alpha_I^1[\tilde{r}_{mt}-\tilde{r}_{ft}]+\alpha_I^2 D+\tilde{\varepsilon}_{it}$		
Industry	Intercept	Coefficient	Coefficient	Intercept	Coefficient	Coefficient
	ϕ_i	β_I^1	β_I^2	φ_i	α_I^1	α_I^2
Banks	0.00053	0.02305	−0.35243	0.00063	0.00760	−0.00283
T-statistics	1.07	0.36	−1.44	1.24	0.12	−1.38
Capital Goods	−0.00131	0.13093	0.78045	−0.00116	0.18550	0.00024
T-statistics	−1.78	1.36	2.13	−1.52	1.97	0.08
Defence	−0.00484	0.21257	1.60708	−0.00497	0.30119	0.00752
T-statistics	−3.06	1.03	2.05	−3.04	1.50	1.14
Diversified Fin.	−0.00117	0.11324	−0.56717	−0.00079	0.10022	−0.00805
T-statistics	−1.82	1.35	−1.78	−1.20	1.25	−3.05
Energy	−0.00179	0.20441	0.75736	−0.00133	0.27409	−0.00471
T-statistics	−2.54	2.23	2.17	−1.83	3.07	−1.61
Health	−0.00239	0.10368	1.28423	−0.00202	0.19990	−0.00150
T-statistics	−2.56	0.85	2.77	−2.08	1.67	−0.38
Insurance	−0.00122	0.37069	−0.28128	−0.00084	0.37446	−0.00702
T-statistics	−0.91	2.11	−0.42	−0.61	2.20	−1.26
Materials	−0.00246	0.12699	−0.04050	−0.00213	0.14233	−0.00538
T-statistics	−4.23	1.68	−0.14	−3.60	1.96	−2.25
Pharmaceutical	−0.00321	0.17629	0.61371	−0.00272	0.23917	−0.00571
T-statistics	−2.86	1.20	1.10	−2.35	1.68	−1.22
Real Estate	−0.00074	0.17403	0.06821	−0.00070	0.17987	−0.00030
T-statistics	−1.55	2.81	0.29	−1.44	2.99	−0.15
Group Retailing	−0.00220	0.07097	−0.06104	−0.00182	0.08744	−0.00615
T-statistics	−4.15	1.03	−0.23	−3.40	1.33	−2.84
Utilities	−0.00084	0.08612	1.02482	−0.00032	0.17487	−0.00473
T-statistics	−0.37	0.29	0.90	−0.14	0.60	−0.50
Water	−0.00071	−0.34035	3.78276	−0.00019	−0.08769	0.00467
T-statistics	−0.23	−0.84	2.45	−0.06	−0.22	0.36

This table presents the regression analysis results for 13 Australian industries after September 11 terrorist attack. The first multiplicative dummy variable equation illustrates the impact on systematic risk and the second additive dummy variable equation shows the impact on the intercept.

the event persists in the long term. The results, presented in Table 7 column 4, show that 30% of the industries exhibit an increase in systematic risk in the long run. For example, the systematic of the Health industry increased by 0.51 after the September attacks.

3.2. Bali

Among all the terrorist attacks studied in this paper, the Bali bombing is geographically the closest to Australian soil. The event occurred on Saturday 12th October 2002 and the first day that the Australian market traded after the attack, was on the Monday 14th October 2002. The results of the parametric test on sector returns for this day are shown in Table 3 (Columns 4 and 5). Only the Water sector was significantly affected, and interestingly it was positively affected on the first day that the market traded. The robustness test also support the claim of a positive effect in the Water sector on the first day of trading. The third column of Table 5 shows the results on the non-parametric test on the various Australian industries. The non-parametric *t*-statistic is positive and significant for the Water industry. Over the 5 day trading period, there were no significant cumulative abnormal cumulative returns recorded (see Table 4) for Bali bombing. We can therefore conclude that immediately after the Bali attack, only one sector, Water, was positively affected while all other sectors were insensitive to the event. Just like the five day CAR analysis, the regression analysis[5] shows no significant results. Based on the empirical results, we can further conclude that Bali bombings did not have a negative effect on the Australian market and on the contrary had a positive influence. We may interpret this positive result as a substitution effect of terrorist attacks. Our

[5] Note that we do not have any regression analysis as they show all the insignificant results.

Table 7
The long run impact of September 11 attacks on the systematic risk of Australian industry indices.

	$\tilde{r}_{It}-\tilde{r}_{ft}=\delta_0+\delta_I^1[\tilde{r}_{mt}-\tilde{r}_{ft}]+\delta_I^2[\tilde{r}_{mt}-\tilde{r}_{ft}]*SD+\delta_I^3\ (SD)$			
Industry	δ_0	δ_1	δ_2	δ_3
Banks	0.00	0.02	−0.27	0.00
T-statistics	1.26	0.38	−1.04	−0.95
Capital Goods	0.00	0.13	0.48	0.00
T-statistics	−1.57	1.37	2.24	−0.68
Defence	−0.01	0.21	0.72	0.00
T-statistics	−3.09	1.02	1.77	0.48
Diversified Fin.	0.00	0.12	−0.28	−0.01
T-statistics	−1.19	1.41	−0.82	−2.59
Energy	0.00	0.21	0.38	−0.01
T-statistics	−1.91	2.30	2.91	−2.51
Health	0.00	0.11	0.51	−0.01
T-statistics	−2.17	0.88	3.09	−1.40
Insurance	0.00	0.37	0.00	−0.01
T-statistics	−0.61	2.13	0.00	−1.18
Materials	0.00	0.13	0.20	−0.01
T-statistics	−3.61	1.73	0.65	−2.34
Pharmaceutical	0.00	0.18	0.25	−0.01
T-statistics	−2.39	1.24	1.61	−1.69
Real Estate	0.00	0.17	0.09	0.00
T-statistics	−1.45	2.81	0.36	−0.26
Group Retailing	0.00	0.07	0.21	−0.01
T-statistics	−3.42	1.10	0.76	−2.93
Utilities	0.00	0.09	0.32	−0.01
T-statistics	−0.16	0.30	1.14	−0.85
Water	0.00	−0.34	0.66	−0.01
T-statistics	−0.11	−0.83	2.46	−0.49

This table presents the regression analysis results for 13 Australian Industries after September 11 terrorist attack. The first multiplicative dummy variable equation illustrates the impact on systematic risk and the second additive dummy variable equation shows the impact on the intercept (see Eq. (14)).

hypothesis is that investors move their investments from countries directly under attack to the neighbouring country in search of an investment haven. Unfortunately our findings show very weak evidence of substitution effect as only the Water sector was affected. Worthington and Valadkhani (2005)[6] showed that only the Australian Consumer Discretionary sector was negatively affected by the Bali bombings. Ito and Lee (2005) also document a negative impact after this event. They recorded a 6% fall in the international demand for airline in the Australian market. Our empirical findings about the Bali bombings appear to conflict with the existing literature in this field.

3.3. Madrid

The bombings in Madrid occurred on Thursday 11th March 2004. We examine the Australian industry reactions both immediately, and five days following the event. The results of the parametric test immediately after the attacks and five days after the attacks are shown in columns 6 and 7 of Tables 3 and 4 respectively. Based on these two parametric tests, only the Insurance industry was significantly negatively affected. This only incurred on the day following the attack, and this negative effect disappeared after five days, i.e. CAR5 for the Insurance sector turned into a positive number. The non-parametric test also detects a negative sentiment on the event day for the insurance sector but fails to show some statistical significance. Of the five terrorist events that we examine, Madrid suffered the second highest injury and fatality rate, and we conclude that this event had a negative impact in only one industry of the Australian economy while the majority of the sectors were unaffected. This result can be regarded as another contribution to the literature as at present there is no study that looks at the impact of Madrid bombings on the Australian market.

[6] Note their results are of a long term nature.

3.4. London

On Thursday 7th July 2005, London was subject to terrorist attacks. Due to our close ties with the western world, one would have thought that it may have had quite an impact on Australian stock market. Surprisingly enough, the Australian stock market's response to the attack was muted. The trading day immediately after the attack saw the Water sector produce an abnormal return of −1.44% (see Table 3, Column 8), and was the only industry to produce a significant result. The non-parametric *t*-statistic also supports the negative movement in the Water sector. The Capital Goods sector showed an unusual cumulative abnormal return of 3.48% over five days. However the majority of the industries were immunized from the London bombings. Although the London terrorist attacks were a major global event, it only affected one industry in the Australian equity market on the day of the impact.

Out of the five attacks studied in this analysis, the Water sector is significantly affected by three of these events. Water sector was negatively affected by September 11 and London and was positively affected in Bali. Hence Water sector becomes the most sensitive industry around terrorist attacks.

3.5. Mumbai

Although Mumbai's terrorist attacks claimed 207 lives and injured 714 people, the response from Australia equity market was immaterial. The empirical testing of this event produced no abnormal performance results. The Mumbai evidence shows that it is wrong to assume that terrorist attacks will impact negatively on stock markets. As such investment havens do exist even under terrorist attacks.

4. Conclusion

Studying the impacts of the recent terrorist attacks on the Australian industries, we are able to identify various market effects. September 11 event had the most impact on the Australian market. The majority of the industries were down on the day of the event, and just under 40% of the industries were still negatively affected 5 days after the event. Approximately one third of the industries studied showed an increase in systematic risk following the 9/11 attacks. Madrid and London bombings, the two European attacks, had mild negative impacts on the Australian market. Surprisingly the lesson learnt from the Bali attacks was positive for Australia. With only one sector positively affected, this can be interpreted as weak evidence of substitution effect. Using the Bali bombing evidence, we argue that terrorist attacks do not always nurture negative sentiment but can also be good for the neighbouring country. Another interesting finding is that the Mumbai bombing had no effect on the Australian market. The Mumbai evidence can be used to demonstrate that some capital markets can be insensitive to some terrorist attacks, and thus investment havens may exist even just after an attack. Finally the industry that was most sensitive to the terrorist attacks was the Water sector. Australia has not been drastically affected by terrorist attacks post 9/11 and we can thus conclude that investment haven may exist after those events.

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