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# The impacts of deviations from standard daily procedures on stock performance – a case study of Carnival Cruise Line

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## Abstract

**Purpose** – In the USA, the cruise industry has generated more than $42bn in total economic activities, involving over 356,000 jobs. The largest and most aggressive operator is acknowledged as Carnival Cruise Line (CCL), with a 48.3 per cent market share including all subsidiary companies in 2013. CCL has had a strong track record of reliability and high quality; however, within the past decade, there have been several deviations from standard daily procedure that have altered the way CCL does business. When trying to interpret changes in company performance, it is important to include other factors that may have contributed to changes at the time of any given deviation.

**Design/methodology/approach** – The authors use time series empirical mode decomposition to visualize whether there are short- or long-term shocks to company performance in the wake of deviating events. Besides, a thorough analysis is carried out with multivariable linear regression to identify the factors that really impact CCL's performance.

**Findings** – This case study shows the seasonal patterns of weather issues with the largest number of hurricanes and tropical storms taking place during the third quarter of each year.

**Originality/value** – Empirical results will enhance understanding of the industry with regard to such events. It will provide shareholders information and opinions to enhance their decision-making processes.

**Keywords** Accidents, Carnival cruise, Deviations, Stock performance

**Paper type** Research paper

## 1. Introduction

The fastest-growing travel sector in the world is the cruise industry. Members of the global cruise industry collectively made $7.2bn in investments and expanded the fleet by acquiring 29 new ships in 2014 with another 20 expected to join the Cruise Lines International Association (CLIA) Global Fleet by 2018. (CLIA State of the Cruise Report, 2014). The importance of the US cruise industry is significant. The USA alone accounts for 51.7 per cent

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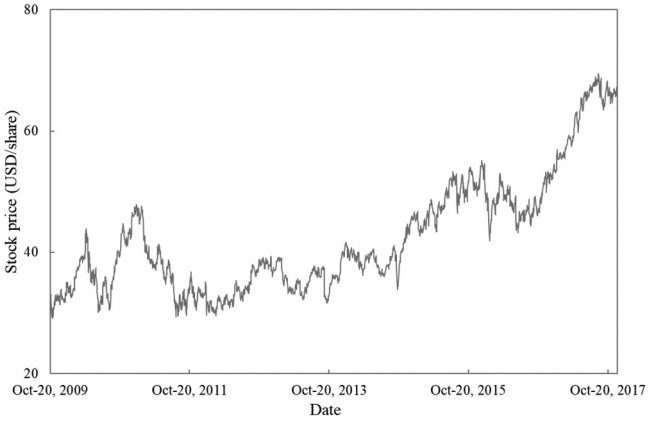
of total cruise passengers, with the UK and Ireland coming in second, accounting for 8.1 per cent. In the USA, the cruise industry has generated more than $42bn in total economic activity, including over 356,000 jobs. The driving force for this large growth in US passenger cruising is leisure spending. The top three reasons consumers provide for taking a cruise by percentages is as follows: the value at 86.6 per cent; the destinations at 77 per cent; and brand reputation at 76 per cent.

Carnival Cruise Line (CCL) is the world's most popular cruise line; this is a result of great prices for consumers and a strong, credible brand reputation. CCL (NYSE:CCL:US) is a publicly traded cruise corporation that specializes in Caribbean and exotic destinations. This largest and most aggressive operator was acknowledged at 20 per cent market share in 1992, 52 per cent in 2012 and, most recently, including all subsidiary companies, 48.3 per cent in 2013. Carnival has established a strong position in the USA, considering it has the most North American departure ports. The most sought-after destination from the USA is the Caribbean. From 2013 to 2014, the Caribbean claimed most of the cruise capacity, at 34 per cent market share, and Caribbean cruise demand by percentage grew the most based out of all global cruise itineraries. The top departure ports in 2011 accounted for 79 per cent of the North American cruise passenger departures. The consistently highest-ranking ports were Miami, Fort Lauderdale and Port Canaveral (CLIA State of the Cruise Report, 2014). Carnival has a strong position in the cruise line industry, with expectations of continued growth. Carnival's overall financial position via stock performance is shown in Figure 1. There have been many fluctuations in stock price of large amplitude, irregular and non-stationary. The period from November 2009 to the end of 2011 was one of particularly drastic fluctuations in stock price; however, a period of growth followed.

CCL has a strong track record for reliability and high quality; however, within the past decade, there have been several notable deviations from standard daily procedure that have altered the way CCL does business. The largest threats to human safety and company performance have become mechanical malfunctions and human error. The purpose of this case study is to observe the impacts of deviations from standard daily procedures on




**Notes:** Carnival's daily stock prices including the highs, lows, closing, and volume over 2009-2014 were obtained from the Thomson One database. The dates are graphed on the x-axis and thedaily average stock price on the y-axis

**Figure 1.**
Stock performance average price for 2009-2017

company performance to better understand the long-term implications of such events. We investigated to what extent product differentiation provided by subsidiaries and deviations from standard daily procedures impacted CCL performance to better inform shareholders and to shed greater light on potential industry fall out.

Note: Carnival's daily stock prices including the highs, lows, closing and volume over 2009-2014 were obtained from the Thomson One database. The dates are graphed on the *x*-axis and the daily average stock price on the *y*-axis.

Studies on predicting shipping companies' financial and stock performances using financial statements have been conducted extensively; however, the same focus on the stock performance of cruise lines has only rarely been observed in academic literature. We use the time series empirical mode decomposition (EMD) to visualize whether there are short- or long-term shocks to company performance in the wake of deviation events. This case study will enhance the understanding of the industry with regard to such events and also provide shareholders with information and opinions to enhance their decision-making processes.

## 2. Literature

Over many decades, the stock price of cruise lines has risen sharply because of more travelers choosing cruises as a vacation alternative. The future of the cruise industry depends on its ability to produce and maintain larger, higher quality ships. The industry trend toward building bigger ships exploits economies of scale to decrease operating costs while increasing revenue (Lois *et al.*, 2004). Economies of scale will not only impact revenue but also are likely to greatly increase the impact of deviations from standard daily procedures on performance. One of Carnival's vessels, Carnival Splendor, lost power in November of 2010, because a fire broke out in the engine room. Passengers felt life threatening when they lived in the cruise with no electricity and limited food. This left many passengers dissatisfied with CCL, even though they received a full refund for the trip. The deviations caused by these unfortunate accidents can significantly damage the long-term reputation of cruise lines, which is notoriously reflected in its stock performance. We reviewed literature ranging from introducing and evaluating typical cruise company performance all the way to analyzing accident-focused industry responses. The results were then used as a way of searching for effective strategies to protect reputation in the face of accidents and weather issues. Moreover, there are already effective methods adopted for reliable prediction of the stock performance of shipping companies in the literature. However, there is little research on quantifying the indirect impact of terrible accidents and weather issues on cruise line's stock performance. This paper aims to fill up the research gap by bringing the EMD method into stepwise regressions and hierarchical regressions. In the following sections, we first review the general studies on cruise performance in Section 2.1 and then identify the impact of possible accidents in the industry in Section 2.2. Above sections provide us a guideline to identify the scope of this current research. Then, traditional economic literature in predicting stock performance is reviewed in Section 2.3 as a fundamental step to move on to the empirical analysis. Detailed research method of EMD is discussed in Section 3.

### *2.1 Cruise performance literature*

The cruise industry has grown increasingly active in modern tourism (Wie, 2004). Cruise lines attempted to attract passengers and travel agents in the competitive cruise market through innovating incentive strategies (Wang *et al.*, 2014) and cruise pricing in operation (Sun *et al.*, 2011). Cruise supply chain was also realized and promoted mainly through horizontal integration achieved by merger and acquisition, and vertical integration within terminal operation, onshore marketing activities and cruise services (Lorange, 2005; Wang

*et al.*, 2015). Extensive empirical studies for cruise lines have been conducted, including measuring cruise supply chain efficiency by using the DEA model (Véronneau and Roy, 2009), assessing cruise lines' performance with their financial statements (Chang *et al.*, 2017), evaluating economic impacts of cruise industry on port-city development (Pallis *et al.*, 2014), investigating passengers' cruise experience, preference and satisfaction (Brida *et al.*, 2013) and discussing the selection process and competitive advantages of cruise ports (Castillo-Manzano *et al.*, 2014; Wang *et al.*, 2014).

Past studies of cruise performance, including that by Aguirre *et al.* (2012), have studied cruisers' experiences and the economic impacts of cruise tourism in the specific case of a homeport destination. Aguirre *et al.* collected data from 402 passengers who embarked in the Cartagena de Indias during the 2009-2010 seasons. To identify the factors that influenced their perceptions and expenditure patterns, a factor-cluster analysis was developed. The three clusters that were obtained reflected the length of stay at a destination, passengers in transit and long- and short-stay passengers. Most passengers in Cartagena stay for a short period, with little contribution to the local economy. First-time cruisers with a high level of education stay longer and have a higher-than-average spending capacity. Han *et al.* (2015) studied interest in cruise vacations, and they evaluated customers' onboard experiences with North American cruise lines and their loyalty formation process. Their results showed that interactional quality and outcome quality were significant and were associated with perceived value. This in turn affected satisfaction and loyalty. These results have helped others observe that cruise vacationers have become more demanding in terms of expected service quality, price and value.

We know that passenger nights can be used to measure cruise ship performance. In a study by Forney *et al.* (2006), cases of diarrheal disease among cruise ship passengers declined from 1990 to 2002. From 2001 to 2004, there was an increase in rate, which was due to a lack of inspections. Gauri *et al.* (2014) gave the history of the cruise industry as it relates to China and then reported the characteristics of Chinese cruise passengers to compare them with others. The article discussed challenges that niche tourism faces, along with how it is impacted by having new policies in place. Elliot and Choi (2011) examined the cruise passengers within cruise tourism and what is behind the recent significant shift in typical passenger profiles. The average annual passenger growth has been 7.4 per cent since 1990. Cruises used to be an older tourism opposition, with the average age of passengers being 65. However, in 2008, the average passenger was 46 years old. Choi and Ellot help explain why the younger generation of cruisers has taken such interest and with such high percentages of repeat business.

### *2.2 Cruise accidents literature*

Since the Exxon Valdez tanker vessel accident in 1989, increasing attention has been given to tanker safety and regulations. However, studies of cruise failures and passenger vessel accidents have received less attention in the maritime literature, even though historical cruise accidents have resulted in huge damages to property and a significant number of fatalities. Among the exceptions to the dearth of literature are studies by Talley *et al.* (2008) and Mileski *et al.* (2014). Talley *et al.* (2008) identified the costs of damage from various types of accidents, including collisions, equipment failure, explosions, fire, flooding, grounding, breakaway, capsizing and sinking, and found that the explosive accidents have the highest unit damage cost per vessel gross ton.

Mileski *et al.* (2014) analyzed the causes of recent cruise ship mishaps and disasters and summarized 116 marine accidents from 1988 to 2014 that involved US vessels or were on US waters. Out of all of these, 37 per cent were related to passenger vessels (National Transportation Safety Board). In the year 2013 alone, the US Coast Guard Maritime

Information Exchange reported that 44 inspected passenger vessels were directly involved in accidents, such as collision, sinking and capsizing of vessels, or indirectly involved, such as vessels providing emergency assistance or witnessing the event.

Studies of cruise accidents include that by Powell *et al.* (2008), who examined the determinants of the property damages and injury severities of cruise vessel accidents over the period ranging from 1991 to 2001. The results suggest that cruise vessel damage cost per vessel is greater for accidents such as allusions, collisions, equipment failure, explosions, fire, flooding and grounding accidents rather than other types of accidents with human cause. Chen *et al.* (2002) addressed collision and grounding and how they are used to assess ship performance. This study focused on three issues that a standard in design needs to be established for as follows: definitions of accident scenarios, evaluation approaches and acceptance criteria. The performance of a ship in an accident can be measured by its energy dissipation, penetration depth and quantity of oil outflow or residual hull girder strength.

The drive toward increased utilization of economies of scale within the cruise industry has created a demand for larger, more technologically advanced vessels; however, with an increased reliance on new technology, there is a reliability hazard. Ship reliability is a vital component of quality in passenger shipping. Serious shipboard equipment failures can hinder ship seaworthiness and inevitably lead to delays with observed and hidden costs (Tzannatos, 2005). In total, 71 per cent of mechanical failures within Greek passenger ships are associated with the main and auxiliary engines, while 16 per cent of the mechanical failures are attributed to maneuvering propulsive equipment (Tzannatos, 2005).

To understand responsibility during cruise tourism accidents, Klein (2011) examined the impact cruise tourism has on marine environments, local economies and the sociocultural nature of port communities. He did this by analyzing three key elements involved in responsible tourism. Case examples were used to identify and describe challenges faced by governments, communities and the cruise industry. Kokotos (2009) examined human reliability regarding all accidents involving Greek flagged ships during the 1993-2006 period. Accident data were processed through a decision tree analysis that enabled the classification of various accident factors, which, for this approach, were treated as the tree variables. Human error maintained its dominance in terms of shipping accidents, especially in open waters. In Indonesia, Mustafa (2012) sought to understand why ship accidents in this area were claiming such a large number of casualties. The four main issues in maritime transport were security, safety, pricing policy and the quality of human resources. Most accidents occurred because of low awareness of the aspects of security and safety of the crew.

### *2.3 Literature on the prediction of stock performance of shipping companies*

We summarized the literature related to shipping stock performance in Table I, including performance indicators, subject of study and the methodology used. Compared to extant predictions of financial performance and stock returns, which have received a lot of attention, the stock performance of shipping companies in general and the cruise industry is relatively understudied.

## 3. Methodology

In this paper, a framework based on EMD and multivariable linear regression was used to analyze the stock performance of CCL. EMD is used to investigate whether there are any short-term or long-term trends in company performance in the wake of deviation events. Multivariable linear regression was used to analyze the impacts of factors such as cruise accidents and weather issues.

| Indicative literature | Performance indicator | Subject of study | Methodology |
|---|---|---|---|
| Grammenos and Arkoulis (2002) | Industrial production, inflation, oil prices, fluctuations in exchange rates against the US dollar and laid up tonnage | Shipping companies traded in stock exchange worldwide | Time series: unit root autoregressive moving average model |
| Kavussanos *et al.* (2002) | Global risk: industrial production, inflation, oil prices, fluctuations in exchange rates against the US dollar and credit risk | International industries | OLS regressions on industry stock return |
| Kavussanos *et al.* (2003) | Systemic risk | Bulk, tanker, container and ferry | Capital asset pricing model on stock return |
| Kavussanos and Marcoulis (2004) | Microeconomic factors: market value of equity, book value to market value ratio, earning to price ratio, leverage. Macroeconomic factors: industrial production, change of oil prices, change in consumption and inflation and industry specific effect | Shipping companies traded in stock exchange worldwide | Literature survey |
| Syriopoulos and Roumpis (2009) | Value at risk measured by weighed portfolios based on market capitalization | Tanker and dry bulk companies traded in the US stock exchange | Exponential and asymmetric power on dynamic volatility of shipping equity |
| Drobetz *et al.* (2010) | Risk factors, returns on size, value or momentum portfolios or macroeconomic variables | Container, tanker and bulker | Seemingly unrelated regressions; GMM |

**Note:** Summarized by authors

**Table I.** Literature on prediction of stock performance

### *3.1 Empirical mode decomposition*

There are always accidents that influence stock performance, and the purpose of this case study is to observe the impacts of deviations from standard daily procedure on company performance to have a better understanding of the long-term implications of such events.

EMD, a nonlinear, non-stationary data analysis method, can explain the time series from a new perspective. The decomposition can be achieved by time scale, without setting any basis function in advance. The method has been applied to lots of research fields successfully, such as signal processing (Flandrin *et al.*, 2004; Wu and Huang, 2009), image filtering (Nunes *et al.*, 2003), machinery fault diagnosis (Liu *et al.*, 2006; Lei *et al.*, 2013), etc. EMD method is helpful in extracting information from original signals and diminishing energy leakage. Moreover, it also works well in medical field (Echeverria *et al.*, 2001), market analysis and forecasting (Zhang *et al.*, 2008; Zeng and Qu, 2014), etc. Zhang *et al.* (2008) analyzed the oil market by using an extended ensemble EMD method, and the economic meanings could be extracted from the crude oil price. The EMD process of the original time series $s(t)$ is briefly summarized as follows:

(1) *Step 1*: Here, $s(t)$ is the original time series. Initialize $r_i = s(t)$ and $i = 1$.

(2) *Step 2*: Define and initialize a new function $w_{i,n}(t) = r_0$, whose local extrema (including maxima and minima) could be identified at first.

(3) *Step 3*: The unknown functions of local maxima and local minima could be closely approximated by a cubic spline interpolation method, which performs better in terms of curve smoothness and easy solution process; $l^h_{i,n}(t)$ and $l^l_{i,n}(t)$ denote upper and lower envelopes, respectively.

(4) *Step 4*: Calculate the mean $m_{i,\,n}(t)$ of upper and lower envelopes.

(5) *Step 5*: Let $w_{i,n+1}(t) = w_{i,n}(t) - m_{i,n}(t)$. If $w_{i,n+1}(t)$ satisfies the characteristics of IMFs, then set: $imf_i = w_{i,n+1}(t)$, else go to *Step 2* with $n = n + 1$.

Conditions that intrinsic mode functions (IMFs) must satisfy include the following:

- The number of extrema must be equal to the number of zero crossings, or differ at most by one.
- At any point, the mean value of the local maxima and minima envelope must be zero.

(6) *Step 6*: Let $r_{i+1} = r_i - imf_i$, then start the next iteration. The decomposition process is repeated until there is only one local extrema or a monotone function in $r_{i+1}$, and $r(t) = r_{i+1}$ is the residual.

At the end of the EMD process, the original time series $s(t)$ is composed of a set of IMFs and a residual and is represented as:

$$s(t) = \sum_{i=1}^{n} imf_i + r(t)$$

First, we separate the volatile highest frequencies from the original time series and leave the remaining as a new time series, repeating the process until there is only one local extreme, or a monotone function in the remaining. The original time series is then decomposed into several IMFs and a residual. As shown in Figure 2, the stock price series is decomposed into eight IMFs and one residual. IMFs are sorted by fluctuation frequency from high to low.

Second, eight IMFs need to be classified into two categories based on $z$-test results. If the $z$-test result of an IMF time series is not significantly deviated from zero, the IMF should be distributed to the first category, which is the high frequency component. If not, the IMF

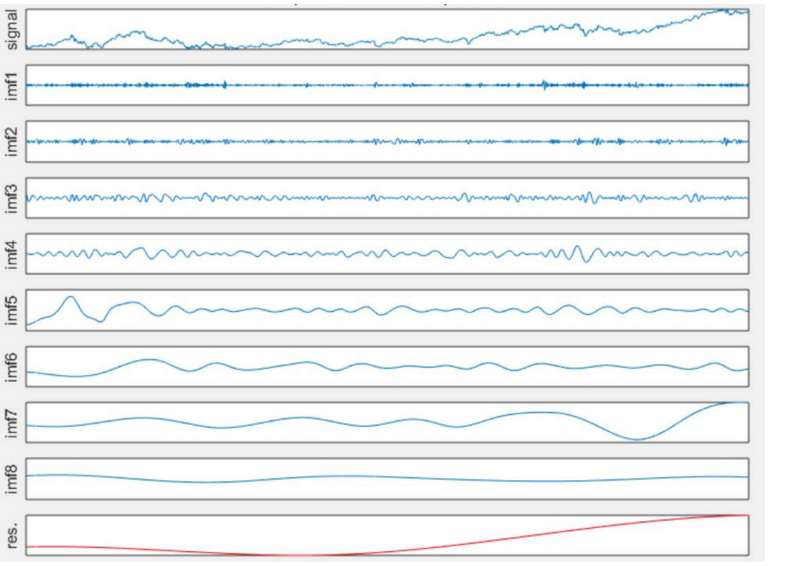



**Figure 2.**
Decomposition result of stock price

should be distributed to the category of low frequency component. Thus, the IMFs decomposed by the EMD method could be classified and re-composed to capture the original economic nature of the stock price. Figure 3 shows three recomposition components: a high frequency component caused by normal market activities, a low frequency component caused by the effects of accidents and a residual component representing the long-term trend.

*3.1.1 Long-term trend.* The residual obtained by the decomposition of the stock price reflects the long-term trend for CCL stock performance. It represents the standard daily price within the business cycle. We observed that the long-term component went down at first and then rose, with a minimum on November 16, 2012. If we choose a different time period of stock price, the decomposed long-term trend of stock looks significantly different (Figure 4).

*3.1.2 High frequency component.* The high frequency component represents the normal fluctuation in stock price, which is mainly caused by the interaction of the supply and demand in the stock market. The stochastic volatility of the daily stock price shown in the high frequency component is based on the hypothesis of efficient markets – rational behaviors in trading and sufficient competition in a market with full information. As shown in Figure 3, the short dash line of the high frequency component fluctuates around a baseline, the long-term trend. As the supply in the stock market is considered relatively stable, the stock price rises with stronger market demand and declines with weaker demand.

*3.1.3 Low frequency component.* The effects of short-term shocks are mainly illustrated by lower frequency IMFs. For example, as shown in Figure 3, accidents always cause fluctuations with large amplitudes. Accidents exert an indirect effect on the performance of Carnival's cruise line by affecting the perceptions of stock market participants. For the public, safety and reliability are of great importance. Other factors such as product differentiation among various travel packages among Carnival cruise subsidiaries and unforeseen weather issues may also create fluctuations in stock performance.

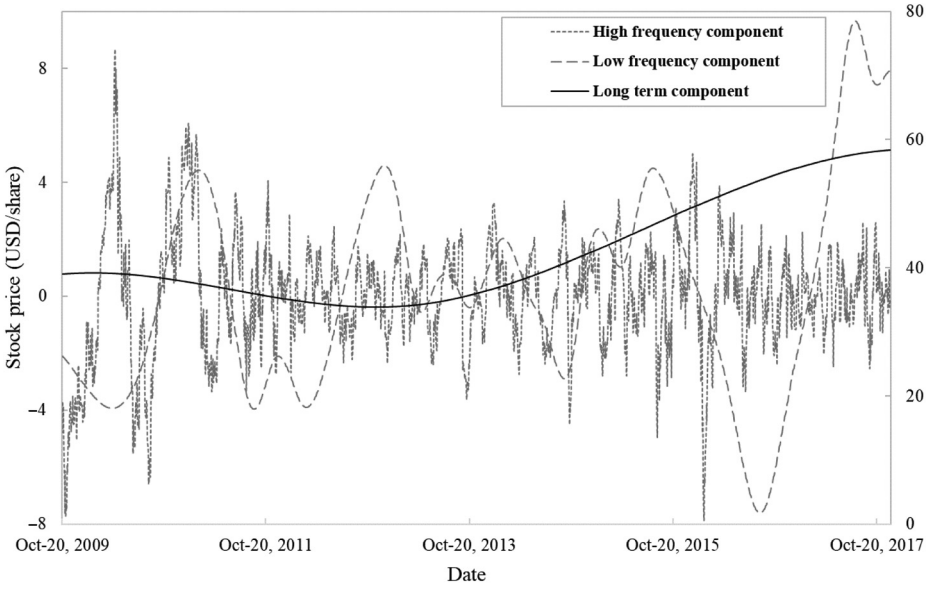
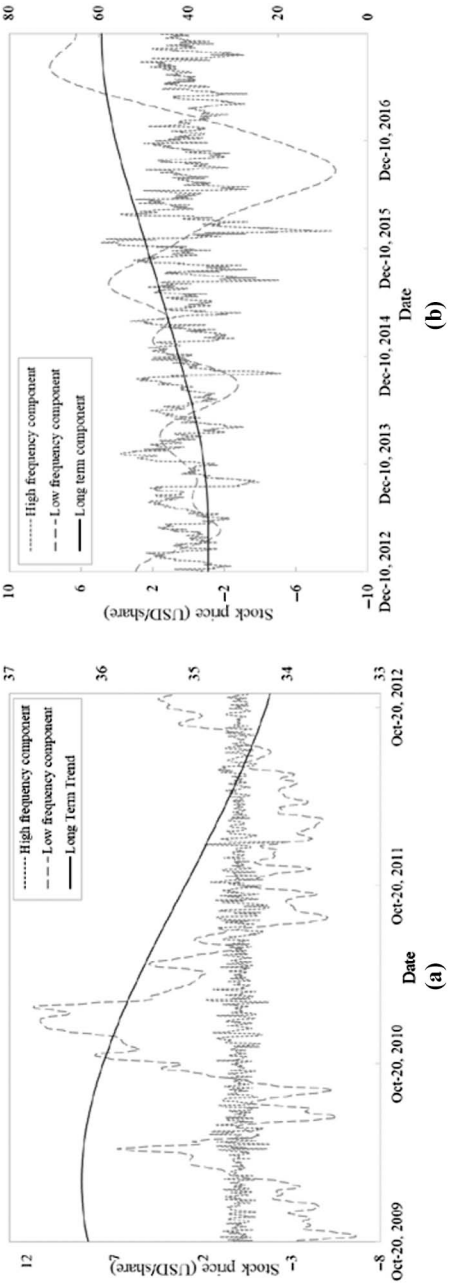



**Figure 3.**
Re-composition component of stock series




**Notes:** (a) Time period from 2009 to 2012 and (b) time period from 2012 to 2016

**Figure 4.**
Re-composition results with different time period

*3.2 Multivariable linear regression*

There are many variables which can affect the performance of a publicly traded stock. By using a variety of performance indicators, we provide a thorough study into what factors really impact CCL's performance, along with possible solutions to improve the cruise industry in the Caribbean.

*3.2.1 Impact of cruise accidents.* Accidents influence not only the performance of the CCL but also the public's perception. The performance of Carnival is determined by their perceived ability to safely transport passengers to destinations in a timely fashion. More specifically, we evaluate the types of accidents and the total accidents for CCL and all subsidiaries – Carnival, Princess, Costa, Holland, Cunard and Seabourn – from 2003 to 2012.

There were 143 incidents selected from case studies summarized by peer-reviewed authors on cruisejunkie.com. To ensure and compare consistent results, only six subsidiaries were selected out of ten, with the data range beginning in 2003 and ending in 2012. Incidents were categorized into seven categories after being sorted using Quarter. The six categories are *itinerary change due to mechanical malfunctions, mechanical problems, collisions, fire, propulsion problems, and others*. *Itinerary changes due to mechanical malfunctions* were instances where an underway cruise had to be altered because of a severe problem in operational equipment. *Mechanical problems* were instances that resulted in no change in schedule, but lack of optimal functionality aboard the vessel. *Collisions* were instances where vessels either collided or nearly missed other vessels or portside equipment. *Fire* entailed events where part of the functionality of the vessel was impeded because of a fire. *Propulsion problems* were instances in which the vessel lost either partial or total maneuverability. *Others* consisted of operational complications and cancellations.

To collect accidents from cruisejunkie.com, we carefully sorted accidents by each subsidiary. For each subsidiary, the accidents had to be tallied to fit one of the six necessary categories mentioned above, depending upon the description provided by cruisejunkie.com. When organizing our data, each subsidiary and CCL entry included incidents broken down by quarter, which were then later aggregated by year, covering the period from 2003 to 2012. Detailed information is broken down in Table II, which presents summary information regarding cruise accidents by type and by subsidiary. From 2003 to 2012, major incidents leading to cruise accidents included *propulsion problems* (42/131 = 32 per cent), followed by *fire* (25 per cent), *collisions* (11 per cent), *mechanical problems* (6 per cent) and *itinerary changes* (6 per cent). Another 20 per cent of total accidents were caused by operational complications and cancellations. Of the total number of accidents, the Carnival fleet was involved in 51 per cent (67/131 = 51 per cent) of them. Princess Cruise (20 per cent), Holland (15 per cent) and Costa (10 per cent) were also involved in various accidents such as collisions, fire and propulsion problems.

| Cruise Line | Itinerary change | Mechanical Problems | Collisions | Fire | Propulsion problems | Others | Total |
|---|---|---|---|---|---|---|---|
| Carnival | 7 | 4 | 1 | 11 | 27 | 17 | 67 |
| Princess | 1 | 1 | 5 | 8 | 8 | 3 | 26 |
| Costa | – | – | 5 | 4 | 2 | 2 | 13 |
| Holland | – | 1 | 2 | 9 | 4 | 3 | 19 |
| Cunard | – | 2 | 1 | 1 | 1 | 1 | 6 |
| Total | 8 | 8 | 14 | 33 | 42 | 26 | 131 |

**Note:** Incidents were only used in this study if incidents were provided by credible sources
**Source:** available at: www.cruisejunkie.com

**Table II.**
Total accidents by types and by subsidiary from 2003 to 2012

*3.2.2 Impact of hurricanes and inevitable weather issues.* Table III shows the total number of hurricanes and tropical storms during the study period from 2003 to 2014. Hurricane and tropical storm data were organized by quarter and year. Then they were documented in the given year in which they began. For example, if a hurricane started on September 30, 2014, then we would categorize the hurricane in the third quarter of 2014. The Atlantic US hurricane season is from June 1 to November 30. The most active month is September, per the graph, which we believe directly links to the performance of Carnival cruise. All six CCL operate in the Atlantic because they travel to common Caribbean destinations.

Because of seasonal weather patterns, high-incidence seasons with hurricanes and tropical storms appear regularly in the third quarter of every year. Low-frequency stock values tend to always bounce back after climatic disasters every year (Figure 3). As in Table II, the total number of accidents reached a high of ten in the first quarter of 2010, which was increased significantly compared with the fourth quarter of the previous year. It is precisely when these large numbers of accidents happened that the stock price decreased most. Similarly, frequent accidents occurred in the fourth quarters of 2010 and 2011, and in the first quarter of 2013, leading to rebounded stock price to stop rising, and then daily stock price began to drop from. Long-term historical data would make little impression on market participants if most accidents happened in the beginning of a single year. A similar decline takes place at Point I in the beginning of year 2014, although there was almost nothing happening from the third quarter of 2013 to the first quarter of 2014. However, comparing four turning points at the beginning of every year, the curve declined more slowly because of the successful operation of CCL.

*3.2.3 Empirical results.* First, hierarchical regression is used for evaluating the effects of different factors on stock performance of CCL. Rather than adding or removing one independent variable at a time in the standard regression procedure, hierarchical regression is to test the effects of a group of variables independent from others.

The procedure of hierarchical regression model is as follows:

- Four scenarios with different dependent variables have been taken into consideration. In Scenario 1, *stock performance end price* is set as the dependent variable, while independent variables are used to explain the long-term trend, high frequency component and low frequency component in Scenarios 2-4, respectively.

| Year | Tropical Storms | Hurricanes | Quarter | Tropical Storms | Hurricanes |
|---|---|---|---|---|---|
| 2003 | 9 | 7 | Q1 | 0 | 0 |
| 2004 | 5 | 9 | Q2 | 15 | 2 |
| 2005 | 12 | 15 | Q3 | 59 | 69 |
| 2006 | 4 | 5 | Q4 | 25 | 17 |
| 2007 | 9 | 5 | Total | 99 | 88 |
| 2008 | 9 | 8 | | | |
| 2009 | 8 | 3 | | | |
| 2010 | 9 | 12 | | | |
| 2011 | 13 | 6 | | | |
| 2012 | 9 | 10 | | | |
| 2013 | 11 | 2 | | | |
| 2014 | 1 | 6 | | | |
| Total | 99 | 88 | | | |

**Table III.**
Total tropical storm and hurricane by year and by quarter

**Sources:** National Weather Service National Hurricane Center (www.nhc.hoaa.gov and summarized by authors). The National Hurricane Center provides information on tropical storms and hurricane paths along with the dates for each year

- Divide all independent variables into three categories, namely financial statements (*EBIT/interest expense, price/earnings, net margin*, *return on equity*, and *sales*), weather issues (tropical storms and hurricanes in the Atlantic Ocean) and accidents (*itinerary change due to mechanical malfunctions, mechanical problems, collisions, fire, propulsion problems* and *others*). So, the specified hierarchy system is designed according to independent variable categories.
- Start with no variables in the model and add the independent variables into regression model layer by layer for empirically testing the effects of the most statistically significant variables.
- A significance test is carried out for all independent variables to recognize whether an independent variable has a contribution to stock performance. If not, the variable should be removed from the regression model.

Data for 2003-2014 were used, and Table IV shows the results of the multivariable hierarchical regressions.

Multivariable liner regression results are shown in Table IV, where stock performance is sensitive to a few, but not all independent variables. It is interesting to find that the long-term trend of stock price is mainly affected by financial indicators, and 91.2 per cent of long-term trend of stock performance changes could be explained by financial indicators. Weather issues only have a short-term impact on the high frequency component of stock performance. In other words, weather issues affect company performance through the high component, which is quite hard to be visualized by investors. Moreover, almost all accidents have impacts on the low frequency component.

Furthermore, more detailed statistical outputs are shown in Table V for analyzing the statistical relationship between several influential factors and stock performance.

The significance of all influential factors could be assessed based on the *t*-test results listed in Table V. Scenario 1 is taken as an example here. Seven factors are statistically significant to stock performance, but the confidence levels are quite different, including price/earnings, quick ratio, return on equity, *mechanical problems*, *fire*, *propulsion problems* and *others*. The *p*-value for price/earnings (0.000) is lower than the common alpha level of 0.01, which indicates that it is significantly related to stock performance at a 99 per cent confidence level. While the *p*-value for fire (0.064) indicates that correlation degree is lower, although *fire* is also related to stock performance. Other factors should be removed from the

| Scenario | $R^2$ | *F*-test | Significant variables |
|---|---|---|---|
| Stock performance end price as dependent variable | 0.812 | 0.000 | Price/earnings, quick ratio, return on equity; Mechanical problems, fire, propulsion problems and others |
| Long-term trend as dependent variable | 0.912 | 0.000 | Price/earnings, quick ratio, net margin, return on equity and sales |
| High frequency as dependent variable | 0.532 | 0.013 | EBIT/interest expense, quick ratio, net margin; Tropical storms; Itinerary change due to mechanical malfunctions others and |
| Low frequency as dependent variable | 0.931 | 0.000 | Price/earnings, EBIT/interest expense, net margin, return on equity; Itinerary change due to mechanical malfunctions, collisions, fire, propulsion problems and others |

**Table IV.** Multivariable hierarchical regression results

**Table V.**
Significance of regression results in various scenarios

| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| Dependent variable | Stock performance end price | Long-term trend | High frequency | Low frequency |
| *Independent variable* | | | | |
| Price/earnings | 6.301*** (0.000) | −2.998*** (0.005) | 1.235 (0.226) | 9.048*** (0.000) |
| EBIT/interest expense | −0.437 (0.665) | −1.581 (0.124) | −2.078** (0.046) | 2.680** (0.012) |
| Quick ratio | −3.944*** (0.000) | −4.526*** (0.000) | −2.976*** (0.006) | 0.212 (0.828) |
| Net margin | 1.136 (0.264) | 1.745* (0.091) | 2.320** (0.027) | −2.054** (0.048) |
| Return on equity | 3.322*** (0.002) | −7.418*** (0.000) | 0.302 (0.765) | 8.128*** (0.000) |
| Sales | −0.269 (0.790) | −3.571*** (0.001) | 1.313 (0.198) | −0.178 (0.860) |
| Tropical storms | 1.568 (0.127) | 0.571 (0.572) | 1.777* (0.085) | −0.187 (0.852) |
| Hurricanes | 1.292 (0.206) | 0.771 (0.447) | 1.529 (0.136) | −0.384 (0.704) |
| Itinerary change due to mechanical malfunctions | 1.657 (0.107) | −0.840 (0.407) | −2.788*** (0.009) | 6.169*** (0.000) |
| Mechanical problems | 2.405** (0.022) | 0.389 (0.700) | 1.545 (0.132) | 1.384 (0.176) |
| Collisions | 0.057 (0.955) | −1.371 (0.180) | −0.890 (0.380) | 1.847* (0.074) |
| Fire | 1.920* (0.064) | −1.214 (0.234) | 0.606 (0.548) | 2.629** (0.013) |
| Propulsion problems | 2.071** (0.047) | −1.603 (0.119) | 0.809 (0.424) | 2.796*** (0.009) |
| Others | 3.017** (0.005) | −0.866 (0.393) | 1.709* (0.097) | 2.694** (0.011) |

**Notes:** *Denotes that independent variable is significant at 90% confidence level; **denotes 95% confidence level ; ***denotes 99% confidence level

final regression model. In Scenario 3, tropical storms are significantly correlated to stock performance at a 90 per cent confidence level, which could not be assessed when stock performance end price is set as a dependent variable. So, cruise companies should also pay attention on weather issues.

Furthermore, a stepwise regression is further used to verify the above regression and identify which factors are of more importance for cruise companies to operate profitably. The stepwise regression is a popular fitting regression model, where a variable is added to or subtracted from the set of explanatory variables based on several criterions in each step, such as $R^2$, $F$-test and $t$-stats. In the end, a high-accuracy regression model would be built by an automatic procedure for explaining the fluctuation of stock price.

The procedure of the stepwise regression model with forward selection is as follows:

- Start with no variables in the model, and test each of the one-variable models for identifying the most statistically significant variable with the smallest $p$-value.
- Select the independent variable with the largest correlation coefficient to stock performance and add it into the regression model.
- Identify the independent variable that explains the residual after Step 2 most through partial correlation coefficients and add it to the model.
- Continue to examine all variables not in the model, whether it could make a significant contribution to the existing model as Step 3 until the pre-set accuracy level is achieved.

Stepwise regression results are shown in Table VI, and the most significant independent variables are listed in sequence.

## 4. Discussions

Weather issues such as tropical storms and hurricanes do have an impact on the short-term trend of cruise line's stock performance, although there is no impact on long-term trend. Weather issues are less statistically significant to stock performance when compared with six categories of disasters, namely, *Itinerary Change Due to Mechanical Malfunctions, Mechanical Problems, Collisions, Fire, Propulsion Problems* and *others*. Terrible disasters that should have been avoided by cruise lines damage their reputation, which can be clearly seen from stock performance. Moreover, the negative influence of weather issues on stock price has been exposed after decomposing stock performance end price. So, cruise companies should also pay attention to weather issues while considering disasters. Based on the findings and data in Section 3, there is an immense opportunity to improve and evaluate cruise-related regulatory frameworks and policy measures. To

| Scenario | $R^2$ | $F$-test | Sequential significant variables |
|---|---|---|---|
| Stock performance end price as dependent variable | 0.668 | 0.000 | Price/earnings, return on equity and quick ratio |
| Long-term trend as dependent variable | 0.893 | 0.000 | Return on equity, sales, quick ratio and price/earnings |
| High frequency as dependent variable | 0.243 | 0.002 | Itinerary change due to mechanical malfunctions and sales |
| Low frequency as dependent variable | 0.883 | 0.000 | Return on equity, price/earnings and itinerary change due to mechanical malfunctions |

**Table VI.** Multivariable hierarchical regression results

provide more transparency and accountability, the cruise industry should consider stakeholders' participation in cruise policy process decision-making. By allowing stakeholders to participate, they may provide more tailored solutions for cruise-related issues, especially if participants are involved in different areas of business. Joint efforts organized by groups, in both the public (government) and private sectors, are able to provide strategic feedback and coordinate hurricane preparedness efforts. The cruise line industry can work to improve regulatory authority for accidents and hurricane prevention in the USA. This would help significantly decrease the number of accidents in the cruise industry, particularly for CCL. The CLIA has been working to improve the safety of North American cruise lines. The CLIA is actively communicating its Passenger Bill of Rights to the public and cruise line guests, and it is working closely with the International Maritime Organization (IMO) to propose solutions to replace outdated cruise policies.

The above results also showcase the importance of how natural disaster impacts the normal operation of cruise activities. In the recent case of Hurricane Irma, which lasted from August 30 until September 16, 2017, and Hurricane Maria, active from September 16 through October 3, major cruise tourism destinations departing from Florida such as Cuba, Saint Martin, Puerto Rico, the Dominican Republic, the Bahamas and other surrounding areas were among the hard-hit areas. With the needed emergency preparation among the local port authorities and stakeholders, reposition and repurpose of the cruise vessels can be done immediately to mitigate the impact of the natural disaster and to maximize the efficient allocation of available resources.

One of the challenges faced is the hurricane season, which is also concordant with Carnival's peak revenue season. This has become a challenge because of the increase in hurricanes near CCL's most popular destination, the Caribbean. Moreover, the increase in accidents may be due to the increase in hurricanes in the Caribbean. The impacts these accidents have on passengers and residents of cruise destinations have been lasting, and lowering the number of accidents has been challenging. However, hurricanes also provide opportunities for CCL management.

With the hurricane season peaking during the busiest times of the year for CCL, there is an opportunity for growth. For example, Carnival can increase sales by making necessary adjustments in their marketing. If Carnival provides more incentive for passengers to board cruise ships during the non-peak season by lowering costs and providing exclusive package deals, this could result in lower overall costs and less risk of accidents for CCL. Carnival can also improve management by having a more flexible itinerary. A flexible itinerary will allow Carnival to change locations and adapt to a variety of situations such as if an accident or storm takes place. An exclusive package provided for loyal customers could be presented through an app such Groupon or Transfer Transportation. Groupon allows customers to purchase package deals up to 50-70 per cent off retail price. Transfer transportation offers combine services between major airports to cruise ports. Combining both a package for customers and increased flexibility with regard to destination would improve sales during the non-peak season, while also mitigating risks associated with the hurricane season.

## 5. Conclusions

As supported by the steady incline in total passenger nights, Carnival is the largest cruise line. However, CCL also accounted for 51 per cent (67/131 = 51 per cent) of accidents over our time frame. The top accident categories out of the eight were *propulsion problem*s, *fires* and *collisions*. Based on the data, there is immense opportunity to improve and evaluate cruise-

related regulatory frameworks and policy measures. To provide more transparency and accountability, the cruise industry should consider stakeholder participation in cruise policymaking process.

Moreover, the cruise line industry can work with stakeholders such as local port authorities, local maritime associations, the Federal Maritime Commission, Homeland Security, Environmental Protection Agency, US Coast Guard and US Maritime Alliance to improve regulatory authority for accidents and hurricane preparedness in the USA. Data show the seasonal patterns of the hurricane period, with the largest number of hurricanes taking place during the third quarter of each year. Improving regulatory authority would help significantly decrease the amount of accidents in the cruise industry. The CLIA has been working to improve the safety of North American cruise lines. The CLIA is actively communicating the Passenger Bill of Rights to the public and cruise line guests by working closely with the IMO to propose solutions in place of outdated cruise policies.

Future research can be conducted if time series of passenger nights, Table VI as an example, can be collected. Using passenger nights to assess the impacts of seven accident factors (*itinerary change due to mechanical malfunctions, mechanical problems, collisions, fire, propulsion problems, weather* and *others*) will provide a better understanding of customer royalty and price elasticity of demand, which serve as critical indicators in

| Time | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|
| Holland | 5,059 | 4,906 | 5,425 | 5,358 | 5,377 | 5,727 | 5,793 | 6,146 |
| Costa | 627 | 868 | 964 | 877 | 590 | 524 | 806 | 282 |
| Princess | 7,691 | 8,316 | 8,486 | 9,647 | 8,570 | 8,357 | 8,778 | 8,230 |
| Carnival | 17,056 | 17,738 | 18,364 | 19,513 | 19,708 | 21,041 | 22,285 | 23,270 |
| Cunard | 809 | 785 | 749 | 824 | 1,004 | 655 | 658 | 803 |
| Seabourn | 45 | 51 | 53 | 37 | 35 | 44 | 55 | 50 |

**Notes:** [a]Under the parent CCL brand, companies include Carnival, Princess, Costa Cruises, Holland America, AIDA, P&O Cruises, P&O Cruises Australia, Cunard, Ilbero Cruises and Seabourn. CCL encompasses ten subsidiary brands. Within each subsidy, the type of consumers, availability of fleet, flexibility in itinerary and choice of destinations vary. With 24 ships in its fleet, Carnival has great flexibility and options for consumers to reach destinations by sailing from 19 North American departure ports. Consumers can change their itineraries anywhere from 3 to 16 days. Holland, rated "Best Overall Cruise Value," has a 15-ship fleet that offers nearly 500 cruises from more than 25 homeports, with the option to visit all seven continents. Their rooms average 25-50% larger than that of CCL, and itineraries range from 2 to 108 days. Costa Cruises are an Italian-style European cruise line. The cruise line offers the largest selection of sailing dates throughout the Mediterranean and Northern Europe. Princess Cruise, operating a fleet of 16 ships on 115 different itineraries, offers cruises ranging from 7 to 107 days in length, while reaching more than 350 destinations around the globe. Cunard is a traditional luxury-type of cruise that began in 1840. The line combines these years of storied heritage and experience with the three youngest fleets at sea, made up of the Queen Mary 2, the Queen Victoria and the Queen Elizabeth. Seabourn Cruise Line has approximately six ships providing an intimate experience for consumers because of their smaller sizes, carrying fewer than 500 guests. The smaller size also allows this cruise line to travel to destinations where larger ships cannot follow

**Source:** Per Maritime Administration Data, the cruise lines, cruise passengers and departure ports were derived from the US Customs and Border Patrol Vessel Entrance and Clearance documents. *Passenger nights* were retrieved from the Maritime Administration Data and Strategy Cruise data source. To use the data provided, we thoroughly sorted the data by total passenger nights, passengers, nights and normal capacity. These data were organized by quarter and year for subsidies – Holland, Costa, Princess, Carnival, Cunard and Seabourn. We organized total passenger nights by year, then summed the four quarters for each year. Passenger nights shows us where cruise line consumers spend the most time and money

**Table VII.**
Passenger nights (in thousands)[a]

pricing and business strategies. Carnival's total passenger nights have grown significantly over this seven-year span compared to other subsidies, which also accounts for Carnival's growth in the cruise industry. Table VI shows total passenger nights by subsidiaries for the years from 2004 to 2011. Passenger nights were determined by multiplying the number of passengers by total nights. CCL counts for 56.16 per cent of total passenger nights, followed by Princess (24.05 per cent), Holland (15.47 per cent), Cunard (2.22 per cent) and Costa (1.96 per cent). Regarding the overall performance, a dramatic fall in growth happened in the year 2007 when the subprime mortgage crisis started to impact the US economy (Table VII).

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