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EFFECTS OF FLUCTUATING FUEL PRICES ON THE VAR OF THE INDIAN AIRLINE INDUSTRY

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Acknowledgment

The inspiration for my thesis occurred to me during my seminar class "Management Control", encouraged to write a research proposal which if graded highly could be developed further into a thesis. I would like to thank Prof. dr. de Groot for encouraging me to continue writing on this topic although it was slightly diverse from the typical managerial topics.

Prof. dr. de Groot also became my supervisor and it was indeed an honour for me to be writing my thesis under his supervision. I would like to thank my supervisor for it would not have been possible to complete this thesis without his valuable guidance.

I would finally also like to thank my parents for giving me this opportunity to do a double master and my wife for her continuous support and patience with me.

Abstract

This study analyses the effect of changes in the aviation fuel oil prices on the Value at Risk (VaR) of the Indian private sector airlines industry. Further, this research also identifies how value at risk can be minimized by hedging against future increases in aviation fuel oil prices.

The first step is to measure the fuel price volatility. Based on my calculations, both the Brent spot and the ATF spot prices are fairly volatile with volatilities of 59.23% and 66.20% respectively. Using five airlines from India, namely, Air India, Indigo, Go Air, Spicejet & Jet Airways I create a stock index. Next I calculate their VaR at 95% and at 99%. Furthermore, I create three unique scenarios, where I simulate an oil price decrease (backwardation), an oil price increase (contango) and a scenario where the oil prices reflect their true value. Fuel costs, being one of the major component of the VaR, have the ability to influence the VaR levels for airlines. A decrease in aviation fuel prices leads to a decrease in the VaR for the airlines and an increase in the aviation fuel prices leads to an increase in the VaR for the airlines. This study rejects the null hypothesis and accepts the alternative hypothesis stating that there is some association and correlation between VaR and changes in oil prices.

To counter this higher value at risk, airlines have to hedge by going long futures. This way any loss made in the spot market is offset by gains in the futures contract. The optimal hedge ratio is calculated as -0.012105523. As the strike price of fuel is falling below the spot price, the expected VaR at 5% is reducing. Airlines must cash in on the difference in the spot price and the strike price. They must sell any hedging contracts they may have. In other words, airlines must short their futures. Next, using Black-Scholes model the VaR is calculated when hedging as against when not hedging, and the VaR is found to be lower when hedging as against when not hedging. Finally a Monte Carlo simulation is conducted to ensure that the results are reliable.

Airlines should have hedged against aviation turbine fuel increase in January 2016, when the price of ATF was the lowest in the period from (Oct-15 - Mar-16). Since ATF prices are a major component of the VaR, those airlines that hedged in Jan 16 had a lower VaR in the periods following Jan 16. Airlines that did not hedge had a higher VaR in the periods following Jan 16. Also, airlines that have hedge their fuel exposures may also find it profitable to sell cheaper air tickets compared with airlines that have not hedged against oil price increases. These airlines that are able to sell cheaper tickets may also see a decline in the VaR.

A summary of an interview conducted with heads of the risk management department of these airlines is attached as an annexure to this thesis.

Introduction

Background

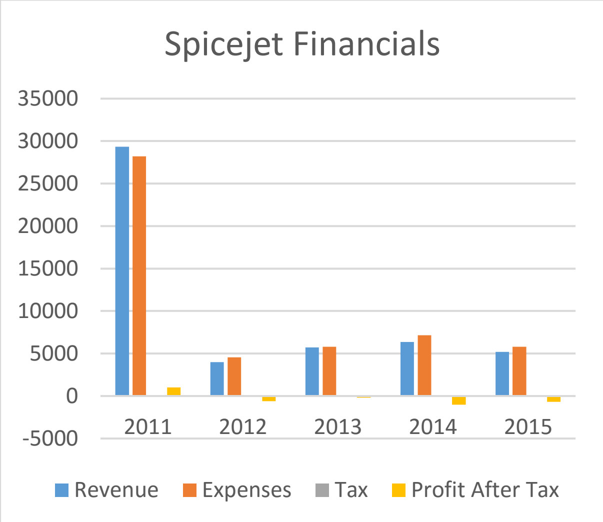
Volatility in aviation fuel prices strongly influences the viability of the air transport sector. It is no different in India and several airlines had to shut shop in the recent past. We are presently witnessing a precipitous fall in the price of oil globally which could as easily reverse direction in the future. Hence this thesis aims to analyse the impact of decline in global aviation fuel oil prices on the Indian aviation industry particularly the private sector. Subsequently I would like to ascertain how this impact could be minimized.

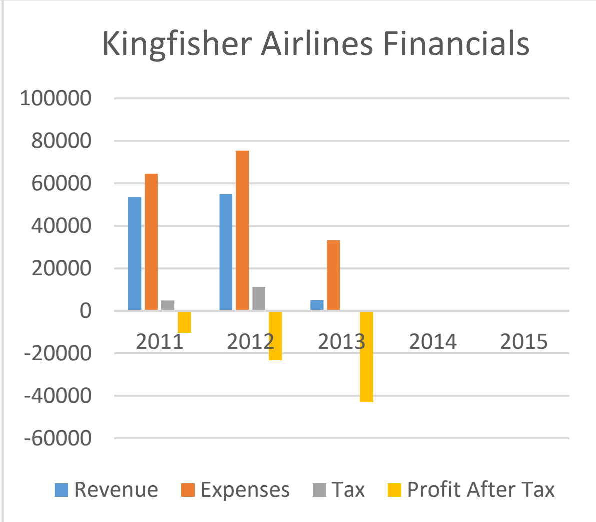
As far as most publicly traded airlines are concerned fuel costs are the second largest operating expense. Prices change for many reasons. They range from increase in supply due to superior technology deployed in exploration, mining and refinery of crude to fall in demand due to global economic slowdown, fluid political situation, efficient engines and improved design of transport equipment which consume less fuel.

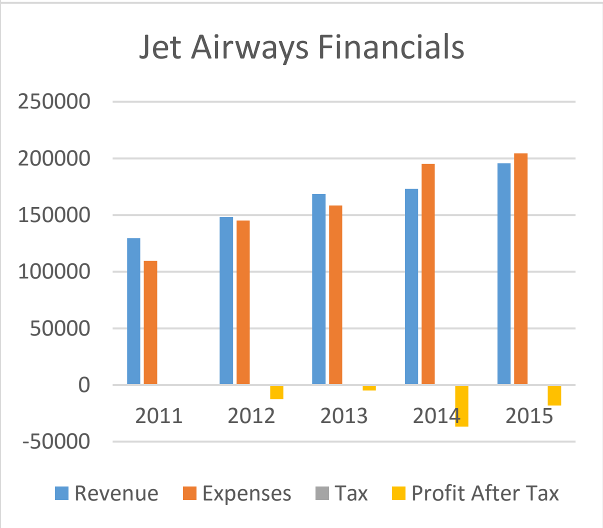
In reality the causes are several and interconnected. Today most of the commodities including aviation fuel are freely traded in open market. Most of the countries of the world today have adopted some form of free market system if not wholly then partially. It is a well-established fact that in a free market, the buyer and seller determine prices depending upon their perception of what the commodity, in this instance ATF is worth. Various factors and events influence the expectations and perceptions.

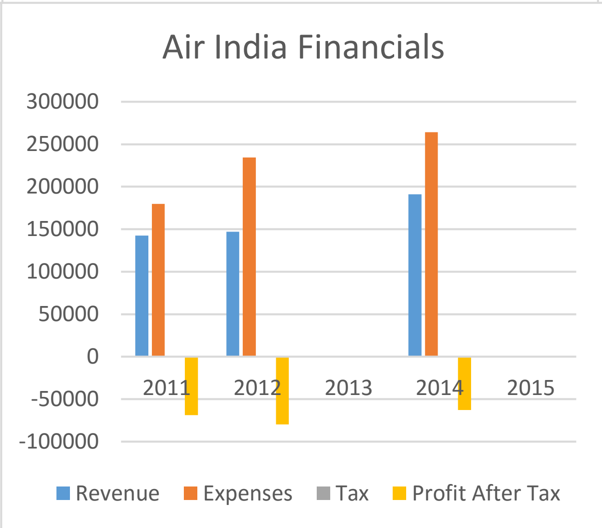
The psychological perceptions of the oil traders are the real underlying reason why oil prices fluctuate. Thus the psychology of the buyer and seller of oil affects the costs of jet fuel for air travel to a certain extent as aviation fuel consumers, traders and manufacturers intensely speculate about the future prices of the aviation fuel with an objective to minimize the risk purely from their psychological view point resulting in greater volatility in the aviation fuel market.

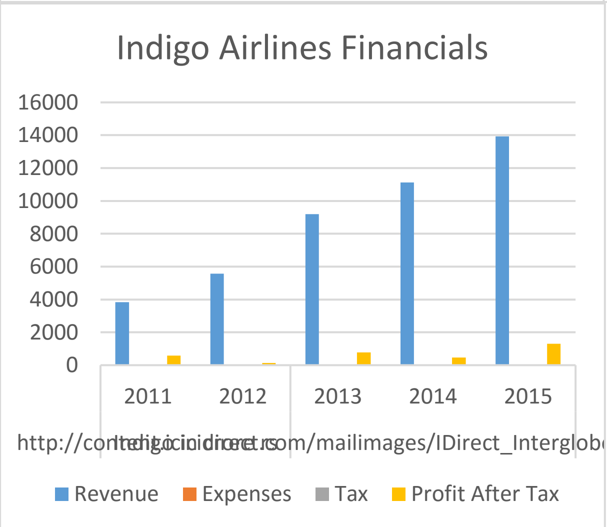
Our research reveals that some Indian airline corporations utilize hedging techniques and fuel derivatives to counteract the effects of volatile oil prices while others pass on the expense on to their customers. Both techniques however do not entirely neutralize all the consequences of the fluctuating oil prices. In order to better understand the impact of the change of oil prices on the airline industry, one must understand the structure of the airline industry in India.











It's an irony that even as new players enter the market due to low barriers of entry; existing domestic carriers are struggling to stay in the air. According to a recent PwC report this is primarily because of a sharp fall in global crude prices which have plummeted by almost 60%. This could help the Indian carriers save up to half a billion US$.

The figures to the left show the financial positions of Spicejet, Kingfisher, Jet Airways, Air India, and Indigo for the years 2011-2015[1].

[1] Source: Bombay Stock Exchange

The problems of excess capacity, aggressive low cost carriers (LCC) lowering ticket prices on key sectors, along with the Indian government's policies emphasising free trade and free competition led to oversupply in the domestic market. As such neither the fuel efficiencies nor the aircraft design systems have undergone major up gradation in the recent past. Hence no company has been able to exploit scale and fuel efficiencies. This makes the aviation industry in India particularly vulnerable to volatility of aviation jet fuel prices.

This is the reason why it is interesting to study the following research question.

Research Question: To what extent do the changes in aviation fuel oil prices affect the value at risk (VaR) of Indian private sector aviation industry?

Sub Question: How can the value at risk be minimized by hedging against future increase in oil prices?

The Indian aviation sector can broadly be bifurcated under two heads. The first is the government owned and operated Air India which is heavily subsidized in every possible manner; the objective being to provide a cheap and affordable airline travel to Indian citizens. The other airlines are privately owned and operated. The private sector aviation in India is highly regulated, but, does not receive any support in the form of subsidies offered to Air India. As such it is extremely vulnerable to changes in aviation fuel prices apart from currency and interest rate fluctuations. Hence even minor changes in the input costs particularly aviation fuel prices can and does drastically affect the business risk of the sector as a whole.

Having assumed that India will be one of major economic power of the 21st century and given its vast geographical size as well as a large population it goes without saying that aviation sector will have a major role to play. This would only be possible if the business model of the sector as a whole is economically viable. As such it is of prime importance to compute the VaR of this industry and ascertain ways and means of minimizing it.

Hypothesis Development:

The first hypothesis states that changes in the aviation fuel oil prices have a positive co-relationship with the VaR of airline industry. In such circumstances to ensure steady cash flow the sector as a whole, as a strategy, attempt to sell journey tickets in advance. In addition, in order to be competitive, they also sell advance journey tickets at deeply discounted prices. Even though the cash flow is secured by selling these discounted tickets, there is a tremendous increase in the value at risk (VaR). This makes the airline sector extremely vulnerable to fluctuating input costs and an upward rise beyond particular level results in the sector compromising on service quality and frequency. A sustained rise eventually results in the bankruptcies and closure of business.

The ATF price volatility is positively correlated with global crude oil prices. As global crude oil prices fluctuates so does the ATF prices. Since ATF prices is a major source of risk for airlines, the amount of risk that the airlines are exposed to fluctuates with the changes in the ATF prices. This brings us to the following hypothesis.

H1: Changes in aviation fuel oil prices has a positive co-relationship with the Value at Risk (VaR) of the airline industry

The second hypothesis follows from the first hypothesis. There is a relationship between oil prices and ticket prices. Oil or aviation fuel being the most important input, a rise in the oil prices will see a proportionate increase not only in the VaR, but also in the price of airline journey tickets. According to Hooker (1996), if the cost of input rises, so does the cost of the final product. An airline will have to pay more to purchase oil, as the price of oil increases, and passes this rise in cost to the consumer as a rise in airline journey tickets.

However, this might not be a viable proposition always, as increase in the prices of tickets could have an adverse impact on sales revenue due to existing competition (Bergman, 2002). As such the airline in question may have to absorb the higher fuel costs which could result in erosion of profits or downright losses as the case may be (Klemperer, 1989).

H2: Airlines that hedge against oil price increases will have a lower value at risk (VaR).

Expected Outcome

The per capita GDP of India is less than 1500 USD. Yet the country is one of biggest economies of the world and the economic growth rate, according to the World Bank, is expected to overtake that of China within two years. Under these circumstances the demand for cheap and affordable airline travel will further rise incessantly in the coming decades. In order to meet this increasing demand several private airlines have set up shop in the country in the past two decades, two of them in 2014. However due to volatile fluctuations in the airline related market costs, in particular aviation fuel oil, most of the entrants had to beat a hasty retreat and withdraw from the markets.

In order to avoid facing similar predicament the airlines have no option but to minimize VaR (while not missing the opportunity to exploit the advantage of declining oil prices). From our first hypothesis we expect the present decline in oil prices to lower the value at risk for these airlines. Since oil prices are still declining, we expect the airlines to **not hedge** as yet (because hedging is a cost which adversely impacts the bottom lines), until they are absolutely sure of no further decline in oil prices. Once airlines do hedge against oil price increases, we could then expect the ticket prices to fall, holding all control variables (competition, taxes, changes in interest rate, changes in exchange rate, inflation) constant. We expect the effect of oil price decrease and drop in ticket prices on the VaR to be ambiguous. Thus the effect of hedging against oil price increases on the VaR becomes clearer. Hence as the oil prices do not decline any further, those airlines that have hedged themselves against increasing oil prices, will see a lower VaR from selling cheaper tickets compared to other airlines that have not hedged.

In such circumstances the future investors and related stakeholders in this sector will naturally be very wary and cautious. This thesis is expected to assist them in evaluating the potential business risk they could face in the future due to increase in aviation fuel oil prices and will identify means of minimizing such risks.

Academic Contribution

This thesis differentiates from existing literature by attempting to link two different topics. None of the studies which have analyzed the impact of oil prices on VaR have simultaneously tried to minimize this exposure. Furthermore, I have focused on the contango effect of aviation fuel oil prices on the Indian aviation sector, for which literature, if available, is rather scarce and not current.

Thesis Structure

In the following chapter I discuss the theory related to measuring and minimizing risk. This is followed by a section on methodology, where I discuss the approach to answer the research question. Furthermore, the 4th section discusses the empirics, where in I present the results relating to measuring VaR and the results for the Black-Scholes Options Pricing Model together with a brief discussion of techniques for hedging fuel derivative positions. In the last section I provide my conclusion and discuss future research.

Theory

Companies are in the business of managing risk. The ones most adept survive, others fail. Company risk is defined as potential fluctuation in future cash flows, cost of raw materials, profits or equity value. Jorion (1997) provides a useful taxonomy of company risk, viz. business risk, strategic risk and financial risk. A company willingly assumes business risk in order to create a competitive advantage and to provide value to its shareholders whereas strategic risk is caused by fundamental shifts in the economy or the political environment. On the other hand financial risk is related to potential losses in financial markets.

This chapter contributes to the growing literature on financial risk management. Earlier studies have explored various kinds of financial risk: credit risk, liquidity risk, market risk etc. In this chapter the focus is on market risk, which is caused by changes in exchange rates, commodity prices and interest rates. This, combined with increased volatility in financial markets over the last decade and a strong growth of derivative products as tools to manage financial risk, has triggered academic and professional interest.

In the finance literature, factor models are used to estimate such exposures. Some well-known examples are Sweeney and Warga (1986) and Flannery and James (1984) who estimate the exposure of shares for the market index and the risk-free interest rate. In general, the exposures of total stock returns for external risk sources can be estimated using this model.

One of the major assumptions of this is that exposures are assumed to be constant. However, due to various factors, these exposures are not constant. The company's activities might cause its exposures to change. Creating a new hedging position or changing its hedging policy can cause the exposures to vary. Also, the perceptions of investors may change over time.

Moving window estimation of the model allows for time-varying exposures. The major drawback of this approach is that the changing exposure might be caused by the new observation that is added to the window as well as by the one that drops out of the window. In the latter case the changing exposure was not triggered by new information. We choose to apply exponential weighting in line with the RiskMetrics approach to estimate exposures.

However according to Culp.et.al., (1998) an airline, might find VaR helpful in assessing its exposure to jet fuel prices; but not for utilization of aircraft capacity. As such the airline industry does serve as an appropriate laboratory for a VaR perspective on risk exposures. There are several reasons for this. The most important reason is that airlines are intrinsically heavily exposed to jet fuel expenses which constitute a significant part of airline costs. This gives rise to commodity price risk.

It is of extreme importance for an airline to know how much risk it faces at any given time and how to measure this risk (Stulz, 2003). As market conditions change, (in our case changes in oil prices) airlines face market risk. Market risk arises from changes in market conditions that yield uncertain future earnings. A method to calculate this risk is called Value at Risk (VaR) (Riskmetrics and Stulz (2003). It measures the z percent chance of losing at least Y over a certain time horizon. A 5% VaR is the dollar amount we do not expect to lose in 95% of the cases (Jorion, 2006). Thus VaR allows corporations to uncover their exposure to financial risk and then try to minimize this exposure. It also allows stakeholders to make informed hedging decisions and avoid expensive failures.

$$Py<Y=z\ \%$$

To calculate VaR, we assume the random variable y is not normally distributed[2]. The distribution is scaled by a factor. This causes a proportionate scaling of the function. This is the power law. The power law is used because it is difficult to collect enough data to accurately estimate the tail of the loss distribution. Riskmetrics measures the exposure of a firm to the market risk by using the market value of a firm. Next the standard deviation of the return is used to measure approximately how much the firm value can move. Riskmetrics also assumes that the returns are normally distributed. The VaR is calculated as follows:

$$VaR_t(5\%) = (2.33\sigma_t V_t)^k$$

Where, the market value and the standard deviation of the firm at point t is given by VaR_t and σ_t. V_t is the market value of the S&P500 Airline index on the first day of the month & k is the scaling factor. We measure the VaR both at 1% and 5% quintile in this thesis.

Minimizing Risk

Black-Scholes (1973) and Merton (1973) showed that forwards, futures, swaps and options are of extreme importance to the finance industry. They demonstrated that a risk free position is created by hedging some of the underlying asset. However, a hedging option can lose or make money and hence carries with it some speculation. Poitras (2002) explained that with the goal

[2] Normal distribution is well disputed specially with regards to risk and VAR.

of minimizing the risk exposure, an optimal risk strategy is also required for profit maximization. Morell and Swan (2006) demonstrated that oil prices are more volatile than any other costs for an airliner. This oil risk has to be factored into the strategic planning (Lu, Chen, 2010).

Airlines face high financial distress costs (Carter, et al. 2006). These are costs incurred as firms go bankrupt. The probability of going bankrupt can be minimized by hedging by reducing the variance of firm value (Mayers and Smith, 1982; Smith and Stulz, 1985). One benefit of risk management is that it reduces such distress costs (Stulz, 2003). According to Stulz, to see if hedging creates value for the firm, one must compare the costs of hedging to the decrease in distress costs. Firm value can be increased if hedging costs are lower than distress costs.
When future prices are less than spot prices we say the market is in backwardation. In the last few decades (as is the case presently too) future prices of oil were in 'Normal Backwardation. (Geman and Kharoubi, 2008). Furthermore, with volatility in oil prices, cash flows of airlines also become volatile. As such there is a higher investment probability as jet fuel costs increase which correlates with a lower cash flow (Carter, et al. 2006).

Modigliani and Miller (1958) show that in frictionless world investors identify and hedge their exposures and do not pay premium for hedging. However according to Cartel et al. (2006), who had analyzed the US airline industry, mentioned that a hedging premium of 5% to 10% for 2001 to 2003 period had to be borne by the industry to reduce the risk. Empirical results also show there is a negative and significant relation between the ratio of fuel costs to operating costs at time t and the hedging percentage at time t-1. As such there also exists a positive and significant relation between this ratio of fuel costs to operating costs at t-1 and jet fuel prices at t. This can be interpreted as proof that hedging reduces fuel costs (Isin, et al. 2014).

Figure 5 below shows the value at risk margins for Jet Airways, Indigo, Kingfisher Spicejet and Air India for 2014. We observe from the graph that these margins are lowest for Jet Airways, followed by Indigo & Spicejet. The VaR margins for Kingfisher are extremely high. This airline company became bankrupt in 2013. One of the major reasons for this high Var Margin was that the company had undervalued its value at risk.[3] This data was unavailable for Air India.

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[3] Discussion with a former employee holding a senior post in the risk management department of kingfisher. See annexure.

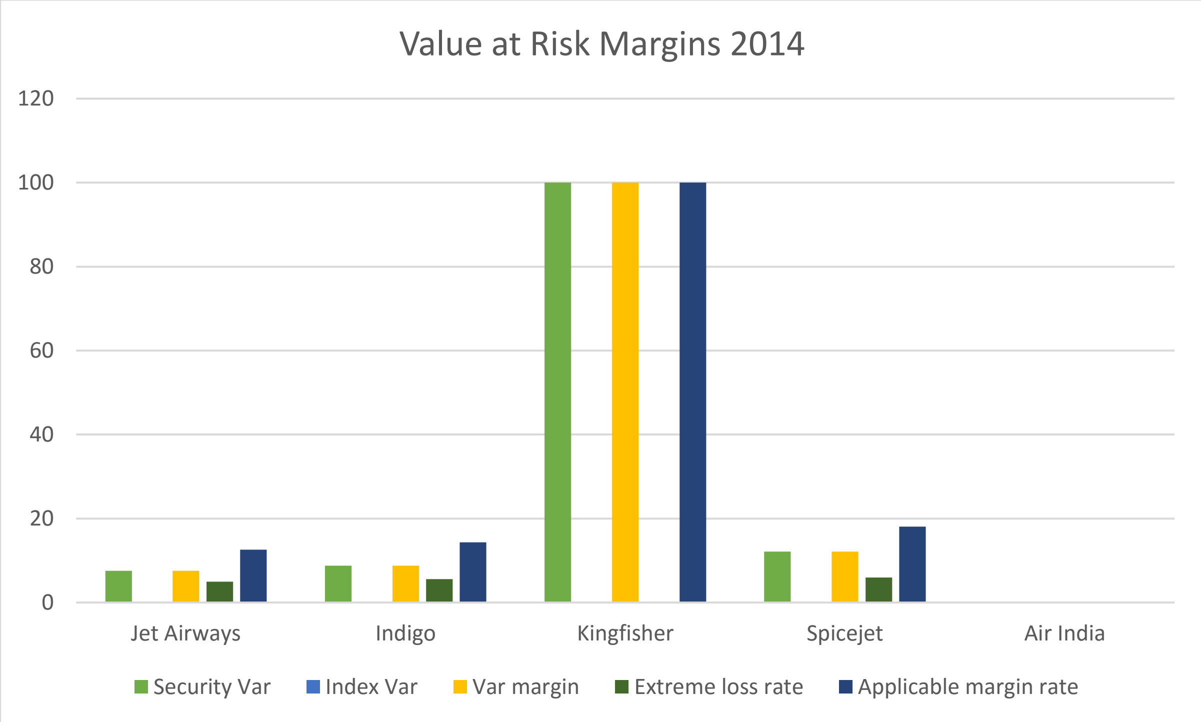

Figure 5: VaR Margins for Jet Airways, Indigo, Kingfisher, Spicejet and Air India.[4]

Fuel Volatility Risk

As discussed in the earlier chapters' fuel costs could account for about 40% of an airline's total operating cost. Thus fuel price volatility contributes significantly to the instability and business risk of the airline industry. In order to minimize the fuel volatility, risk several risk management measures are employed by the airline companies. One of such measures is adoption of financial hedging strategies which are based on the projected fuel consumption and the forecast of fuel price in the future.

In practice airlines adopt levying of fuel surcharges as well as fuel hedging strategies to protect themselves against fuel price volatility. Under the surcharge system, fuel surcharges are added to the tariff payable by the customers to be paid by the customers to the airlines in order to offset the rise in fuel prices. This enables the airlines to transfer the risk of fuel price volatility to the customers. However, such surcharges, as expected, are quite unpopular among the customers as they contribute to unpredictability of tariff rates (Menachof and Dicer, 2001). Many customers argue that the fuel price risk of the airline should be dealt with in a more transparent way than the fuel surcharge (Wang et al, 2011).

[4] Data not available for Air India

Apart from charging the customers with the fuel surcharge, hedging is the most widely used strategy adopted to minimize the impact of fuel oil price volatility. As such, by adopting effective hedging practices, the policy of levying surcharges and its negative implications can be minimized. There is an extensive body of work that shows the positive impact of hedging on a firm's value in the presence of risks. Recent papers include Carter et al (2006), Jin and Jorion (2006). Samitas and Tsakalos (2010) find that firms that practice hedging have better net cash flow than non-hedgers.

Menachof and Dicer (2001) have compared the effectiveness of fuel surcharge with oil commodity futures contracts and find that fuel hedging strategy using fuel futures contracts is more effective than fuel surcharge in minimizing risk. Alizadeh et al (2004) have investigated the effectiveness of using different fuel futures contracts to hedge against fuel price fluctuations and found that hedging effectiveness varied across different regional fuel markets and different fuel types.

The above section pertains to the literature overview and prior research of VaR and hedging. In the following sections we will see the practical application of the above mentioned theory.

Methodology

This thesis analyses the effect of changes in the aviation fuel oil prices on the Value at Risk (VaR) of the Indian private sector airlines industry. Further, this research also identifies how value at risk can be minimized by hedging against future increases in aviation fuel oil prices. In the following sub sections we will apply the theory presented above.

Measuring Risk

VaR can be measured by using the standard normal method, a historical simulation or by using a monte-carlo simulation. Power law distributions which is the log of the volatility over log of time interval can also be used to measure risk. Firms that do not use the power law to calculate their VaR may be under prepared for large events that would normally not occur under a normal distribution but extremely common in the real world.

One advantage of VaR is that it captures risk in one number, making it easy to understand. VaR first emerged in the trading community. The objective of VaR was to systematically measure a trading firm's risk exposure across its dealing portfolios. Regulators' interest followed soon after. Both the SEC and the Basle Committee consider VaR a sound approach to meet risk reporting requirements.

In recent years the Value at Risk (VaR) concept for measuring downside risk has been widely studied. VaR quantifies the exposure of an asset or portfolio to market risk. Jorion (1997) provides an extensive discussion on Value at Risk. His definition is:

"The Value at Risk is the worst expected loss over a given time interval under normal market conditions at a given confidence level".

VaR has been developed for financial firms to evaluate (trading) portfolio risk. The inherent simplicity of the concept greatly facilitated dealers' reporting of risks to senior managers and directors. The popularity of VaR nowadays owes much to Dennis Weatherstone, former chairman of JP Morgan & Co, Inc., who demanded to know the total market risk exposure of JP Morgan at 4:15pm every day. Weatherstone's request was met with a daily VaR report. Various methodologies have been developed to estimate VaR.

It is of extreme importance for an airline to know how much risk it faces at any given time and how to measure this risk (Stulz, 2003). As market conditions change, (in our case changes in oil prices) airlines face market risk. Market risk arises from changes in market conditions that yield uncertain future earnings. A method to calculate this risk is called Value at Risk (VaR) (Riskmetrics and Stulz (2003). It measures the z percent chance of losing at least Y over a certain time horizon. A 5% VaR is the dollar amount we do not expect to lose in 95% of the cases (Jorion, 2006). Thus VaR allows corporations to uncover their exposure to financial risk and then try to minimize this exposure. It also allows stakeholders to make informed hedging decisions and avoid expensive failures.

$$Py<Y=z\ \%$$

To calculate VaR, we assume the random variable y is not normally distributed. The distribution is scaled by a factor. This causes a proportionate scaling of the function. This is the power law. Riskmetrics measures the exposure of a firm to the market risk by using the market value of a firm. Next the standard deviation of the return is used to measure approximately how much the firm value can move. Riskmetrics also assumes that the returns are normally distributed. The VaR is calculated as follows:

$$VaR_t(5\%) = (2.33\sigma_t V_t)^k$$

Where, the market value and the standard deviation of the firm at point *t* is given by VaR_t *and* σ_t. V_t is the market value of the S&P500 Airline index on the first day of the month & *k* is the scaling factor. We measure the VaR both at 1% and 5% quintile in this thesis.

In October 1994, JP Morgan released their RiskMetrics methodology, which consists of two steps. First a portfolio's exposure to pre-specified risk sources is identified. These sources relate to bond, equity, foreign exchange and money markets. Second, the portfolio VaR can be estimated using JP Morgan's data sets containing variance and covariance forecasts for these risk sources.

Statistically, RiskMetrics is based on time-weighted moving averages, where the weights decline in an exponential fashion. The covariance matrix forecast is equal to an exponentially weighted sample variance. This is equivalent to an IGARCH estimate. Extensive empirical research suggests a decay factor of 0.94 for daily observations and a decay factor of 0.97 for monthly observations.

The major virtue of the RiskMetrics framework is that it provides an easy-to-use risk estimate. Since it keeps track of the correlation between different financial series, it is an integrated approach. RiskMetrics tgrough its exponential weighting accommodates a time-varying volatility by considering recent shocks more important. As Stulz (1996) puts it, "It is relatively simple to calculate VaR for a financial institution's portfolio over a horizon of a day or a week. It is not very clear how one would compute VaR associated with, say, an airline's ongoing operating exposure to oil prices."

Monte Carlo Simulation

Monte Carlo simulation is implemented to support not only one-factor model but also multi-factors ones, because it can include many sources of uncertainty in its simulations. Thus, it may be used to value options and derivatives depending on two or more energy prices, as well. Introduced by Boyle (1977) to value the options, the Monte Carlo method simulates the possible paths that the prices, as well the payoffs, can undertake until the option maturity. So, the evolution of spot prices, expressed by the GBM, is simulated through random samples from a standard normal. For instance, if we wish to simulate the fuel spot prices evolution, we need to divide the time period into N intervals and repeat the simulation process N times. In this way, we can obtain the possible path of the spot price. At the end of the process, we calculate the option price with the Call or Put formula

The Monte Carlo method is similar to historical simulation but it differs because, instead of conducting a simulation using the data from the past, it generates a statistical distribution approximating the future changes of market factors. For example, in the case of an energy forward contract, it generates thousands of changes in spot commodity price so as to construct a portfolio of hypothetical profit and loss: VaR is then computed from this distribution.

There are five steps to perform a monte-carlo simulation, namely:

1) Identifying the market factors and expressing the value of the financial instrument in term of these factors, that in our case means expressing the energy forward contract in term of the spot commodity price;

2) Assuming a statistical distribution for the changes in market factors: risk managers are free to choose any distribution that they believe approximating the future changes (observed past changes, beliefs may influence it);

3) Using a random generator for N hypothetical changes in market factors (N may exceed 1000 or even 10000) to generate N portfolios of profit and losses;

4), 5) are the same as in historical simulation (Linsmeier and Pearson, 1996).

The drawback of Monte Carlo method is that simulations take a longer amount of time, since portfolio has to be revalued many times.

Hedging of Risk

Airline companies often use financial derivatives to minimize the fuel price volatility risks. A derivative is a financial instrument whose value depends upon the values of other underlying variables, such as prices of traded commodities, currencies, bonds or equities (Hull, 2009). As such, hedging refers to the taking of a futures position vis-a-vis the present position in order to minimize risk due to price fluctuations of the latter. The most frequently used derivatives by airlines, to hedge against fuel price fluctuations, are fuel futures contracts, fuel forward contracts, fuel call options and fuel swaps.

A fuel futures contract is one that requires the airline to buy certain quantity of fuel at a predetermined price at a particular date in the future. (As there are very few exchanges in the world offering fuel futures contracts for eg; SGX – Singapore Exchange. But the trading volume of fuel futures is still insignificant.)

On the other hand, cross-hedging refers to the hedging of a commodity with a futures contract of a related commodity, which is traded on exchanges such as New York Mercantile Exchange (NYMEX) The trade is expected to be completed by a specified date, and if the contract is not sold before that date, it becomes a physical contract of delivery. However, vast majority of the contracts are sold before the expiry of the date (Lerner, 2000).

A forward contract is an OTC (over-the-counter) derivative, i.e. a contract traded directly between two private parties, without going through an exchange. For instance; an OTC contract between a seller and a buyer is an agreement to exchange a specified quantity of fuel at an agreed price, at a specified delivery location and time. According to the terms of the contract, settlement is made on the difference between the agreed price and the spot price of fuel at the delivery point on the expiry date. However, when the contract expires, the buyer will have to buy back the fuel at the agreed price from the seller.

On the other hand, a fuel call option is not an agreement but gives the airline the right, but not the obligation, to buy fuel within a certain period of time at a specified price. Fuel call options are usually bought to insure against unexpected contingencies. (They not only protect the air lines from adverse fuel price movements, but also enable them to benefit from potential favorable fuel price movements.) Though, this is not always the case if the airline can exercise the option, for whatever reason and if it does so the seller must honor the transaction. The option seller in turn receives a premium from the air line when the option is purchased. (Options are traded in both OTC and exchange-based markets, such as NYMEX and ICE.)

However, a fuel swap is in essence a series of fuel forward contracts with different maturing dates and is the most popular OTC instrument used for hedging against fuel price fluctuation. The agreement facilitates both the buyers and sellers of fuel oil in conversion of the floating price to a fixed price, for a certain period. The floating price is based on published sources, whereas the fixed price is derived from the floating price itself. The airlines enter into fuel swaps with the floating price players, who are usually investment banks or fuel traders.

All the hedging instruments described above (except call options) offer the benefit of protection against contango markets without the payment of upfront premium (again except all call options). In addition, they also offer the benefit of exploiting the advantage of lower prices in the eventuality of fall in market prices. Thus by using fuel swaps, air lines exchange floating fuel price risk for fixed fuel price risk. In most cases, the difference between the floating and the fixed price is settled in cash. In practice, however, the airlines use both fuel surcharge and fuel hedging strategies in order to minimize its fuel price risk.

It is obvious from the above that net cash flow to the airline is essentially the difference between fuel surcharge and the swap price which is fixed. In this manner no matter how much or in which direction the fuel price changes, the net cash flow is unchanged and the profit margin is thus secured. An airline will normally hedge three to six months ahead if it is of the view that fuel prices are expected to rise. Fuel swaps are used most of the time to lock in the fuel price. While on the other hand call options are used for the separate purpose of limiting the fuel price at certain level.

Implementing the Hedging Strategy

On the basis of the future fuel requirement, the finance department of an airline company will decide on the proportion of the fuel requirement to be hedged by using appropriate hedging instrument. Most airlines calculate estimated fuel costs based on the 'average' forecasted fuel price. Usually an airline adopts a two-month planning horizon for its bunker hedging practice and the hedging decision is made at the beginning of each month. Subsequently, three scenarios of price developments are chosen as follows:

Scenario 1: Market with upward price movement where fuel prices are likely to rise.

Scenario 2: Highly uncertain market where there is no clear trend in the fuel price movement.

Scenario 3: Market with downward trend where fuel prices are likely to fall.

In order to implement a successful hedging strategy which will perform equally well in different environments, a combination of hedging instruments such as swaps, call options and collars, among others, which are colloquially termed as exotic hedging instruments, are used.

Usually airlines engaged in hedging strategies also conduct a "stress test" of their hedge portfolio on a regular basis in order to analyze the performance of their individual hedge positions, in all potential price environments. These tests include price risk, apart from, credit and operational risks too. Airlines do not solely depend on their fuel suppliers, banks or trading counterparts to provide them with potential hedging strategies as simply accepting the recommended hedging structure is often not in the airlines best interest as the other parties usually adopt a counter position to hedge their own bets.

To begin with, the airlines hedging strategies should be appropriately aligned with the financial goals and objectives; for is the goal of the airline to ensure minimal exposure to cash flow volatility caused by fuel price volatility? It is only after answering such questions should an airline begin to develop and implement a hedging strategy.

In addition, there are a number of common hedging mistakes that airlines should avoid at all costs. First, it is crucial to remember that hedging should not be intended as a potential source of revenue. If an airline initiates a hedging program with the primary goal of generating revenue, then, it is no longer attempting to minimize the volatility risk instead is merely indulging in fuel market speculation.

After taking into consideration the above mentioned facts, we can conclude that minimization of fuel risks strategy of an airline, in reality, depends upon its ability to precisely forecast fuel oil prices in the future. This in turn depends upon their ability to collect necessary data in real time and process it quickly by employing sophisticated econometric models. Subsequently, once the risk is so computed the airlines need to find a suitable counterparty that is willing to enter into a suitable hedging arrangement

Date Sources and Feasibility of the Research

In order to investigate the effect of oil prices on the VaR, I will use the following datasets. For the oil prices I have used both the Brent Crude Oil spot price in USD and the Aviation Turbine Fuel (ATF) spot prices in India in USD. Also, oil prices can be obtained from the Western Texas Intermediate (WTI) which is used as a benchmark in oil prices. Since world oil prices are unified, there is little or no difference between the two prices. As a good indication of the overall airline industry I will use the S&P500 Airline index. I will collect data for past 15 years as the aviation fuel prices have experienced huge price swings during this period. With regards to airlines I have used data from two airline stock price indices, namely the Bombay Stock Exchange Index and a specially developed Indian Airline Index. Both are indices that include the stocks of a number of airlines and give a good indication of the airline industry as a whole. For futures contract I have used the price of a constant 18-month maturity contract.

In the following section I present my results related to the VaR and the Black Sholes options pricing model. I also test the hypothesis of this study in the section below.

Empirics

This section will discuss the empirical results found during the research. First The Indian Airline Stock index is created to understand the effect of fluctuating oil prices on the indian airline industry as a whole.

Measuring Fuel Price Volatility

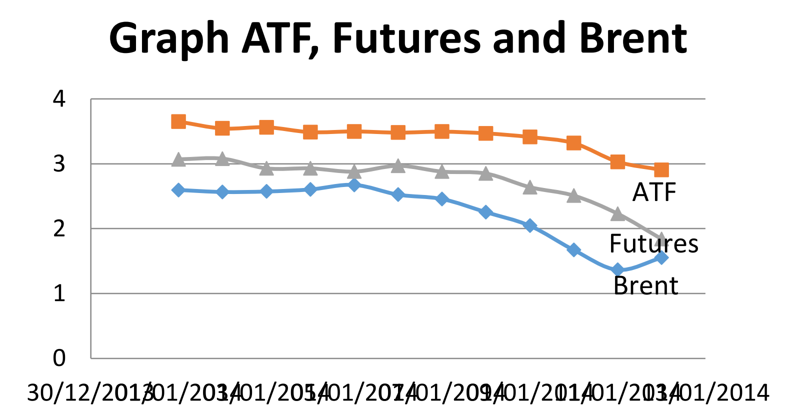

Figure 6

As can be seen from Figure 6 & 7, for the most part of 2014 the oil price has been fairly stable. During this period of oil price stability, the stock price indices have increased significantly. The fact that the airline stocks increased in value following a period of oil price stability supports the theory that with stable oil prices airlines have a more stable cash flow, which enables them to invest on a continuous basis and grow as a firm.

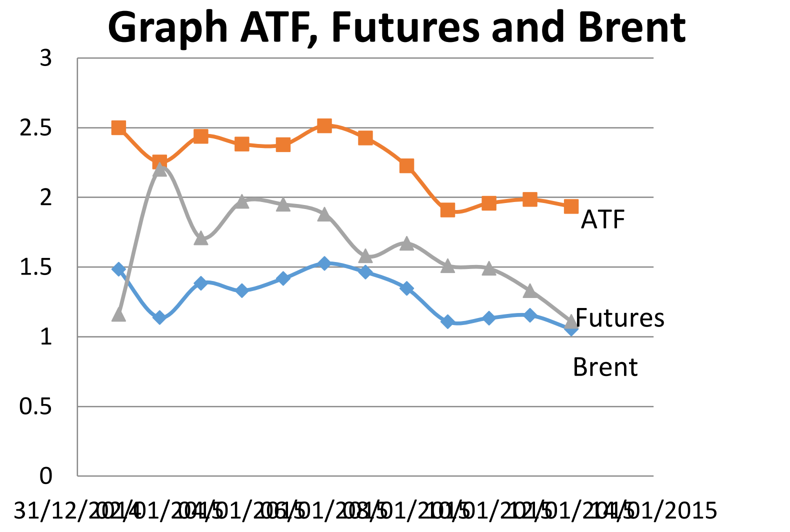

Figure 7

Constructing the Indian Airlines (IA) Stock Index

In order to develop the Indian Airlines (IA) Stock Index we have taken into consideration the monthly stock prices of the five selected airline companies and have allotted weightings to them depending on their market share. Subsequently I have multiplied the allotted weightings with the market share and have ascertained the average of the products to arrive at the monthly Indian Airline (IA) index. Table 1 below shows the Indian Airlines Stock Index from 01/01/2014 to 01/12/2015. The stock index average was 177.2028.

Date	IA Stock Index
01/01/2014	41741.64
02/01/2014	41739.03
03/01/2014	41746.41
04/01/2014	41744.01
05/01/2014	41737.12
06/01/2014	41733.86
07/01/2014	41744.05
08/01/2014	41780.52
09/01/2014	41806.38
10/01/2014	41858.77
11/01/2014	41829.66
12/01/2014	41849.12
01/01/2015	42159.94
02/01/2015	42164.67
03/01/2015	42125.11
04/01/2015	42177.31
05/01/2015	42149.68
06/01/2015	42145.27
07/01/2015	42192.89
08/01/2015	42612.68
09/01/2015	42672.05
10/01/2015	42014
11/01/2015	42015
12/01/2015	42016

Table 1: Indian Airlines Stock Index

Correlation between IA Index & Fuel Volatility

POPULATION VARIANCE/COVARIANCE MATRIX

	BRENT	***ATF***	***FUTURES***
BRENT	0.33620	0.33410	0.33928
ATF	0.33410	0.38610	0.37341
FUTURES	0.33928	0.37341	0.41999

Table 2: Correlations between IA Index & Fuel Volatility.

Table 2 above displays the correlations between the airline stocks, crude oil, ATF and futures prices. The results are exactly as expected; the airline stocks and the crude oil price are negatively correlated. The correlation underlines the fact that costs of fuel are a big part of an airlines cost and an increase in them will have a direct effect on the airline profit margin and stock price. An interesting result is that airlines are not correlated with future prices, even though the future prices themselves are heavily correlated with the crude oil price. This shows that the speculation of the future market does not influence airline stock, probably due to the fact that airlines in India do not use the future markets themselves to hedge against the oil price risk. Based on my calculations, both the Brent spot and the ATF spot prices are fairly volatile with volatilities of 59.23% and 66.20% respectively.

The futures price are also important to look at when you consider oil price risk because it shows what speculators think the oil price will be in the future. The futures market offers some indication of the uncertainty present in the current oil markets by comparing spot prices with future prices (Kesicki, 2010). What is most interesting of the oil futures market is how the future price influences the spot price. One way to look at this relation is the following: when speculators bet on future contracts with a higher price than the current spot price they expect the market to go up and this higher price will be fed back into the spot price and vice-e-versa.

A higher futures price means providers of oil will hold off selling their oil driving the price up. Schwarz and Szakmary (1994) proved this direct linear relationship in their research. However other studies like the one from Silvapulle and Moosa (1999) find that there exists a bi-directional relationship between future price and spot price. This suggests that they can both influence each other. It is therefore interesting for us to look at situation when the future market is either in Contango (Future price > Spot price) or Backwardation (Future price < Spot price) (Stulz, 2003).

In a little over two years the price of the Brent Crude Oil Spot has decreased from over USD 130 on 01/01/2014 to a low of USD 40. The effects this has on the airline indices can be seen clearly. We can conclude from this that even under a steadily decreasing oil price, airlines can manage their costs probably using hedging techniques and building up reserves. However, when oil prices vary rapidly, the airlines do come into trouble.
What can be concluded from this scenario test is that during periods of a steady oil price or a steady variation, airlines are able to grow, most probably due to hedging and other measures that anticipate a variation in oil price. However, when the oil prices start to vary rapidly, the heavy dependence of airlines on oil prices is starkly exposed. The rapid increase in the period from 2007-2008 preceding the financial crisis in 2008 affected the airlines significantly. Airlines could not keep up with the increased costs and their value decreased. Therefore, we can say that oil price risk is crucial for airlines, especially during times of crises.

Measuring VaR

Now that we have looked at the relationship between the oil price and the airline stock price indices and have also looked at future prices we can take a look at the Value-at-Risk for airlines. To compute the Value-at-Risk I have used monthly data from the IA index. Table 3 below shows the value at risk (at 95% and 99%) for the airlines. As described in the previous chapter I have calculated both the VaR for the 1% and the 5% quantile, calculating the probability of 1% or 5% that a loss will exceed a certain amount. The formula's can be found below:

$$VaR_{t_{1\%}} = 2.33\sigma_t V_t$$

$$VaR_{t_{5\%}} = 1.65\sigma_t V_t$$

VaR	JET	KF	Global VEC	Indigo	IAS INDEX
95%	6.45	6.98	5.53	5.43	6.45
99%	9.11	9.86	8.18	8.18	9.72

Table 3: Value at Risk for the Airlines

For overview purposes I have calculated the monthly instead of the weekly VaR for the period of January 2014 until now. The annual standard deviation (σt) is the standard deviation of the monthly returns multiplied by the square root of the number of trading days of data of the year which is approximately 252. The *Vt* is the market value of the IA index on the first day of the month.

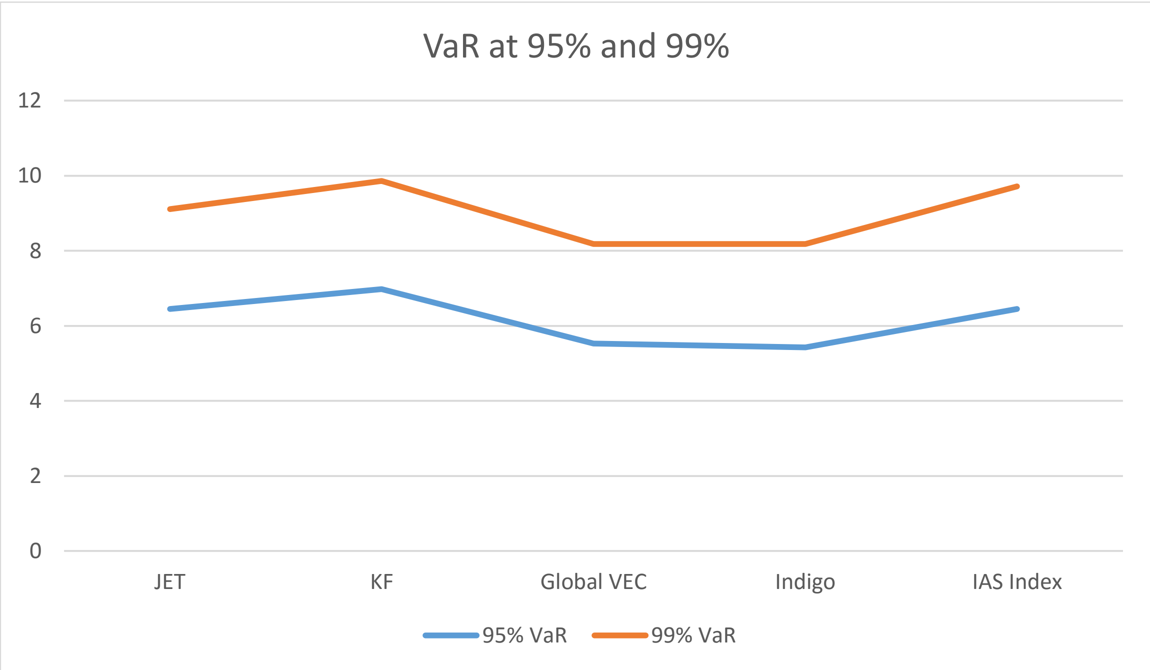

Figure 8: VaR at 95% and 99%

As can be seen from figure 8 above the VaR(99%) line lies above the VaR(95%) at all times. This is because I have assumed a normal distribution of returns, therefore a higher probability of a certain loss will yield a lower amount of Value-at-Risk. To calculate the accuracy of this Value-at-Risk measurement, I have used the *RiskMetrics* back testing method to compute the realized percentage of VaR violations. The realized percentage of VaR violations shows the amount of times the actual profit or loss, computed by using the market value of the first and last day of the month which exceeds the amount indicated by the VaR method. As you can see all values are below 1% or 5% respectively. We can therefore conclude that these VaR are accurate. Now that we have concluded that the Value-at-Risk calculations are accurate we can look at their relation to the crude oil spot price and its implications.

To be able to compare them I have computed the Brent monthly oil price using the weekly data and turned them both into price indices with January 2014 as a base value. As you can see from the Figure, no clear relation can be discovered between the oil price and the VaR. This data mostly supports the argument that under a constant or steadily increasing oil price, airlines are able to manage the oil price risk. The VaR will only move with the oil price during periods of significant oil price variations.

Considering all the above mentioned statements it can be concluded that during periods of increased Value-at-Risk airlines stocks lose value. As said before when the probability of default increases consumers, suppliers and banks will be less likely to invest in the firm and the firm will start to face financial difficulties. Therefore, VaR is an important measure for firms and can be a predictor of difficult economic times ahead.

Alternatives to Value-at-Risk

Deciding which of the described VaR methods is the best one is not an easy task: it depends on the risk management system. As a consequence, it is interesting for this work to come up with a choice of the most adequate method to measure risk in a portfolio of energy derivatives. Clewlow and Strickland (2000) examined the three methods that energy companies use to compute VaR in a portfolio of energy derivatives and outlined the main advantages and disadvantages of each of them.

Despite its popularity, VaR has some drawbacks. First of all, it can be insufficient when there are big changes that are it does not tell us what happens in 5% of cases, when the potential loss exceeds the threshold. VaR is not able to provide information about the magnitude of the loss, when the 95% confidence interval is violated, a likely scenario in the energy markets.

If a portfolio is exposed to few market factors, the *sensitivity analysis* consists in trying to figure out the hypothetical changes of them, and to compute the value of the portfolio given these changes. It is easy to understand how it may become complex when there are many market factors varying at the same time, whose changes are not easily predictable. As a consequence, it is not a suitable method for a portfolio exposed to multiple factors, like the energy derivatives one.

To wrap up, we can say that nowadays VaR is the most popular technique for risk management in energy companies. It is very straightforward and provides satisfying results for risk management and energy derivatives. Among the techniques to apply it, Monte Carlo results to be the most suitable for a changing environment like the energy one, allowing incorporating of changes, multiple risk factors and volatility jumps in its simulations.

Developing a Hedging Strategy

Aviation Turbine Fuel (ATF) costs have been fluctuating for the past several years which adds considerably to the operating risk and profits of the airline sector all over the world. However, it is not easy to mitigate the risk entirely by developing a suitable hedging strategy. This is because the market for ATF derivatives is not adequate enough hence airlines usually use futures contracts of commodities which are highly correlated ATF such as crude and heating oil.

The Indian domestic airlines have a variety of hedging strategies available to them which they can use such as over-the-counter (OTC) and exchange-traded derivatives or remain unhedged. At present the Indian airlines sector in India prefers to remain unhedged. This strategy enables the airlines to lock in prices at a lower price in order to exploit future price decline.

As these futures contracts are based on a commodity other than ATF, a basis risk is introduced because they are not perfectly correlated. Basis is generally defined as:

*Basis Risk = spot price of hedged item * futures price of selected contract.*

As such basis risk can be considered to be a function of the spread between the spot price and futures price. Hence the optimal hedge ratio considers the basis risk as the keystone of the futures contract.

The relationship is explained by the following formula:

$$\Delta \text{ Jet Fuel Spot Price. } H * \Delta \text{ Futures contract}$$

Where H is the hedge ratio.

The value of H determines the number of futures contracts. It is calculated as follows:

$$H = \rho * \sigma [spot] / \sigma [futures]$$

Where:

ρ: the correlation between the spot jet fuel price and selected futures contract

σ: the standard deviation, or volatility, of each respective contract.

The optimal hedge ratio was calculated as -0.012105523. As the strike price of fuel is falling below the spot price, the expected maximum loss at 5% or the VaR at 5% is reducing. Airlines must cash in on the difference in the spot price and the strike price. They must sell any hedging contracts they may have. In other words, airlines must short their futures.

By not opting to develop a hedging strategy the airlines are accepting the risk of rising ATF prices into their business model. Some airlines claim that this risk is present regardless of whether they hedge or not. However, when fuel prices rise unexpectedly then the airlines have to absorb if not fully then at least partially the additional costs as they are unable to pass on the incremental costs on to their customers. The hedging premium can be compared to the benefits an airline reaps by generating stable cash flows and consistent profits.

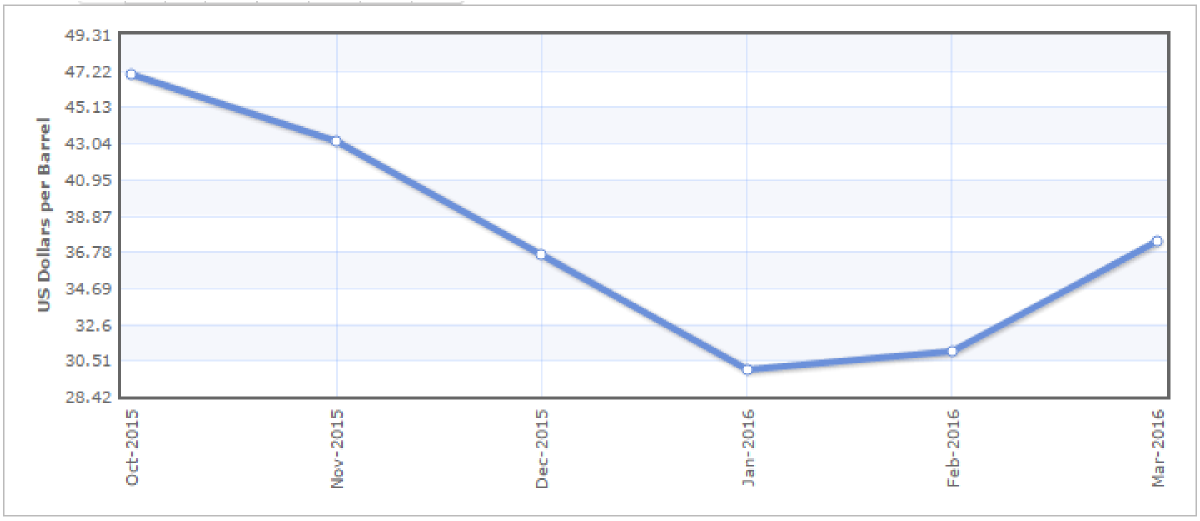

Figure 9: Crude petroleum prices in US Dollars/barrel for the last six months

Many airlines attempt to hedge some portion of the future cost of ATF. In large part, they do this by purchasing futures contracts of crude oil or heating oil as the prices of the three commodities are fairly correlated and as such in the long run, if the price of crude oil goes up significantly, the price of the refined products also goes up. But this is not always the case particularly in the short run.

When airlines choose the mix of contracts that make up their hedging strategy, they have to factor in the 'cost' paid for each type of contract and find the cheapest mix. They then have to weigh the total 'cost' of hedging against the benefits in order to arrive at their chosen hedge ratio.

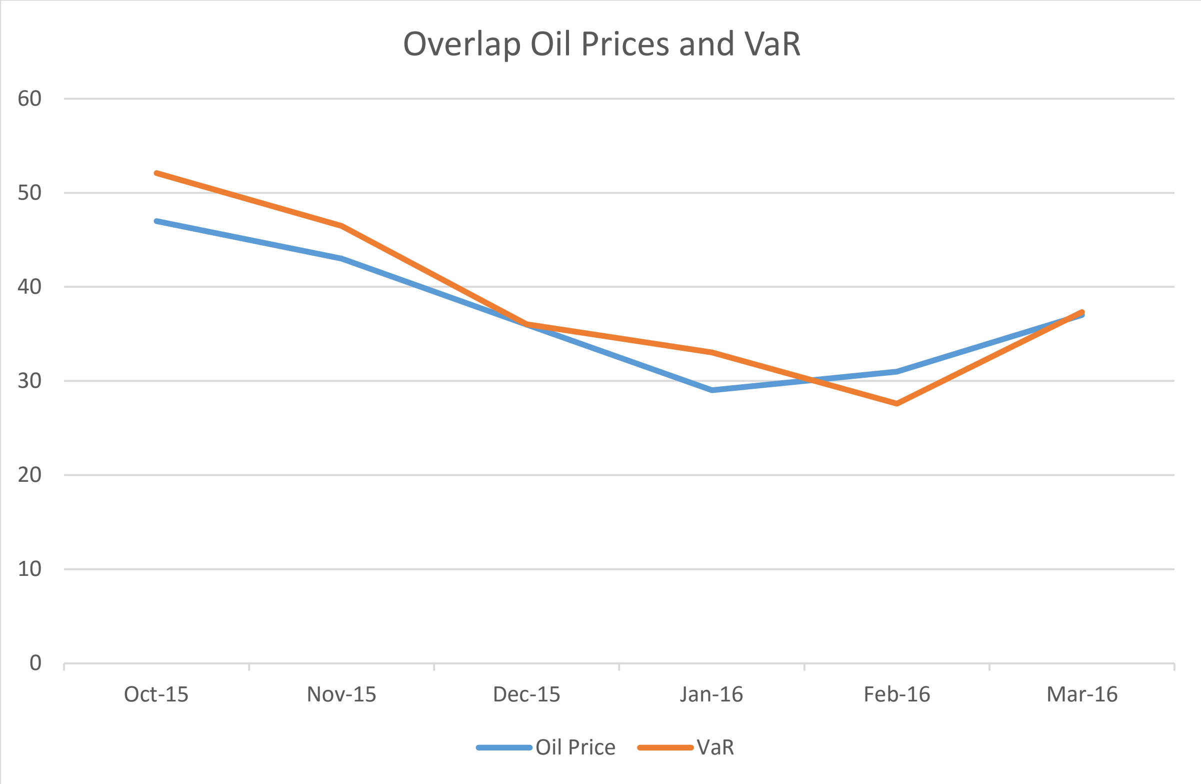

Figure: 10: Overlap Crude petroleum prices in USDollars/Barrel and VaR

Figure 10 shows us that as the crude oil prices reduced over the last six months, there is also a reduction in the VaR reported by the airlines. This suggest a direct relationship between the Crude oil prices and VaR. This further tells us that Crude oil prices are one of the major component of VaR.

Black-Scholes Option Pricing Model

An option is a financial contract that allows the purchase or sale of a given asset, such as a stock, bonds, or commodity, for a predetermined price on a predetermined date. The contract is named as such because the transaction in question is optional for the purchaser of the contract. Options are bought and sold because they allow firms with risk exposure to hedge against potential price fluctuations.

The question that begs an answer is the price of the option we have to pay for the privilege of purchasing an asset at a fixed price on a future expiration date? The difficulty with this question, of course, is that while we know the asset’s previous prices, we are uncertain as to its future price. In a seminal paper from 1973, Fischer Black and Myron Scholes introduced what is now known as the Black-Scholes Option Pricing Model. They had a key insight that a firm which had sold/purchased an option could "hedge" against the future cost/return of the option by buying and selling the underlying asset as its price fluctuates. Their model is based on stochastic calculus and requires a critical assumption that the asset's price behaves according to a Geometric Brownian Motion (GBM) with known drift and volatility.

The GBM assumption in particular implies that (almost surely) an asset's price fluctuates continuously. The Black-Scholes model additionally requires that the firm be able to buy and sell continuously until the option's expiration date. But this is not always possible as the stock market is not open always and prices are known to gyrate wildly on occasion due to numerous reasons. Hence such hedging strategies do not entirely cover risk exposures and and have led to much criticism of the Black-Scholes model.

The model developed in 1973 by Fischer Black and Myron Scholes requires several assumptions in order to become applicable. First of all, this model can only be implemented if there is a fixed decision date. Secondly, the limiting distribution has to be the Normal Distribution and finally the price process needs to be continuous.

The main advantage of this model is the simplicity required to calculate the value of the option as it requires to enumeration of only six variables - initial value of the underlying asset, time until maturity, exercise price, difference between capitalization rate and the percentage of expected change in the value of the underlying asset, continuous compound risk-free rate of return and, finally, the volatility in the underlying asset.

The disadvantages concern some of the assumptions adopted to enumerate the variables (price, volatility and duration) as it involves certain amount of speculation and biases.

Based on the Black Scholes model, table 4 below shows the VaR associated with the changes in ATF prices.

Date	S	X	r	T	VaR 95% (monthly)
Oct 15	34	47	2%	0.5	-5.08
Nov 15	34	43	2%	0.5	-3.47114
Dec 15	34	36.5	2%	0.5	-0.01944
Jan 16	34	30	2%	0.5	4.052684
Feb 16	34	31	2%	0.5	3.425348
Mar 16	34	37	2%	0.5	-0.3168

Table 4: VaR associated with actual changes in ATF prices. (scenario 2)

Date	S	X	r	T	VaR 95% (monthly)
Oct 15	34	37	2%	0.5	-0.3168
Nov 15	34	39	2%	0.5	-1.45866
Dec 15	34	42	2%	0.5	-3.00455
Jan 16	34	46	2%	0.5	-4.7212
Feb 16	34	49	2%	0.5	-5.75445
Mar 16	34	53	2%	0.5	-6.83071

Table 5: VaR associated with an increase in strike prices for ATF (Scenario 1)

Date	S	X	r	T	VaR 95% (monthly)
Oct 15	34	38	2%	0.5	-0.8978
Nov 15	34	34	2%	0.5	-0.3168
Dec 15	34	31	2%	0.5	3.4253
Jan 16	34	29	2%	0.5	4.667
Feb 16	34	26	2%	0.5	6.372
Mar 16	34	25.5	2%	0.5	6.628

Table 6: VaR associated with a decrease in strike prices for ATF (scenario 3)

Table 5 and 6 correspond to the scenarios where I simulate a fuel price increase (fuel market in contango) and a fuel price decrease (fuel market in backwardation). As can be seen from table 5 and figure 11, as fuel prices increase, the VaR associated with the rise in fuel prices also increases. The airlines are now exposed to higher risks. To counter this higher value at risk, airlines have to hedge by going long futures. This way any loss made in the spot market is offset by gains in the futures contract.

From table 6 we see that the fuel prices are falling. The strike price is above the spot price for the month of October and November. VaR in October and November are positive. After these two months we see that the strike price is lower than the spot price. VaR in the following months are negative as can be seen from figure 12. Now that the fuel prices have fallen, airlines are cashing in on cheap fuel prices. Airlines must short their futures and end any hedging contracts they may have. Any loss made in the futures contract is offset by gains in the spot market. Figure 13 shows a comparison between the Hedged VaR and unhedged VaR with regards to the fluctuations in oil prices.

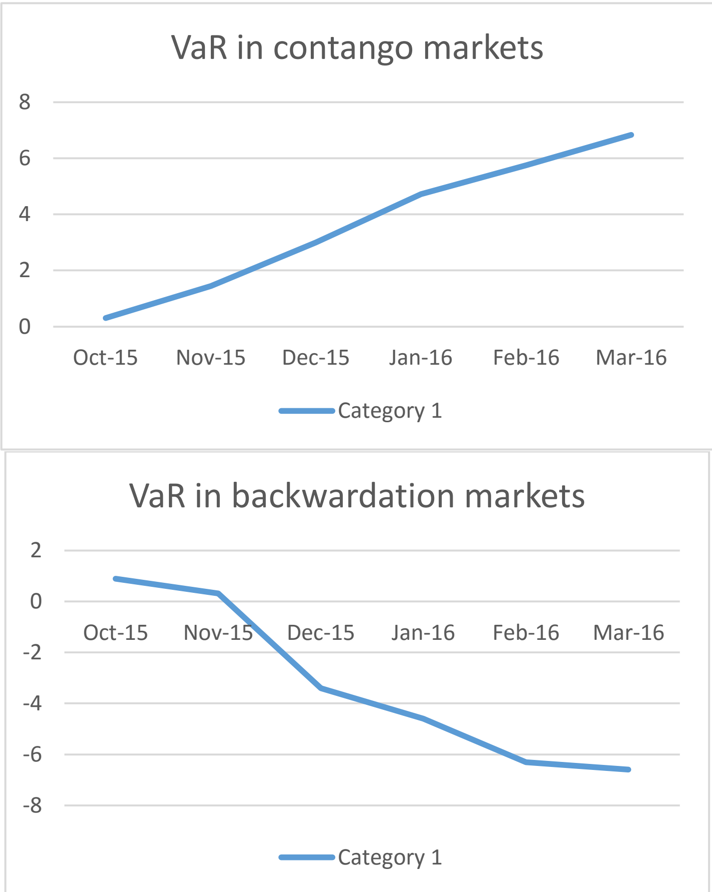

Figure 11 & 12: VaR associated with contango & backwardation markets

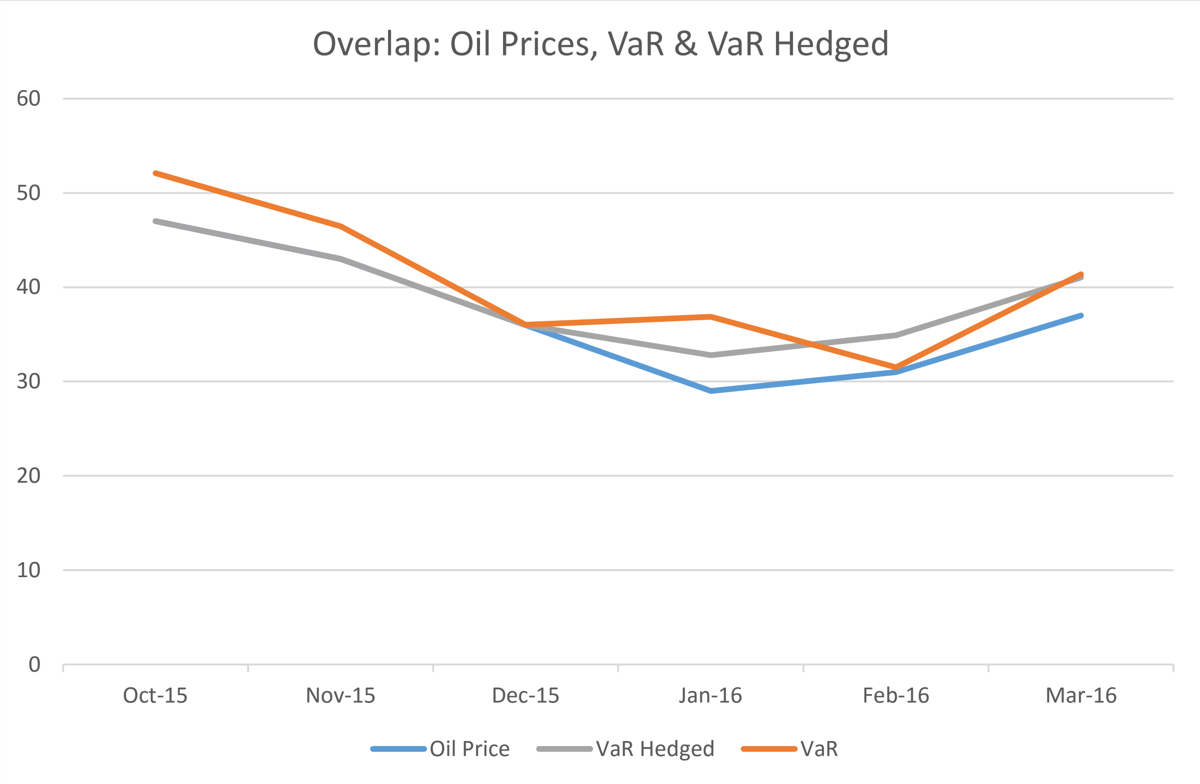

Figure 13: Overlap of Oil Prices, VaR & Hedged VaR in the 6 months

Hypothesis Testing

To test the first hypothesis, namely, Changes in aviation fuel oil prices has a positive co-relationship with the Value at Risk (VaR) of the airline industry I make use of a linear regression of the following linear equation:

$$ChangesinVar = \alpha + \beta . OilPriceChanges + \varepsilon$$

I test for $\boldsymbol{H_o}$: $\boldsymbol{\beta = 0}$ & $\boldsymbol{\rho = 0}$ against $\boldsymbol{H_1}$: $\boldsymbol{\beta \neq 0}$ & $\boldsymbol{\rho \neq 0}$. In other words the null hypothesis says that there is no association and no correlation between aviation fuel oil prices and the value at risk. The alternative hypothesis predicts some relation between aviation fuel oil prices and value at risk. Below are the spss summary statistics for the linear regression.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Oil Price	25	30.0	111.0	70.380	27.0498
VaR	25	-9.484040000000000	4.052684000000000	-6.480166720000001	4.095498034000000
Valid N (listwise)	25				

Table 7: Descriptive Statistics

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.750[a]	.562	.543	2.768933051000000

a. Predictors: (Constant), OilPriceChanges

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	226.214	1	226.214	29.505	.000[b]
	Residual	176.341	23	7.667		
	Total	402.554	24			

a. Dependent Variable: ChangesinVaR

b. Predictors: (Constant), OilPriceChanges

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.508	1.571		.960	.347
	OilPriceChanges	-.113	.021	-.750	-5.432	.000

a. Dependent Variable: ChangesinVaR

Table 8, 9, 10: representing summary statistics

From the above tables we can conclude that there is sufficient evidence to reject the null hypothesis and accept the alternative hypothesis that there is sufficient association between the two variables. Also there is a negative relation between the two variables. Note that the Pearson correlation constant is negative. This is not true since in the data there is a reduction in VaR as the oil prices decrease. However since VaR is depicted with a negative sign, the model interprets VaR as an increasing function. But in my data VaR has been shown to decrease. Hence I choose to ignore the negative sign in the Pearson correlation coefficient. There is a positive relation of 0.750 between Oil Price Changes and VaR changes.

Montecarlo Method (6 of 5000 observations)

Drawing	Change in price	New price	d1	d2	c	p
-0.300232	-0.316444696	33.68356	-0.028712	-0.37391	3.66578	6.0889005
-1.277683	-1.346678059	32.65332	-0.118697	-0.46390	3.18079	6.6341469
0.244257	0.257447202	34.25745	0.0202286	-0.32497	3.95179	5.801016
1.276474	1.345403111	35.3454	0.1107971	-0.23440	4.52430	5.2855765
1.19835	1.263061131	35.26306	0.1040406	-0.24116	4.47961	5.3232232
1.733133	1.826722291	35.82672	0.1499792	-0.19522	4.78995	5.0699038

This is a snapshot of my Monte Carlo simulation. I have 5000 observations that calculate the VaR for each observation separately. I observe consistent VaR values for all these observations. In other words the VaR values do not deviate significantly from each other.

Conclusion

The purpose of this thesis was to capture the effect of the changes in aviation fuel oil prices on the value at risk of the Indian aviation industry. Further I wanted to try to minimize this risk by hedging against increasing fuel oil prices. In order to do so I calculated the VaR levels for Jet Airways, SpiceJet, Indigo & Go Air. Next I calculated the optimal hedge ratio for these airlines. In order to capture the effect of changes in oil prices on VaR, I created three scenarios using the Black Scholes model (VaR associated with actual changes in atf prices over a period of 6 months, VaR associated with increase in atf prices over a period of 6 months, VaR associated with decrease in atf prices over a period of 6 months). Finally I created a Monte Carlo Simulation to check my VaR conclusions for stability.

Main Findings

There is a direct relationship between VaR and ATF Prices as shown from the Pearson's correlation coefficient. I rejected the null hypothesis that there is no association and no correlation between changes in oil prices and changes in VaR's. As ATF prices increase (decrease), the VaR also increases (decreases). This signifies that ATF prices is one of the major components of VaR. Table 5 and 6 correspond to the scenarios where I simulate a fuel price increase (fuel market in contango) and a fuel price decrease (fuel market in backwardation). As can be seen from table 5 and figure 11, as fuel prices increase, the VaR associated with the rise in fuel prices also increases. The airlines are now exposed to higher risks. To counter this higher value at risk, airlines have to hedge by going long futures. This way any loss made in the spot market is offset by gains in the futures contract. From table 6 we see that the fuel prices are falling. The strike price is above the spot price for the month of October and November. VaR in October and November are positive. After these two months we see that the strike price is lower than the spot price. VaR in the following months are negative as can be seen from figure 12. Now that the fuel prices have fallen, airlines are cashing in on cheap fuel prices. Airlines must short their futures and end any hedging contracts they may have. Any loss made in the futures contract is offset by gains in the spot market.

The optimal hedge ratio was calculated as -0.012105523. As the strike price of fuel is falling below the spot price, the expected maximum loss at 5% or the VaR at 5% is reducing. Airlines must cash in on the difference in the spot price and the strike price. They must sell any hedging contracts they may have. In other words, airlines must short their futures.

Airlines should have hedged against aviation turbine fuel increase in January 2016, when the price of ATF was the lowest in the period from (Oct-15 - Mar-16). Since ATF prices are a major component of the VaR, those airlines that hedged in Jan 16 had a lower VaR in the periods following Jan 16. Airlines that did not hedge had a higher VaR in the periods following Jan 16. Also, airlines that have hedge their fuel exposures may also find it profitable to sell cheaper air tickets compared with airlines that have not hedged against oil price increases. These airlines that are able to sell cheaper tickets may also see a decline in the VaR.

Discussion of Results and Conclusion

Since ATF prices are hedgeable, albeit indirectly, some stakeholders might find useful to hedge future prices of ATF. That will be possible only if the hedging strategy leads to enhancement of the airline firm’s value. This fact would also be reflected in the higher intrinsic value, as its underlying risk is reduced. On the other hand, the variability of the stock should be reduced if the price of ATF is fixed or is reduced as in India due to the prices being insulated to a certain extent from market forces. However, it is obvious, that the stock of airlines that engage in hedging are generally perceived to be less risky.

Though hedging ATF costs may increase firm value, it is of little importance to stakeholders as their returns on investment do not depend on whether the airline implements the hedging strategy. The stakeholders are more concerned with the overall risk exposure of their portfolios rather than with improvement of individual stocks.

Smith and Stulz in their research have found that hedging is more valuable to firms as investment opportunity and on occasion also adds to the profits of the company. It should also be emphasized here that hedging also reduces the need to access outside expensive capital during the periods when fuel prices shoot up. Furthermore, higher fuel costs are also consistent with lower cash flow.

However, Morrell and Swan (2005) find empirical justification behind hedging. According to them, hedging to a certain extent only serves the purpose of smoothing airline profit volatility and thus soothes the nerves of the investors. In conclusion, the authors go on to state that hedging is a signal to investors that management is technically alert. Although this aspect cannot be explained by a mathematical or economic model, it can be just the psychology of the market that pushes airline hedging. In conclusion it can be said that there is no clear link between jet fuel hedging and market value of the firm as there are numerous simultaneously operating factors. So far, it can be noted that the airline industry appears to view volatile jet fuel prices as a source of risk exposure.

It should also be noted that though the airlines control their own expenses, albeit to a limited extent, they are unable to exercise even a limited control on their revenues due to the highly competitive nature of the industry. Hence airlines adopt a hedging strategy to reduce fuel expenditures and increase fuel-efficiency as measured by the percentage of operating expenses. This fact is reflected by the fact that Jet Airways is perceived to be more fuel-efficient compared to the other airlines and hence their stock performs better.

After all results have been discussed I can conclude that my research helps answer both the hypothesis.

H1: Changes in aviation fuel oil prices has a positive co-relationship with the Value at Risk (VaR) of the airline industry

H2: Airlines that hedge against oil price increases will have a lower value at risk (VaR).

Interview

After calculating my results and comparing my results with the financial statements of the airlines, I wanted to go one step further and get some insight into hedging and VaR from the experts working with these airlines. I decided to set up an interview over the telephone. I spoke to a senior employee of Air India from the risk management committee. I also managed to speak with another employee of Jet Airways working with its risk department. Out of all the airlines that I tried to interview, I only managed to get Air India and Jet Airways to speak to me. A summary of these interviews is as an annexure to this thesis.

Limitations

Under the Black-Scholes model the cost of hedging may be 2% - 3%. However if we use the power law to calculate the cost of hedging this is almost 5 times the original cost of hedging. This suggests that hedging may be prohibitive. This could also be the most important reason why some airlines do not hedge.

Future Research

As stated earlier there is no clear link between hedging, business risk and stock price due to numerous factors acting simultaneously. Though the general perception appears to be that hedging results in lowering of business risk which could be reflected in the stock price of the specific airline. But it definitely requires further research.

Furthermore, the matter becomes further complicated due to accepting of basis risk due to the small size of the ATF futures market. Hence it necessitates further study for determining commodities where the risk would be mitigated.

It is also observed from the available data that ATF and crude prices are in lockstep. However, it is difficult to ascertain the precise roles of factors such as refining and transport efficiency in developing and maintain this co-relationship. Hence more sophisticated models need to be constructed which would employ more variables and real time data.

Hedging against atf price fluctuations is a major factor affecting the VaR. However, there are other factors like foreign currency hedging, ticket pricing, routes, passengers that also have an effect on the VaR. Further research should be focused on combining the effects of changes in oil prices together with currency risks on the VaR.

Furthermore, India is a closed economy where ATF prices are administered and hence it becomes difficult to ascertain precisely the impact of volatility in global ATF prices on the business model of privately owned domestic airlines.

If and when the airline sector in India adopts hedging strategy measures such as audit would have to be instituted to differentiate genuine hedging and pure speculation. The future research will have to be identify such measures.

India is experiencing increasing growth in the airline sector by way of revenue as well as passengers. As such the number of business failures will also increase due to volatility in business cycles. This necessitates further detailed research to assist the sector to grow and serve the country.

Literature Matrix

Authors	Published	Title	Research	Data period	Results	Agree / Disagree
Bergman, M.	2002	Textbook of rule elves – an ESO report – Policy management for deregulation			-	-
Bisignani	2005	Aviation and the Environment Summit, Geneva			-	-
Black, F., & Scholes, M.	1973	The Pricing of Options and Corporate Liabilities	- The Black Scholes model, which estimates the price of the option over time, was first derived in this paper. The main idea behind this model is to hedge the option by buying and selling the underlying asset in a way to eliminate risk.		-	**Agree:** Hedging is a tool designed not to make profits but to be used in order to eliminante or reduce risk exposure.
Carter, D., Rogers, D. A., & Simkins, B. J.	2000	Does Fuel Hedging Make Economic Sense? The case	- Is hedging a source of value for airline companies?	1994-2000	- Positive correlation between hedging and firm value - Given that fuel costs are hedgeable, airlines with	**Agree:** Saving on fuel costs by hedging can help airlines expand.

		of the US Airline Industry			a desire for expansion may find value in hedging future purchases of jet fuel. - Benefit of jet fuel hedging comes from a lowering of underinvestment costs.	
Carter, A. D., Rogers, A. D., & Simkins, B. J.	2006	Does Hedging Affect Firm Value? Evidence from the US Airline Industry	- The paper investigates jet fuel hedging behaviour of US airline firms to examine if hedging is a source of value.	1992-2003	- There is a positive relation between hedging and an increase in capital investment. - Hedging premium is attributable to the interaction between hedging and investment. - Results are consistent with the assertion that the benefit of jet fuel hedging comes from reduction of underinvestment costs.	**Agree:**
Cunningham, F., Slovin, M. B., Woods, W. R., & Zaima, J.K.	1988	Systemic Risk in the Deregulated Airline Industry	- Analyse the impact of deregulation on the systemic risk of airline industry.	1974-1983	- A free market environment significantly lowered systemic risk relative to the period of regulation. - Systemic risk increased in the period immediately after passing of the airline deregulation act.	-

					- National carriers have greater systemic risk than regional carriers.	
Fernando, S.	2006	Risk Management Practices in the Airline Industry	- This paper examines the use of financial derivative instruments by non-financial entities to manage risk exposure	2005	- Strong evidence to support the effective use of derivative instruments to manage operating costs and hence maximize firm value.	**Agree:**
Flannery, M. J., & James, C. M.	1984	The Effect of Interest Rate Changes on the Common Stock Returns of Financial Institutions	- The paper examines the relation between interest rate sensitivity of common stock returns and the maturity composition of the firm's nominal contracts.		- Common stock returns are found to be correlated with interest rate changes. - The movement of stock returns and interest rate changes in positively related to the size of the maturity differences between the firms nominal assets and liabilities.	-
Hallerbach, W. and Menkveld, B.	1999	Value at Risk as a Diagonastic Tool for Corporates: The Airline Industry	- What are the risk exposures in the airline industry using component VaR?	1990-1999	- Drawback of Riskmetrics is that it underestimates risk for high VaR confidence levels. - Component VaR does not suffer from this bias.	**Agree:** The case of Kingfisher Airlines

Hooker, M, A.	1996	Exploring the Rhobustness of the Oil Price-Marco economy Relationship	- Paper examines the oil price-macroeconomy relationship with rolling Granger Causality and structural stability tests.		- This relationship broke down as a result of falling oil prices and market collapse of the 80's, suggesting misspecification of oil prices - Oil prices affect the economy indirectly by inducing monetary policy responses.	-
Isin, A. A., Gyoshey, S. B., & McMeeking, K.	2014	Hedging and Firm Value: Measuring the Implications of Airline Hedging Programs	- The paper examines the relation between hedging and firm value	2000-2012	- Hedging strategies are effective at reducing the variability of operating cash flows. - Show that value maximization via hedging when firms have potential financial distress costs and significant investment opportunities.	**Agree:**
Jorion, P.	1990	The Exchange-Rate Exposures of U.S. Multinationals.	- The article examines the exposure of U.S multinationals to foreign currency risk.		- Across multinationals, the relationship between stock returns and exchange rates differs significantly.	-
Jorion, P.	2006	Value at Risk: The New Benchmark for	- Provides information		-	-

		Managing Financial Risk, 3rd Edition	needed to understand VaR. - Also helps understand newer dimensions of financial risk.			
Klemperer, P.	1989	Price Wars Caused by Switching Costs	- Research analyses a market model with switching costs. This results in a price war.		- The paper shows how the type that arises as a result of a price war depends on the size of switching costs.	-
Laux, P.A., He Yan & Chi Zhang	2014	Cost, Risk Taking & Value in the Airline Industry	- Assess the potential for value-added oil price hedging/risk-taking in the airline industry	1998-2009	- Potential value-added of hedging fuel costs with oil derivatives is limited but varies across the business cycle.	**Agree**: Limited in a sense of the difference between hedged oil price and unhedged oil price
Linsmeier, T., & Pearson, N, D.	1996	Risk Measurement: An Introduction to Value at Risk	- Introduce the concept of Value at Risk. - Describe in detail the three methods for computing it. - What are the advantages of these three		-	-

			methods for computing var?			
Mabro, R.	1984	On Oil Price Concepts	- The paper reviews various price concepts relating to crude oil in order to access their economic meaning, to interpret the different roles which each concept attributes to the price it defines and to establish the relationships between these price notions.	1950s – 1970s	-	-
Morrell, P., & Swan, W.	2006	Airline Jet Fuel Hedging: Theory and Practice	- Paper explores the nature and extent of airline jet fuel hedging. - Why do airlines Hedge?	2002-2005	- Hedging protects profits against sudden upturn in crude prices. - Hedging increases volatility with hedging gains reinforcing improved profits from higher traffic and improved yields if higher oil prices are caused by strong economic growth.	**Disagree**: Hedging is not a tool designed to protect profits. **Agree**: During bankrupcy hedging strategies can help minimize risk exposures and hence reudce the VaR, hence

					- Hedging may have an accounting role by moving profits from one period to another. - Oil prices can either decrease or increase airline profit cycles, depending on the time period. - A fuel price hedge would create immense value when an airline is on the verge of bankruptcy. - Hedging may be a zero-cost signal to investors that management is technically alert.	increasing firm value
Panchasara, B. M.	2012	The King Without Fishes…!!!: The Case on Crisis of Kingfisher Airlines	- This case study outlines the financial turmoil of Kingfisher Airlines	2005-2012	-	-
Poitras, G., Wilkins, T., & Kwan, Y. S.	2002	The Timing of Asset Sales: Evidence from Earnings Management?	- The paper provides empirical evidence from a sample of publicly traded Singaporean firms to the		- There is evidence to support the hypothesis that managers of firms with decreasing net earnings-per-share smooth earnings upwards using asset sales.	-

			question: How are earnings managed by firms through the timing of asset sales?			
Schreurs, T.	2012	Oil Price Risks for Airlines	- What is the effect of oil price risk on airlines?	2003-2012	- Airlines face significant risk from changing oil prices. - Airlines are sensitive to oil prices during a period of crisis. - Airline stock hardly affected during oil price stability or steady increase. - During erratic movements of oil prices airline stock is more volatile. - During periods of extreme oil price increases, VaR is influenced by oil prices.	**Agree**: VaR is influenced by oil prices.
Silvapulle, P., Moosa, I. A.	1999	The relationship between spot and futures prices: Evidence from the crude oil market	- Examines the relationship between the spot and futures prices of WTI crude oil using a sample of daily data.		- Future prices lead spot prices, but nonlinear causality tests reveal a bidirectional effect. - Both spot and futures prices react simultaneously to new information	-

Smith, C., & Stulz, R. M.	1985	The Determinants of Firms' Hedging Policies	- This paper develops a positive theory of the hedging behaviour of value maximizing firms. - Why some firms hedge and others do not? - Why firms hedge some risks but not others?		- Firms hedge for three reasons: (1) Taxes, (2) Costs of financial distress and (3) managerial risk aversion.	-
Stulz, R. M.	1996	Rethinking Risk Management	- This book represents a theory of corporate risk management		-	-
Stulz, R. M., Karolyi, G. A., & Kee-Hong Bae	2003	A New Approach to Measuring Financial Contagion	- Proposes a new approach to evaluate financial market contagion.	1990s	- Contagion is predictable and depends on interest rates, exchange rate changes and conditional stock return volatility.	-
Sweeney, R. J., & Warga, A. D.	1986	The Pricing of Interest-Rate Risk: Evidence from the Stock Market	- The paper looks at whether firms are required to pay an ex ante premium to investors for bearing the risk		- Most of the interest rate shocks are in the utility industry. - Evidence that the interest factor is priced in the sense of the APT.	-

			of interest-rate changes		- Regulatory lags are a likely candidate for interest sensitivity.	

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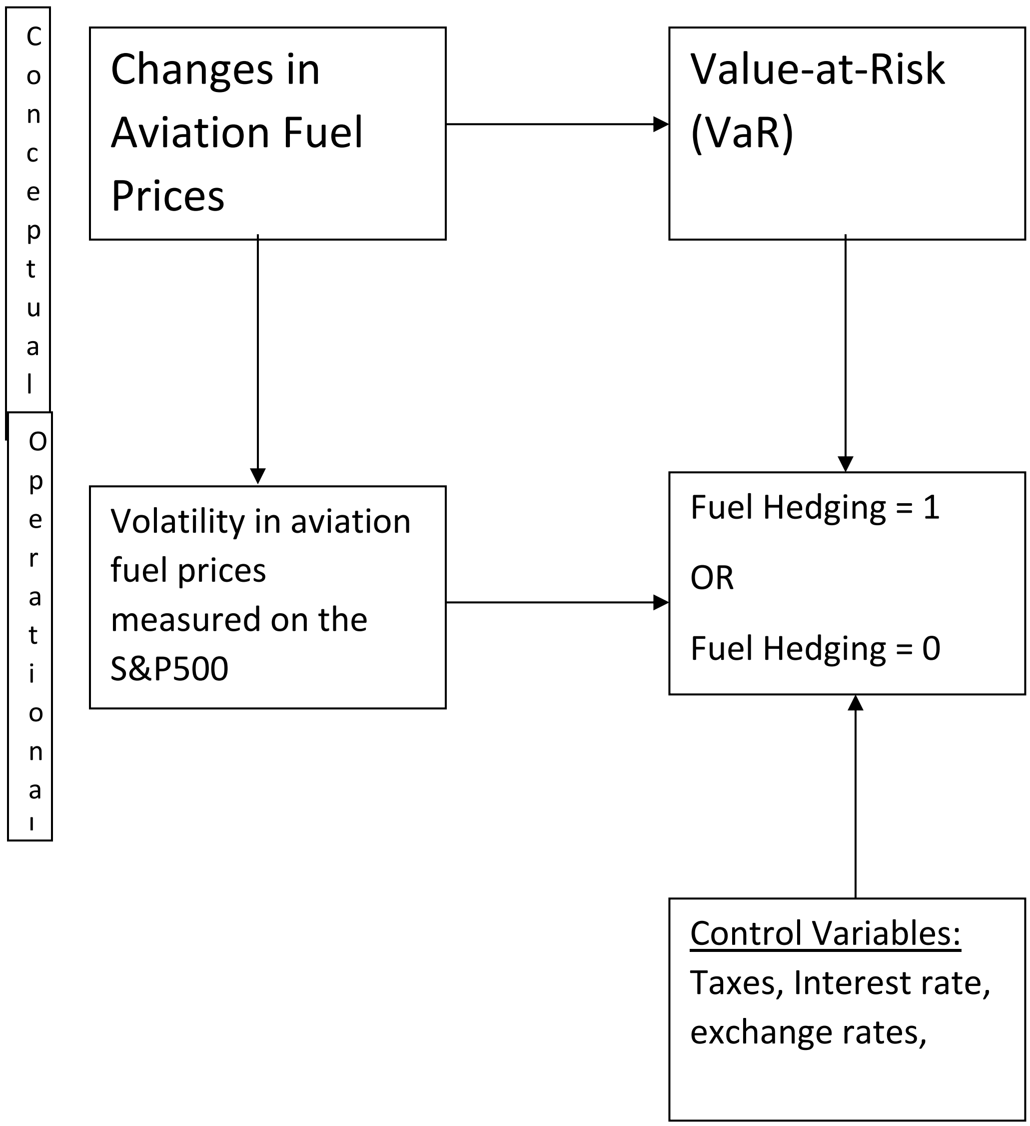
Annexure 1:Predictive Validity Framework



Annexure 2: Summary of Interview

Question:	Air India	Jet Airways	Spicejet	Indigo	Kingfisher
What is your role in your airline company?	Managing risk. Our goal is to minimize exposure. Hedging against fuel price increase, interest rate risks, credit risks are just some risks that we deal with	I work with the risk department at Jet Airways. I minimize our exposure to currency risk	Price/Credit Risk department	Hedging	I was part of the risk exposure minimization team with Kingfisher
Do you hedge against fuel price increase?	We hedge against Gas Oil. Our risks with hedging are linked within our framework of a hedging strategy. We have started hedging for a duration of 2 years. We are hedging at least 25% of volumes consumed. Our hedge instruments are: call, swap, call spread, three ways and four ways. The risk management committee meets every quarter to discuss risks relating to fuel prices, and to decide on target hedge ratios, and the hedging instrument. Our hedge decisions are good. We are doing well even if the price of crude reaches 60$.	No. We do not hedge against fuel price increases. Etihad Airways, which owns a stake in Jet Airways, does hedge against fuel price increase. We benefit from this in that we do not generate any costs from hedging	No. We hedge against our exposure to foreign currency.	Yes we have started hedging against fuel price increases. We hedge our fuel exposure with heating oil. We are hedging 30% of our fuel requirements. 70% fuel is purchased in the spot market. This may change very soon when the oil prices start increasing tremendously.	We did not hedge our fuel prices. In highsight I feel that we would have performed much better with hedging.
What are the costs of hedging?	The difference between the forward rate and the future spot rate is one of the big cost of hedging. It is difficult to get a perfect hedge. Risk is an essential variable here.			Very high. However, this is not a profit or loss scenario. It is more to do with minimizing risk.	
Do you need government approval for hedging?	No. Its our decision completely.			No permission required from the government.	
What is a major component of VaR	Oil Prices is a major component. Interest rate risk, currency risk.	Our major VaR component is the spot oil prices. If its	Interest rates and oil prices	Exposure to oil prices. We hedge to try to minimize this exposure.	Soaring oil prices was the most important aspect of var. Add to

		low then our var is also low.			that interest rate risks. Market share was also a major concern for us.
How do you calculate your hedging strategies?	We have our own software. Which is based on VaR and Black Sholes Model			Our own hedging software. First we calculate our VaR, and comparing it with oil prices we decide on how much to hedge.	
What about other airlines hedging?		It is for our board members comprising of Jet Airways and Etihad airways to decide on that strategy.	Air India started hedging because it is not running profitably. We are running profitably.		
What went wrong?					We had a liquidity problem. We had secured loans from private and government banks. However, fuel prices went up a lot and hence our Value at risk increased tremendously. We could not repay our debt. Add to that tough competition. We had under estimated our VaR.