

**Cash Flow at Risk Models:**  
**Principles, Application and a Case Study**

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## Introduction

The reality of changing market dynamics and a strong desire to more effectively manage financial risk has led some corporates internationally and in Australia to introduce Cash Flow at Risk (CFaR) frameworks.

The term “Cash Flow at Risk” is used as both a generic label for a risk management methodology that draws heavily from the experience and success of Value at Risk (VaR) used within the financial services industry, and as a specific implementation of the approach. Central to its application is the measurement of traded risk against a preselected performance metric, such as Cash Flow, Economic Value Added (EVA), or Earnings Before Interest Taxes Depreciation and Amortisation (EBITDA).

The identification and management of risk by corporates has traditionally been executed on a single product basis, with interest rate risks, individual foreign exchange risks and commodity risks managed separately across the entity. In reality, the relationships between these markets deliver in some cases diversification and in others concentration of risks. The heart of the CFaR approach is to identify these effects and present risk on the same basis as other decisions are made – by using a company’s business metric of choice. For example, a business that measures its performance by EBITDA can also understand the totality and sensitivity of its financial and commodity market risks in EBITDA terms.

The presentation of multi-asset class risks in business terms with attached statistically valid probabilities provides a very powerful picture of risk for a company. The additional use of stress tests and other features of the model provide Executive Management and Boards with considerable risk insight.

## Principles

This section introduces some of the principles from which the Cash Flow at Risk approach is based and developed.

### ***Market risks are taken together***

Traditionally, corporates have sought to manage risks on an individual basis. For example currency and commodity risks have often been managed independently.

Markets are inter-related, and as such activity in one market will lead to upstream and downstream impacts, of various degrees, in others. Relationships between asset classes (interest rates, currencies, commodities and equities) change over time and have varying degrees of intensity.

In some cases an analysis of exposures on a portfolio basis can identify particular natural diversification or natural concentration effects.

**Natural Diversification.** In some cases, the mixture of financial market risks that manifest within an entire organisation may have the effect of reducing total risk exposure.

An example of this situation is a commodity exporter, where the commodity is priced in USD and where the price is positively correlated to the AUD. In the event of the commodity depreciating (appreciating), the AUD is more likely to depreciate (appreciate), resulting in a dampening of revenue volatility in AUD terms.

**Natural Concentration.** In other cases, the mixture of financial market risks that manifest within the entire organisation may have the effect of increasing total risk exposure.

An example of this situation is a different commodity exporter, whose commodity is priced in USD and is negatively correlated to the AUD. In the event of the commodity depreciating (appreciating), the AUD is more likely to appreciate (depreciate), resulting in an exaggeration of revenue volatility in AUD terms.

The effects of hedging may synthetically alter the combined nature of the portfolio. In some cases reducing (diversifying) and in other cases increasing (concentrating) risk.

### ***Risk identification and mapping***

The identification of risk within the company is a fundamental component of any risk management framework or approach. Assumptions made during this process will be transmitted throughout the risk function, making the identification of risk an extremely important aspect of the design of any risk management approach.

Through detailed risk mapping and economic analysis, a detailed model of the company can be created to understand more fundamentally the effects of financial market risk, and its management. During this stage other risks can be integrated within the approach to deliver a true enterprise wide solution.

### ***Risk measurement***

The communication of financial market risk information (including limits, exposures and budgets) is usually done on the same basis as the underlying market exposure.

The evaluation of performance within the organisation is often measured against a key metric, whether it is EBITDA, EVA, EPS or some other metric. Financial market risk is rarely presented or evaluated in these terms. The dynamic nature of financial market risk is one of the single largest impediments to the evaluation of financial market risk in key metric terms.

CFaR overcomes these obstacles and provides for the dynamic evaluation of risk in terms of a company's key metric.

## ***Company specific risk vision***

Any risk management approach should be firmly aligned with the company's individual vision of risk. The preferences of key stakeholders must be considered when developing and implementing a risk management framework. Stakeholders include some or all of the following:

- Board of Directors
- Shareholders
- Financiers
- Customers
- Executives

The formal confirmation, statement and communication of a risk vision within the firm provides a touchstone from which future decisions and policies can be reconciled.

## ***Changing nature of risk and the external environment***

The reality of business within the modern global economy is that the pace of change is accelerating. Information used in forming views about markets, products and risk are similarly changing at a rapid pace. Any financial market risk framework which is employed must be able to change with the changing reality of markets. The key is to develop a framework for assessing risk – not a rigid mechanism for assessing risk based on stagnant criterion.

## ***Management of risks***

The employment of financial instruments to manage financial market risk (hedging) is an approach commonly used by Australian corporates. The performance of these instruments against the underlying exposures to which they have been employed to manage is often not measured or managed. In other words, hedge effectiveness is often measured only at the time the hedge is entered into.

The integration of hedge transactions within the wider risk framework completes the circle, enabling management to measure the effectiveness and efficiency of actions already taken, and those being considered, against the underlying exposures and in terms of the firm's key metric.

## **Approach**

This section provides an approach to implementing a CFaR framework to a corporate entity. It provides a high level summary of the steps necessary to effect such an implementation.

## ***Market risk assessment***

The use of traditional scenario and sensitivity analysis tools provides a company with an indication of what risk looks like as a result of specific market outcomes.

The CFaR approach significantly enhances the traditional scenario / sensitivity test by generating thousands of scenarios – each with market derived correlation, volatility and forward data to reflect the inter-relationships between and within markets. The scenarios modelled should reflect normal market conditions. Abnormal market events are not considered at this point.

Different simulation techniques are used to reflect the normal characteristics of each market – currency markets and commodity markets perform differently. These differences are reflected in the CFaR approach and modelled accordingly.

Probability weighted market derived rate outcomes can then be passed through the next component of the approach – the Business Model.

### ***Business modelling***

Through detailed risk analysis it is possible to construct a high level model of risk within an organisation. We start by isolating each discrete element of the organisation that is exposed to the movement of financial markets. We conclude with developing a risk model that takes these elements through to the calculation of a key metric, or group of metrics.

The effects of hedge transactions, taxation and accounting requirements should also be integrated within the approach. The outputs of the business model are the values of the key metrics. The business model should be able to provide a value of the key metric based on an input set of market prices and hedge transactions (the required market prices having been determined in the market risk assessment phase).

### ***Analysis***

As market rates are passed through the model, the key metric (e.g. EBITDA) is calculated and recorded. As thousands of market derived rate scenarios are produced, so too are thousands of key metric results each providing a picture of the performance as a result of each market scenario.

The analysis of results becomes an analysis of the distribution of the key metric. Several key pieces of information are examined based on various hedge strategies. For example probability density graphs and maximum losses at a given level of confidence are compared to ascertain the level of comfort afforded by various structures and hedging strategies.

### ***Stress tests***

Simulations are used to analyse the performance of markets in normal market conditions. The use of stress-tests compliment the simulation approach to cover abnormal market events. Stress tests can be run on a myriad of rate scenarios. This sophisticated ‘what if’ capacity is coupled with the functionality to re-base and re-run the effects of historical events and realistic market abnormalities.

This picture of financial market derived risk then facilitates the measurement and management of risk against the company's vision of risk and return.

Risk management techniques drawn from VaR provide the company with the tool set to measure and manage the changing nature of financial market risk facing the organisation.

## Case Study

ABC Mining is a small, fictional, resource company with its head office in Melbourne. The company is Australian owned, and is primarily concerned with the generation of EBITDA in Australian dollars. It operates two facilities, a copper mine and smelter in Java, Indonesia and a gold mine and smelter in Western Australia.

The company finances its activities through the issuance of floating rate debt in the US. However, its financiers have mandated that it enter into hedge transactions which lock-in the exchange rate paid on the debt. The company has entered into these transactions, and their cost is included in the Interest Paid line of their Financial Performance Report. The hedges are assumed to be efficient and are not considered further in this analysis as they do not contribute to the EBITDA of ABC Mining.

The CFO of ABC Mining is considering entering into a series of hedge transactions offered by one of the big Australian Banks. These transactions are designed to insulate ABC's Aussie Dollar EBITDA to volatility in the prices of Gold, Copper, US Dollars and Indonesian Rupiah. The following is an overview of the CFaR analysis performed on behalf of the CFO.

### **Market risk assessment**

The CFO has performed an historical analysis of the commodity and currency markets. Using this analysis, and his professional judgement, he developed the following distributions, means and standard deviations for the market risk factors to which ABC Mining is subject.

Commodity/Currency	Mean	Standard Deviation	Distribution
US Dollar (per AUD)	0.6000	0.0600	Normal
Rupiah (per AUD)	5,300	795	Normal
Gold (USD per Oz.)	325	20	Lognormal
Copper (USD per Tonne)	1,600	75	Lognormal

In addition, he developed the following co-variance matrix for the market risk factors.

	<b>US Dollar</b>	<b>Rupiah</b>	<b>Gold</b>	<b>Copper</b>
<b>US Dollar</b>	1.000	0.000	0.750	0.000
<b>Rupiah</b>		1.000	0.000	-0.500
<b>Gold</b>			1.000	0.000
<b>Copper</b>				1.000

Note that whilst the US Dollar and Gold co-variances result in diversification of risk to ABC Mining, the Rupiah and Copper co-variances result in concentration of risk to ABC Mining.

### **Corporate Model**

Following discussions with ABC Mining's Chief Operations Officer, the MD's of the Java and WA facilities, and the Treasurer, the CFO has compiled the following summary of ABC's anticipated operations for the coming year.

	<b>Copper Mine &amp; Smelter</b>	<b>Gold Mine and Smelter</b>
<b>Location</b>	Java, Indonesia	Western Australia
<b>Production</b>	1,000,000 Tonnes	1,500,000 Ounces
<b>Operating Costs</b>	10,000 Billion Rupiah	\$850 Million Australian
<b>Additions to P&amp;E</b>	None	\$750 Million Australian
<b>Sales of P&amp;E</b>	8,500 Billion Rupiah	None

The purchase of additional Plant and Equipment will be financed through the issuance of additional debt, and proceeds from the sale of Plant and Equipment will be used to repay existing debt.

The company expects to have costs of \$200 Million Australian to cover head office expenses in Melbourne, primarily salaries for the corporate functions including Executive, Finance, Research and Marketing.

The CFO has estimated the following interest and foreign exchange rates and commodity prices in setting his budget for the year.

<b>US Dollar</b>	0.6000 per AUD
<b>Rupiah</b>	5,300 per AUD
<b>Gold</b>	325 USD per Oz.
<b>Copper</b>	1,600 USD per Tonne

In response to the CFO's interest in hedging, the Corporate Treasurer has obtained quotes from several of the big banks to put together a program to help ABC Mining hedge their exposures. After comparing the various proposals, the Treasurer has put forward what he considers the best two alternative proposals.

The first proposal is a series of long and short forward contracts on each of the market risk factors. These forward contracts effectively lock-in the exchange rates and commodity prices on 75% of the budgeted exposure for the coming year. The cost of this hedging program is \$30 Million Australian. We will refer to this program as the “Forward Program”.

The second proposal is a series of long call and put options on each of the market risk factors. These option contracts effectively provide ceilings and floors for the exchange rates and commodity prices on 50% of the budgeted exposure for the coming year. The cost of this hedging program is \$200 Million Australian. We will refer to this program as the “Options Program”.

As a result of the above operational facts and assumptions, the CFO has put together his high level EBITDA budget for the coming year as follows.

<b>Budgeted EBITDA</b>	<b>(AUD Millions)</b>	<b>Underlying Position</b>	<b>Forward Program</b>	<b>Options Program</b>
<b>Cash flows from operating activities</b>				
Receipts from customers		3,479	3,479	3,479
Payments to suppliers and employees		-2,887	-2,887	-2,887
Payments for other operating activities		-200	-200	-200
<b>Net cash inflow / (outflow) from operating activities</b>		<b>392</b>	<b>392</b>	<b>392</b>
<b>Cash flows from Investing activities</b>				
Payments for property, plant and equipment		-1,604	-1,604	-1,604
Proceeds from sale of property, plant and equipment		750	750	750
<b>Net cash inflow / (outflow) from investing activities</b>		<b>-854</b>	<b>-854</b>	<b>-854</b>
<b>Cash flows from financing activities</b>				
Proceeds from borrowings		1,667	1,667	1,667
Dividends paid		-100	-100	-100
Option premiums		0	-30	-200
Repayment of borrowings		-667	-667	-667
<b>Net cash inflow / (outflow) from financing activities</b>		<b>900</b>	<b>870</b>	<b>700</b>
<b>Budgeted EBITDA</b>		<b>438</b>	<b>408</b>	<b>238</b>

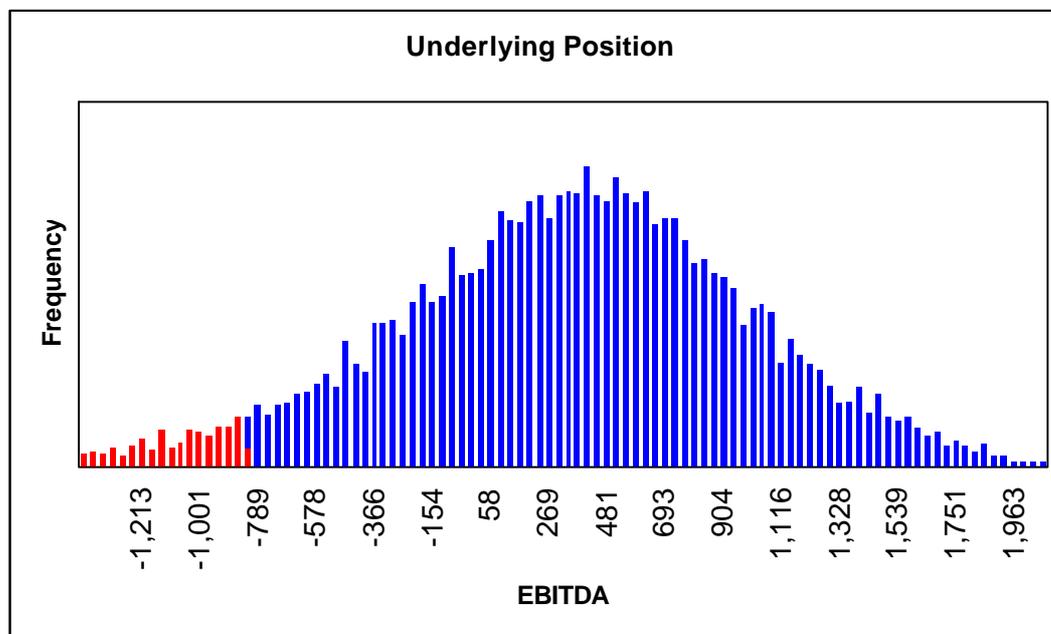
### ***CFaR analysis***

The analysis has been performed by generating 10,000 economic scenarios. Each scenario contains a possible value for each of the four risk elements. The scenarios have been generated using the CFO’s assumed distributions, parameters and co-variances of the risk elements.

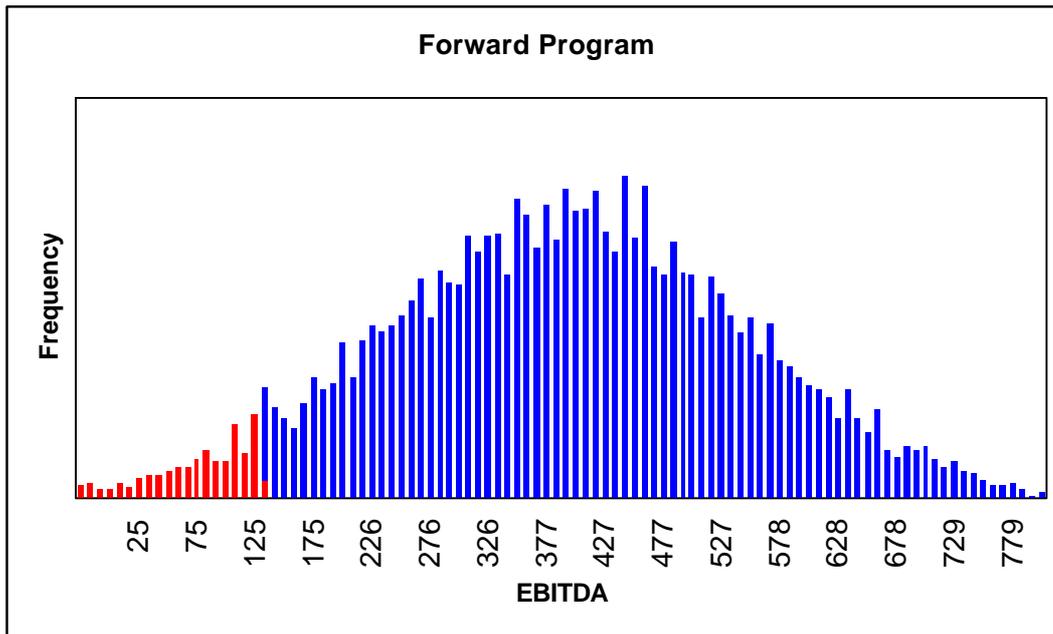
For each scenario, the risk element values are run through the EBITDA Budget, resulting in three values for EBITDA: Underlying Position (assuming no hedging program), Forward Program (assuming ABC enters into the Forward Program described above), and Options Program (assuming ABC enters into the Options Program described above). The results are compiled, and distributions of scenario values are presented below.

<b>EBITDA (AUD Millions)</b>	<b>Underlying Position</b>	<b>Forward Program</b>	<b>Options Program</b>
<b>Budget</b>	438	408	238
<b>Mean</b>	390	405	453
<b>Median</b>	425	408	403
<b>Standard Deviation</b>	680	157	489
<b>CFaR at 5.0%</b>	-778	143	-248

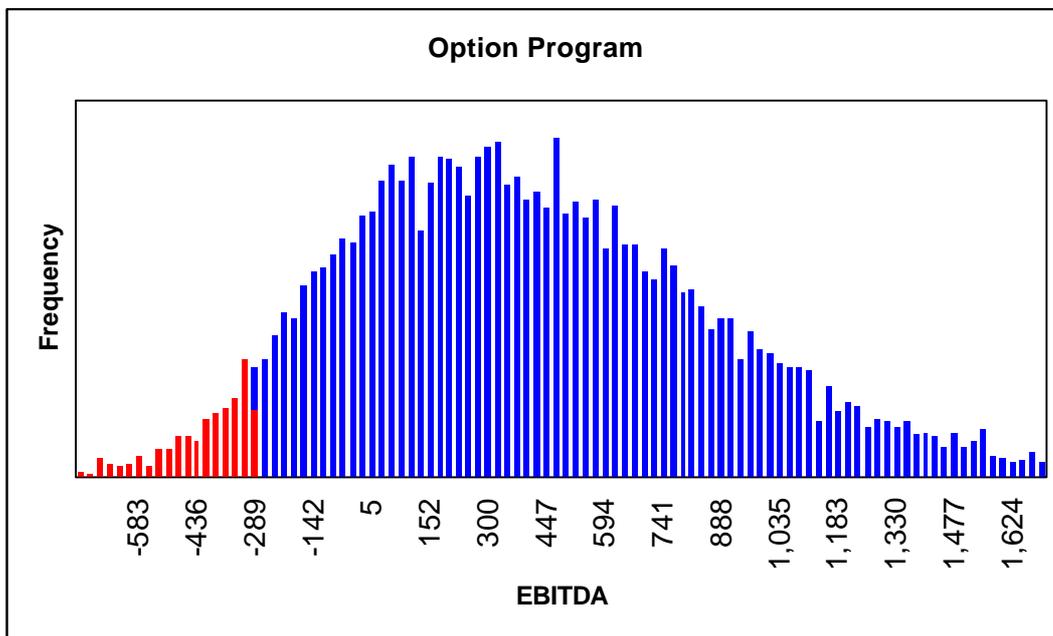
The complete distributions of EBITDA are also provided graphically below.



The CFaR analysis shows a wide dispersion of possible EBITDA values for the coming year. ABC is exposed to a negative EBITDA of \$778 Million Australian with a 5% probability.



The Forward Program reduces the volatility of ABC's EBITDA significantly. Note, however, that ABC's up-side, as well as down-side, risk has been reduced by this strategy.



The high initial cost, \$200 Million Australian, has shifted the distribution dramatically to the left. Nonetheless, the Options Program has significantly reduced ABC's down-side without affecting (other than via the option premium) its upside potential.

## Stress tests

The Directors of ABC Mining are accustomed to seeing projected results over eight simple economic scenarios. These simple scenarios are based on varying one of the four market risk factors. They are intended to provide insight into the sensitivity of the company's EBITDA to market movements. The CFO has calculated the "Board Scenarios" for presentation to the Board, and the results can be found in the table below.

Scenario Description (AUD Millions)	Underlying Scenario EBITDA	Forward Program Scenario EBITDA	Option Program Scenario EBITDA
Budget	438	408	238
<b>Board Scenarios:</b>			
AUD = US \$0.70 (AUD appreciates by US \$0.10)	-201	229	-106
AUD = US \$0.50 (AUD depreciates by US \$0.10)	1,334	602	1,134
AUD = 4,000 Rupiah (AUD appreciates by 1,300 Rupiah)	-696	180	-250
AUD = 6,600 Rupiah (AUD depreciates by 1,300 Rupiah)	1,126	610	926
Gold = US \$250 (Gold depreciates by US \$75)	251	361	144
Gold = US \$400 (Gold appreciates by US \$75)	626	455	426
Copper = US \$1,400 (Copper depreciates by US \$200)	105	325	72
Copper = US \$1,800 (Copper appreciates by US \$200)	772	492	572

In addition, and as part of the CFaR analysis, the CFO has performed several Stress Tests on the company, producing the three EBITDA figures for each scenario. These scenarios have been judgementally developed, in conjunction with extreme historical market movements, to reflect the company's position in abnormal market events. The following table provides the results of the CFO's Stress Testing.

Scenario Description (AUD Millions)	Underlying Scenario EBITDA	Forward Program Scenario EBITDA	Option Program Scenario EBITDA
Budget	438	408	238
<b>Stress Tests:</b>			
AUD = US \$0.75 (AUD appreciates by US \$0.15) and Gold = US \$225 (Gold depreciates by US \$100)	-658	87	-327
AUD = 3,800 Rupiah (AUD appreciates by 1,500 Rupiah) and Copper = US \$1,200 (Copper depreciates by US \$400)	-1,606	-23	-670
AUD = US \$0.75 (AUD appreciates by US \$0.15) and Gold = US \$225 (Gold depreciates by US \$100) and AUD = 3,800 Rupiah (AUD appreciates by 1,500 Rupiah) and Copper = US \$1,200 (Copper depreciates by US \$400)	-2,569	-335	-1,243
AUD = US \$0.45 (AUD depreciates by US \$0.15) and Gold = US \$425 (Gold appreciates by US \$100)	2,264	774	2,064
AUD = 6,800 Rupiah (AUD depreciates by 1,500 Rupiah) and Copper = US \$2,000 (Copper appreciates by US \$400)	1,875	806	1,675
AUD = US \$0.45 (AUD depreciates by US \$0.15) and Gold = US \$425 (Gold appreciates by US \$100) and AUD = 6,800 Rupiah (AUD depreciates by 1,500 Rupiah) and Copper = US \$2,000 (Copper appreciates by US \$400)	3,923	1,183	3,723

## ***Conclusion***

Based on the Cash Flow at Risk analysis, the CFO, with approval from the Board, decided to enter into the Forward Program. The company considered the \$30 Million Australian cost of the program, plus the up-side give-up inherent in the program, to be reasonable in light of the reduced exposure to down-side risk.

Whilst there was some interest internally for the Option Program, the high initial cost of this program was deemed excessive given the company's current emphasis on reducing down-side risk. Should the company increase its risk appetite in the future, retaining the up-side potential, as could be achieved with the Option Program, would be a viable alternative.