

## Two Popular Risk Measures

Let  $X = \text{Loss}$

(i) Value at Risk (VaR) defined by

$$\text{VaR}_p(X) = \inf \{u : F_X(u) \geq p\}$$

where  $0 < p < 1$  and  $F_X(\cdot)$  denotes the CDF of  $X$ .

VaR is due to J. P. Morgan.

Interpretation:  $\text{VaR}_p(X)$  is the loss exceeded with probability  $1-p$ .

Eg 1  $\text{VaR}_{0.99}(X)$  has a 1 percent chance of being exceeded.

Eg 2  $\text{VaR}_{0.999}(X)$  has a 0.1 percent chance of being exceeded.

Eg 3  $\text{VaR}_{0.9999}(X) < \text{£}10$  then OK to investment

Eg 4  $\text{VaR}_{0.9999}(X) > \text{£}1 \text{ million}$  then better not to invest.

2) Expected shortfall (ES) defined by

$$ES_p(X) = \frac{1}{p} \left[ E(X I \{X \leq VaR_p(X)\}) + p VaR_p(X) - VaR_p(X) P(X \leq VaR_p(X)) \right]$$

where  $I\{\cdot\}$  denotes the indicator function defined by

$$I\{A\} = \begin{cases} 1 & \text{if } A \text{ is true} \\ 0 & \text{if } A \text{ is false.} \end{cases}$$

ES is due to Artzner et al in the 1990s.

Interpretation:  $ES_p(X)$  = average loss provided  $X \leq VaR_p(X)$ .

Eg 1  $ES_{0.99}(X)$  = average of the losses not exceeded with 1 percent chance.

Eg 2  $ES_{0.999}(X)$  = average of the losses not exceeded with 0.1 percent chance.

Are VaR and ES coherent risk measures?

	<u>VaR</u>	<u>ES</u>
1) Normalised	✓	✓
2) Translative	✓	✓
3) Monotone	✓	✓
4) Positive homogeneity	✓	✓
5) Sub-additivity	✗	✓

VaR is not a coherent risk measure.

ES " " " " "





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# VaR: The number that killed us

By Pablo Triana

December 1, 2010 • Reprints

FROM THE ARCHIVES



On Sept. 10, 2009 former trader and bestselling author Nassim Taleb did something that he very seldom does: he wore a tie. Taleb has oftentimes publicly expressed his distaste for the blood-constraining artifacts, as well as for those who tend to do them, so the Lebanese-American let the world know that was a very special day for him by betraying a sacred personal disposition.

So what prompted the composer of "The Black Swan" to button his shirt all the way up on that fall date? He had been invited to a very solemn

venue by very distinguished hosts. And that was an invitation that Taleb had every intention of accepting. In fact, he had been waiting and expecting it for more than a decade. The *raison d'etre* of the event for which his company was now being required had been close to Taleb's heart for most of his professional and intellectual life. It represented a central theme in his actions and ideas, close to an obsession. He had through the years incessantly warned as to the havoc that might be wreaked should others massively act in a manner counter to his convictions. Such concerns typically went unheeded (to the detriment, it turned out, of society), but now he was being offered a pulpit that seemed irresistible. This time, the world would have no option but to listen attentively.

As Taleb entered the Rayburn Building of the U.S. House of Representatives on Capitol Hill that September morning, he must have felt vindication. As he approached the sober room where several men and women awaited the start of the House Committee on Science and Technology's hearing on the responsibility of mathematical model Value at Risk (VaR) for the terrible economic and financial crisis that had caused so much misery, Taleb probably reflected proudly on all those times when, indefatigably and in the face of harsh opposition, he alerted us of the lethal threat to the system posed by the widespread use of VaR in finance. Now that the damage wrought by VaR seemed so inescapably obvious that lawmakers had been motivated into investigating the device, Taleb no longer seemed like a lone wolf howling at the moon.

What is so wrong about VaR, and why was Taleb so concerned about its impact? More importantly, why should VaR be held responsible for the crisis? VaR is a number that purports to estimate future losses derived from a portfolio of financial assets, and presents two major problems: 1) it is doomed to being a very wrong estimate, because of its analytical foundations and the realities of real-life markets; 2) in spite of such (well-known) deficiencies, it has for the past two decades become an ubiquitously influential force in the financial world, capable of directing decision-making inside the most important banks. In other words, by letting trading activity be guided by VaR, we have essentially exposed our economic fate to a deeply flawed mechanism. Such flawedness, as was the case not only in this crisis but also before, can yield untold malaise.

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Emini	2697.00	+34.75	(+1.31%)
Euro	1.14225	-0.00245	(-0.21%)
Gold	1233.3	-2.1	(-0.17%)
Oil	67.15	-0.47	(-0.70%)
Gas	3.133	-0.069	(-2.15%)
Corn	3672	-12	(-0.34%)

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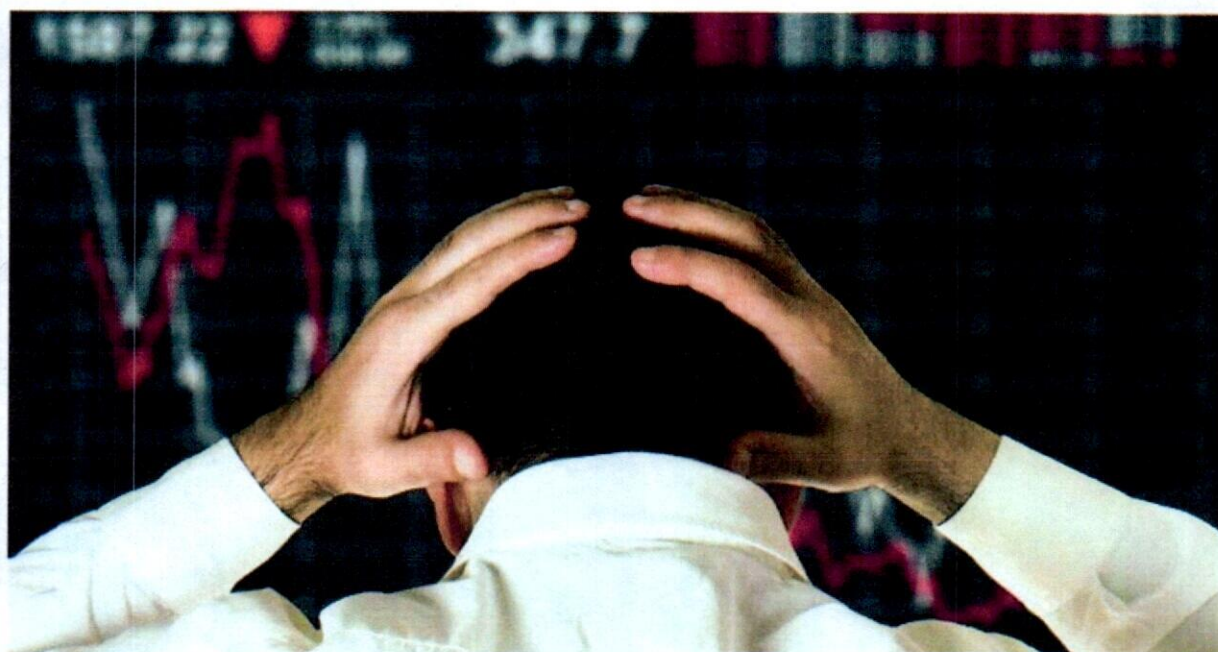


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## News - Did Value at Risk cause the crisis it was meant to avert?



### News

## Did Value at Risk cause the crisis it was meant to avert?

12 May 2016

What were the causes of the crisis of 2008? We show that managing risk using the procedure recommended by Basel II, which is called *Value at Risk*, may have played a central role. We make a very simple model for the banking system that captures the key elements of risk management under Value at Risk. Providing the banks' only take modest risks, the financial system remains stable. But if they take higher risks, or if the banking sector gets larger, the market begins to spontaneously oscillate, in a way that resembles the period leading up to and including the Global Financial Crisis. For about 10 - 15 years prices and leverage slowly rise while volatility slowly falls, then prices and leverage suddenly crash and volatility



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## Did Value at Risk cause the crisis it was meant to avert?

What were the causes of the crisis of 2008? [New research](#) by Oxford Mathematicians Doyne Farmer, Christoph Aymanns, Vincent W.C. Tan and colleague Fabio Caccioli from University College London shows that managing risk using the procedure recommended by Basel II (the worldwide recommendations on banking regulation), which is called Value at Risk, may have played a central role.

The team made a very simple model for the banking system that captured the key elements of risk management under Value at Risk. Providing the banks only take modest risks, the financial system remains stable. But if they take higher risks, or if the banking sector gets larger, the market begins to spontaneously oscillate, in a way that resembles the period leading up to and including the Global Financial Crisis. For about 10 - 15 years prices and leverage slowly rise while volatility slowly falls, then prices and leverage suddenly crash and volatility spikes, as they did in the crisis.



The key problem is that Value at Risk manages risk as if each bank existed in its own universe. But if all banks follow it, the buying and selling necessary to maintain individual risk targets can destabilise the market.

The team then investigated alternative methods of managing risk and demonstrated that it is possible to do much better. The best policy depends on the size of the banking sector in relation to the rest of the market and how much risk the banks take. While the model does not show that the financial crisis and the period leading up to it were due to the use of Value at Risk, it does suggest that they could have been caused by it, and that the housing bubble may have just been the spark that triggered the crisis.

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# VaR and its Role in the Credit Crisis

Page 1 of 3

by Mark Kirkland, VP Treasury, Bombardier Transportation

The causes of the credit crisis of 2009 will be discussed by many for numerous years to come, although probably for fewer years than we now think. People have a unique ability to forget, perhaps black out, the worst episodes. I have sat down on a number of occasions and tried to think, what were the possible causes of the crisis? An inherent weakness in accounting of results, large numbers of over the counter derivatives with large fair values, weak governance by regulatory bodies or even that bankers were paid too much? In the end, I believe that none of the above was a key contributor to the crisis. In my mind there are two unrelated causes.

The first is the mode of compensation in the financial industry. Not the amounts. Most bankers receive a kind of option pay out. If the firm makes a large profit (based on the mark to market of future uncertain cash flows), the employees receive large cash bonuses. If the firm makes a loss, in the worst

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case, staff may receive no bonus. Clearly, for a betting man, this gives carte blanche to load up the company with significant risk. Since most bonuses are not discussed with the owners of the company (the shareholders) but set by a compensation committee, often chaired by senior employees, there is a tendency to overpay since this justifies the compensation of the very people making the decisions. I will not dwell on this cause much longer – except to stress that the whole model encourages large risk taking.

The second is the point of this article. Risk was and still is, very badly understood, managed and reported. It is now clear that very few shareholders of banks understood the risks that some banks were in fact taking. In part, this is because disclosure of risk is unclear. A more fundamental issue, however, is that it appears that some of the banks did not fully comprehend the risk and actually outsourced much of their risk assessment to the rating agencies and then used flawed measures such as Value at Risk (VaR) not only to manage risk but also to report to management and shareholders alike.