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VALUE AT RISK: A NEW METHODOLOGY FOR MEASURING PORTFOLIO RISK IN VARIOUS INDUSTRIES

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Derivatives Management

A derivative is a term that refers to a wide variety of financial instruments whose values are derived from one or more underlying assets, market securities or indices. In practice, it is a contract between two parties that specifies conditions (especially the dates, resulting values and definitions of the underlying variables, the parties' contractual obligations, and the notional amount) under which payments are to be made between the parties. The most common underlying assets include: commodities, stocks, bonds, interest rates and currencies.

Derivatives may broadly be categorized as “lock” or “option” products. Lock products (such as swaps, futures, or forwards) obligate the contractual parties to the terms over the life of the contract. Option products (such as interest rate caps) provide the buyer the right, but not the obligation to enter the contract under the terms specified.

Usage

Derivatives are used by investors for the following:

1. Hedge or mitigate risk in the underlying, by entering into a derivative contract whose value moves in the opposite direction to their underlying position and cancels part or all of it out;
2. Create option ability where the value of the derivative is linked to a specific condition or event (e.g. the underlying reaching a specific price level);
3. Obtain exposure to the underlying where it is not possible to trade in the underlying (e.g., weather derivatives);
4. Provide leverage (or gearing), such that a small movement in the underlying value can cause a large difference in the value of the derivative;
5. Speculate and make a profit if the value of the underlying asset moves the way they expect (e.g., moves in a given direction, stays in or out of a specified range, reaches a certain level).

Hedging

Derivatives allow risk related to the price of the underlying asset to be transferred from one party to another. For example, a wheat farmer and a miller could sign a futures contract to exchange a specified amount of cash for a specified amount of wheat in the future. Both parties have reduced a future risk: for the wheat farmer, the uncertainty of the price, and for the miller, the availability of wheat. However, there is still the risk that no wheat will be available because of events unspecified by the contract, such as the weather, or that one party will renege on the contract. Although a third party, called a clearing house, insures a futures contract, not all derivatives are insured against counter-party risk.

Speculation and arbitrage

Derivatives can be used to acquire risk, rather than to hedge against risk. Thus, some individuals and institutions will enter into a derivative contract to speculate on the value of the underlying asset, betting that the party seeking insurance will be wrong about the future value of the underlying asset. Speculators look to buy an asset in the future at a low price according to a derivative contract when the future market price is high, or to sell an asset in the future at a high price according to a derivative contract when the future market price is low.

Individuals and institutions may also look for arbitrage opportunities, as when the current buying price of an asset falls below the price specified in a futures contract to sell the asset.

Types of Derivatives

- **Over-the-counter (OTC) derivatives** are contracts that are traded (and privately negotiated) directly between two parties, without going through an exchange or other intermediary. Products such as swaps, forward rate agreements, exotic options - and other exotic derivatives - are almost always traded in this way. The OTC derivative market is the largest market for derivatives, and is largely unregulated with respect to disclosure of information between the parties, since the OTC market is made up of banks and other highly sophisticated parties, such as hedge funds. Reporting of OTC amounts are difficult because trades can occur in private, without activity being visible on any exchange. According to the Bank for International Settlements, the total outstanding notional amount is US$708 trillion (as of June 2011). Of this total notional amount, 67% are interest rate contracts, 8% are credit default swaps (CDS), 9% are

foreign exchange contracts, 2% are commodity contracts, 1% are equity contracts, and 12% are other. Because OTC derivatives are not traded on an exchange, there is no central counter-party. Therefore, they are subject to counter-party risk, like an ordinary contract, since each counter-party relies on the other to perform.

- **Exchange-traded derivative contracts** (ETD) are those derivatives instruments that are traded via specialized derivatives exchanges or other exchanges. A derivatives exchange is a market where individuals trade standardized contracts that have been defined by the exchange. A derivatives exchange acts as an intermediary to all related transactions, and takes initial margin from both sides of the trade to act as a guarantee. The world's largest derivatives exchanges (by number of transactions) are the Korea Exchange (which lists KOSPI Index Futures & Options), Eurex (which lists a wide range of European products such as interest rate & index products), and CME Group (made up of the 2007 merger of the Chicago Mercantile Exchange and the Chicago Board of Trade and the 2008 acquisition of the New York Mercantile Exchange). According to BIS, the combined turnover in the world's derivatives exchanges totaled USD 344 trillion during Q4 2005. Some types of derivative instruments also may trade on traditional exchanges. For instance, hybrid instruments such as convertible bonds and/or convertible preferred may be listed on stock or bond exchanges. Also, warrants (or "rights") may be listed on equity exchanges. Performance Rights, Cash xPRTs and various other instruments that essentially consist of a complex set of options bundled into a simple package are routinely listed on equity exchanges. Like other derivatives, these publicly traded derivatives provide investors access to risk/reward and volatility characteristics that, while related to an underlying commodity, nonetheless are distinctive.

Common Derivative Contract Types

1. Forwards: A tailored contract between two parties, where payment takes place at a specific time in the future at today's pre-determined price.
2. Futures: are contracts to buy or sell an asset on or before a future date at a price specified today. A futures contract differs from a forward contract in that the futures contract is a standardized contract written by a clearing house that operates an exchange where the contract can be bought and sold; the forward contract is a non-standardized contract written by the parties themselves.
3. Options are contracts that give the owner the right, but not the obligation, to buy (in the case of a call option) or sell (in the case of a put option) an asset. The price at which the sale takes place is known as the strike price, and is specified at the time the parties enter into the option. The option contract also specifies a

maturity date. In the case of a European option, the owner has the right to require the sale to take place on (but not before) the maturity date; in the case of an American option, the owner can require the sale to take place at any time up to the maturity date. If the owner of the contract exercises this right, the counter-party has the obligation to carry out the transaction. Options are of two types: call option and put option. The buyer of a Call option has a right to buy a certain quantity of the underlying asset, at a specified price on or before a given date in the future, he however has no obligation whatsoever to carry out this right. Similarly, the buyer of a Put option has the right to sell a certain quantity of an underlying asset, at a specified price on or before a given date in the future, he however has no obligation whatsoever to carry out this right.

4. Binary options are contracts that provide the owner with an all-or-nothing profit profile.
5. Warrants: Apart from the commonly used short-dated options which have a maximum maturity period of 1 year, there exists certain long-dated options as well, known as Warrant (finance). These are generally traded over-the-counter.
6. Swaps are contracts to exchange cash (flows) on or before a specified future date based on the underlying value of currencies exchange rates, bonds/interest rates, commodities exchange, stocks or other assets. Another term which is commonly associated to Swap is Swaption which is basically an option on the forward Swap. Similar to a Call and Put option, a Swaption is of two kinds: a receiver Swaption and a payer Swaption. While on one hand, in case of a receiver Swaption there is an option wherein you can receive fixed and pay floating, a payer swaption on the other hand is an option to pay fixed and receive floating.

SWAPS Can Basically Be Categorized Into Two Types

Interest rate swap: These basically necessitate swapping only interest associated cash flows in the same currency, between two parties.

Currency swap: In this kind of swapping, the cash flow between the two parties includes both principal and interest. Also, the money which is being swapped is in different currency for both parties.

Economic Function of the Derivative Market

1. Prices in a structured derivative market not only replicate the discernment of the market participants about the future but also lead the prices of underlying to the professed future level. On the expiration of the derivative contract, the prices of

derivatives congregate with the prices of the underlying. Therefore, derivatives are essential tools to determine both current and future prices.

2. The derivatives market relocates risk from the people who prefer risk aversion to the people who have an appetite for risk.
3. The intrinsic nature of derivatives market associates them to the underlying Spot market. Due to derivatives there is a considerable increase in trade volumes of the underlying Spot market. The dominant factor behind such an escalation is increased participation by additional players who would not have otherwise participated due to absence of any procedure to transfer risk.
4. As supervision, reconnaissance of the activities of various participants becomes tremendously difficult in assorted markets; the establishment of an organized form of market becomes all the more imperative. Therefore, in the presence of an organized derivatives market, speculation can be controlled, resulting in a more meticulous environment.
5. Third parties can use publicly available derivative prices as educated predictions of uncertain future outcomes, for example, the likelihood that a corporation will default on its debts.

Commercial banks, investment banks, insurance companies, nonfinancial firms, and pension funds hold portfolios of assets that may include stocks, bonds, currencies, and derivatives. Each institution needs to quantify the amount of risk its portfolio may incur in the course of a day, week, month, or year.

For example, a bank needs to assess its potential losses in order to set aside enough capital to cover them. Similarly, a company needs to track the value of its assets and any cash flows resulting from losses in its portfolio. An investment fund may want to understand potential losses on its portfolio, not only to allocate its assets better but also to fulfill its obligation to make set payments to investors. In addition, credit-rating and regulatory agencies must be able to assess likely losses on portfolios as well, since they need to set capital requirements and issue credit ratings.

A new methodology called value at risk (VAR or VaR) can be used to estimate these losses. This article describes the various methods used to calculate VAR, paying special attention to VAR's weaknesses.

Value at Risk

Value at risk is an estimate of the largest loss that a portfolio is likely to suffer during all but truly exceptional periods. More precisely, the VAR is the maximum loss that an institution can be confident it would lose a certain fraction of the time over a particular period. Consider a bank with a portfolio of assets that would like to characterize its potential losses using VAR.

Example

The bank could specify a horizon of one day and set the frequency of maximum loss to 98 percent. In that case, a VAR calculation might reveal that the maximum loss is $1 million. Thus, on average, in 98 trading days out of 100, the loss on the portfolio will not exceed $1 million over a one-day horizon. But on two trading days in 100, losses will, on average, exceed $1 million.

Time Varying Volatility

The problem with the constant volatility method is that substantial empirical evidence shows volatility is not constant from day to day but rather varies over time. A look at a graph of the daily dollar return on the deutsche mark shows that volatility tends to cluster together. Notice that highly volatile times, characterized by large up-and-down swings in the exchange rate, tend to follow one another, while quiet periods, characterized by smaller up-and-down swings, tend to follow each other as well.

It is easy to calculate volatility using the constant volatility method. Bollerslev's GARCH method is much harder to implement: to find the right weight for each past squared return, we must employ a complicated, computer-intensive procedure. Once we have found today's volatility, we can multiply the confidence factor times the square root of today's volatility times today's stock price to find today's VAR. When we use Bollerslev's GARCH method, the confidence factor is the only number that does not change daily.

VAR For a Portfolio of Assets

Up to this point, we have considered only how to calculate the VAR of a portfolio consisting of a single stock. Now let's look at a portfolio of two stocks. The principles we are about to discuss apply generally to portfolios of many assets, but we will consider just two stocks to make the ideas clear.

As before, ultimately we want to find the volatility of the return on the portfolio. It's clear that the volatility of the portfolio should depend on the volatility of the return of each stock in the portfolio. So, we need to estimate the volatilities of the returns of both stocks. But stock returns may co-vary as well. For example, if the covariance between the stocks in a portfolio of two stocks is negative, then when one stock has a positive return, the other has a negative return, and vice versa.

Thus, the two stocks dampen each other's swings in return, producing a portfolio whose volatility is lower than the volatility of each stock in the portfolio. Adding more stocks to the portfolio would reduce the volatility further, provided the additional stocks'

returns are not highly positively correlated with the return of the initial portfolio. To account for this effect, we must also estimate the covariance between the stocks' returns. Once we know the stock returns' volatilities and co variances, we can calculate the volatility of the entire portfolio and find the VAR as before.

As an example of the calculation, suppose we have invested $1 in stocks 1, 2, and 3. Then by an elementary statistical formula, the daily volatility of the portfolio would be

Volatility (portfolio)=volatility(stock 1) +
Volatility (stock 2) + volatility (stock 3) +
2.0 x covariance (stock 1, stock 2) +
2.0 x covariance (stock 1, stock 3) +
2.0 x covariance (stock 2, stock 3)

Notice that if the covariance between the daily returns of stocks 1, 2, and 3 were zero, we could sum the volatilities of each stock to get the volatility of the portfolio. Thus, if covariance's between all assets were zero, we could find the VAR of each asset separately and then sum them to get the VAR of the portfolio. But since covariances are, in general, not zero, we can't, in general, find the VAR of individual assets and sum them to get the VAR of the portfolio. Moreover, we can't find the VARs of asset classes such as stock and currency portfolios separately and sum them. We must account for the covariances between asset classes as well.

To calculate covariance's between the assets' returns using the constant covariance method, we use an equally weighted average of the products of each stock's past daily returns.

Weaknesses of VAR

When properly used, VAR can give an institution an idea about the maximum losses it can expect to incur on its portfolio a certain fraction of the time, making VAR an important risk-management tool. Using VAR calculations, an institution can judge how it should re-allocate the assets in its portfolio to achieve the risk level it desires. But VAR methodology is not without its weaknesses, and, improperly used, it may lead an institution to make poor risk-management decisions. This can happen for one of two reasons: either the VAR is incorrectly calculated or the VAR is correctly calculated but irrelevant to the institution's real risk-management goals.

Liquidity of Assets. VAR measures the maximum loss that an institution can expect a certain fraction of the time over a specific horizon. Losses are measured by assuming that the assets can be sold at current market prices. However, if a firm has highly illiquid assets--meaning that they cannot quickly be resold--VAR may underestimate the true losses, since the assets may have to be sold at a discount.

Credit Risk. Another potential problem for VAR is that the methods used to evaluate the assets in the portfolio may not properly treat credit risk. Suppose a bank buys a portfolio of derivatives from many different firms. The derivatives are valuable to the bank because they impose obligations on the firms.

For example, one of the derivatives may obligate a firm to sell foreign currency to the bank at a price below the current market price, yielding a profit to the bank under some conditions, but it may also obligate the bank to deliver foreign exchange at a below-market price under other conditions.

Conclusion

VAR is an important new concept in portfolio risk management. It gives the maximum loss that an institution can expect to lose with a certain frequency over a specific horizon, and it can be calculated by using a constant volatility or time-varying volatility method. There are, however, problems in implementation and interpretation. To implement VAR calculations, it is important to use the right method, especially under unusual circumstances such as stock market crashes. Although much progress has been made in describing how volatilities change through time, not as much progress has been made in the description of time-varying covariances. Thus, VAR numbers should be viewed with caution at this point.

Besides the problem of identifying the right method, VAR measures may mislead unless they properly account for liquidity risk, rare or unique events, and credit risk. In many situations, it may not be the right risk-management concept. An institution may want to investigate an alternative, such as worst-case-scenario analysis.

Despite the contribution that VAR can make to a firm's understanding of the risks in its portfolio, these risks can be misunderstood if they are not communicated effectively to a management that understands the value and limitations of sophisticated financial technology. Poor management practices, which could lead to unauthorized trades, may also contribute to this misunderstanding. Thus, a firm should use VAR in the context of a broader risk-management culture, fostered not only by the firm's risk managers but also by its senior management.

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