Risk Management Summary

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The most commonly used risk management tools are forward and futures contracts. Beginning in the 1970's and accelerating through the 1980's and 1990's, interest has developed in option-based risk management. Basically, interest in options has grown for two reasons.

First, options enable investment and funding managers to act upon their views, and yet retain downside protection. Historically, these managers have tended to fix or float as part of their ongoing financial strategy. If they developed a relatively negative view toward their usual strategy, they would adjust a fraction of their fix position to float, and vice versa. The stronger the conviction that the standard strategy is not right, the greater the fractional adjustment. Only rarely would the manager reverse their normal strategy completely.

Options permit the manager to reverse strategy on a position completely, yet be sure that his downside is limited to an acceptable loss. This alternative requires payment of an option premium, which was a barrier to early management interest. However, option dealers learned how to back load or otherwise make the costs transparent. In both cases, option pay outs were adjusted to compensate the dealer for the premium value on the contract initiation date. As managers' option understanding increases, their resistance to paying option premiums has lessened.

Generally, options are the right, but not the obligation, to buy or sell (pay or receive) a fixed amount given payment or receipt of another amount. Relative to forward contracts the "right" feature of options is important. This right implies that options should be used in cases when our level of uncertainty or sensitivity to risk is greater than what the market is pricing in option premiums. Otherwise, the appropriate fixing or floating (full or fractional) strategy should be followed.

There are two major sources of uncertainty that lead to interest in options: direction uncertainty, and transaction size or occurrence uncertainty. Direction uncertainty means that we are not sure in which direction rates, currency prices, or whatever are headed. However, we are relatively certain that they will move a lot. Such a scenario is a volatile one. When faced with volatility, we will want to consider options or option-like insurance tactics. As an aside, note that two related measures of uncertainty are the range of outcomes envisioned, and/or the standard deviation of the underlying value risk.

When transaction size or occurrence are an issue, options are, again, a risk management alternative. Transaction size risk arises when we know a payment will be made or received, but don't know its size. Occurrence risk arises when a transaction may or may not be completed, such as bid-to-award, buy-out and restructuring situations. In all of these cases, we can hedge our risks with forward contracts. Nevertheless, we face the question of how much of the uncertain quantity to hedge. If we hedge the full potential amount, and the actual transaction size differs from our hedge, then we can lose (or gain) on the mis-hedged portion of our position. When it is in our interest, option positions let us walk away from such transactions. Forward (or futures) hedges do not.

Option markets have developed on most commodities and financial instruments. In our discussion, we treat currency risk. The principles underlying currency risk management are the same as those underlying rate, yield, commodity, bond, equity and most other risks. The basic insights are based on the forward or futures value of these "underlying". When long an underlying (or receiving the underlying in the future), we worry about its value falling. Therefore, our hedge is to sell the underlying forward. If we are relatively certain that the underlying will drop, then it's a done deal.

When we are worried about a long position price fall, but believe that their is an equal or greater chance of a price run-up, we won't want to give up our potential upside. We could hedge only a portion of our risk. Alternatively, it may be better to buy, or otherwise create, option-based protection. This protection insures a limited loss, while retaining the opportunity for gain.

As with forward contracts, this protection may be bought directly as an option, or created synthetically with a trading strategy, which will (in normal markets) roughly replicate the option protection. The underlying logic of such an option-replicating strategy for equities is well-known as portfolio insurance. Sometimes, e.g. October 17, 1987, the option insurance replication is not so good. We will see that an option replication strategy is one of fractional hedges, which are updated as the underlying value and/or time changes.

Just as forward contracts may be used to hedge long or short exposures, options exist for insuring long and short exposures. Specifically, put options (or the synthetic "equivalent") are used to insure receivable (long) exposures. (Puts are the right, but not the obligation, to sell.) Call options are used to insure payable (short) exposures. (Calls are the right, but not the obligation, to buy.)

Managing Receivable Risk - Put Insurance

When we will receive a stock, bond, commodity, loan or currency in the future, we are said to face a long exposure. Our exposure break-even is the associated forward price, because it is the value for which our position can be sold on the receipt date. For our long position-receivable example, we use currency.

In Figure 1, we have plotted the long exposure profit and loss relative to a $1.6583 forward currency price, the dashed (45 degree slope) line. To insure this position's value, we must buy or create a cash flow which will increase as the currency price falls. The option that rises in value as the underlying price falls is a put.

The Put

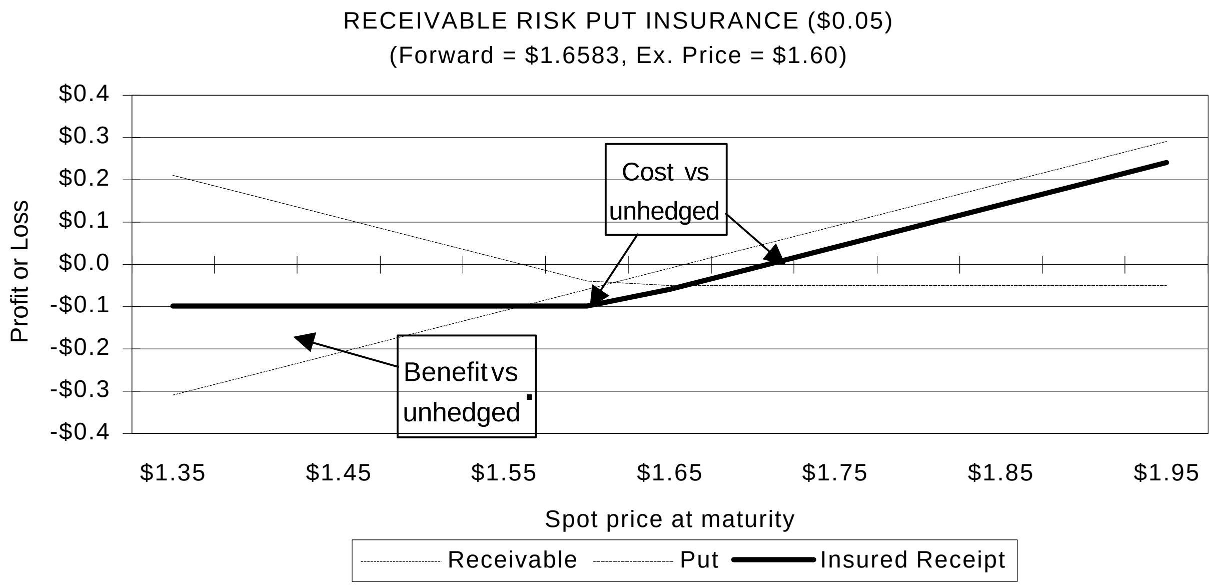
Let us assume the put, which we may buy, costs five cents in future value terms, and is exercisable at a price of $1.6083. Put option pay outs are equal to the maximum of the exercise price less the currency price and zero. The net put option value at maturity is equal to this pay out less the premium future value.

In a few scenarios, example put values are the following:

Exercise price less	1.6083	1.6083	1.6083	1.6083	1.6083	1.6083
Underlying price	1.4583	1.5083	1.5583	1.6083	1.6583	1.7083
Difference	.15	.10	.05	0	-.05	-.1
Max(difference,zero)	.15	.10	.05	0	0	0
less premium	-.05	-.05	-.05	-.05	-.05	-.05
Net	.1	.05	0	-.05	-.05	-.05

The net put pay out is depicted in Figure 1 by the long dash-short dash line. We next consider how this put will protect against floating position losses, while maintaining up market profit potential (relative to fixing).

Figure 1



If we buy this put, then the net of our floating long underlying exposure and put option cash flow is the following:

Underlying price	1.5083	1.5583	1.6083	1.6583	1.7083	1.7583
Put net	.05	0	-.05	-.05	-.05	-.05
Total	1.5583	1.5583	1.5583	1.6083	1.6583	1.7083
Relative to Fix	-.1	-.1	-.1	-.05	0	.05

In Figure 1, the total insured receivable exposure is plotted as the "Insured Receipt" solid line.

To highlight the costs and benefits of the insured floating receivable, three areas are noted in the figure. First, the insurance benefit is clear relative to going unhedged. If prices drop significantly, then the put protection kicks in to offset our currency loses.

Nevertheless, the insured position net is less than we would receive had we fixed. With price drops, insured floating is better than floating, but worse than fixing (by the amount of the premium plus the amount that the exercise price is below the forward price, or ten cents in our example.)

When prices rise significantly, we benefit relative to fixing. We let the option expire worthless, and sell our receivable at the higher market price. Note, again however, that our gain is reduced by the option premium. With price increases, the insured floating position is better than fixing, but worse than floating (by the premium amount).

If the underlying price does not move significantly, the last region highlights a final option insurance cost. In this eventuality, the option insurance-floating combination is worse than either floating or fixing. The cost of insurance is greater than the gains from floating in a mildly up market, and deducts from the gains from fixing in a mildly down market. Basically, the level of uncertainty insurance that costs out in the option premium was not borne out in accumulated market movements over the life of the exposure. In this range, the value gained is less than the price paid. In retrospect, we would have been better off not buying the option.

In all three cases, the higher the put premium, the less protection we get. Option premium levels are set by the level of uncertainty expected by dealers and their other customers. With more perceived uncertainty, options grow more expensive.

The Dynamic Put

When an option dealer sells an option, they make a judgment as to how much their costs of hedging the option will be over its life. This cost is directly related to the amount of underlying value variation throughout the options life. The more variation expected, the higher the price charged.

The investment or funding manager can replicate option-like pay outs through certain series of transactions. These transactions are exactly the same as what the option dealer will do to hedge their option sales. Therefore, our analysis of option hedging will focus on the manager's alternative. We outline how the manager can, by updating fractional hedging transactions, roughly duplicate put option protection.

With a currency receivable, the static forward hedge is to sell forward contracts. It can be shown that the put option receivable insurance is roughly equivalent to selling a fraction of the receivable forward, then adjusting the position as the currency price moves over the receivables life.

For a receivable case, we might sell 30 percent of the position forward. If the underlying currency price rises, we buy back some forward (maximum 30 percent). If the currency price falls, we want to be more hedged and, hence, sell more forward. If monitored and transacted frequently enough, then our position can be protected at roughly the $1.60 level also.

If the currency runs down significantly, our net sequence of forward sales will have built up a fully short position by maturity, and we are hedged. If the currency runs up significantly, our net sequence of forward purchases will have closed out our short position by maturity. We end up long. By making these trades as currency prices change, we can, effectively, mimic option-like insurance. The costs of the strategy arise in funding the underlying and cash positions that insure the exposure.

The danger in this dynamic strategy is that prices will fall or rise precipitously. In this event, our hedge revisions will be both too little and too late. If the price jumps down, then our losses will rise above the associated option protection level. If the price jumps up, then our gains will be limited by having an overly short hedging position. Effectively, the risk in currencies was greater than we expected. In retrospect, it would have been better to buy option insurance, than to try to do it ourselves. Nevertheless, there will be many instances in which our dynamic hedging costs will be less than quoted option premiums.

When we overpay for option insurance, option dealers make money. They make money, effectively, by undertaking the dynamic hedging for us. If they are right, low volatility yields hedging costs that are less than the premium charged. In turn, when option insurance proves to be valuable relative to the dynamic hedging alternative, dealers lose. The price that they received does not compensate for their hedging cost, and we were smart (or lucky) enough to buy underpriced insurance.

Managing Payable Risk - Call Insurance

When we will pay a currency or be required to deliver cash, a bond, stock or a commodity in the future, we are said to face a short exposure. The breakeven on our exposure is the associated maturity forward price, because it is the cost of covering our position on the receipt date. For our short position-payable example, we, again, use currency.

In Figure 2, we have plotted the short exposure profit and loss outcome relative to an $1.6583 forward currency price, the dashed (negatively sloped 45 degree) line. To insure this position's value, we must buy or create a cash flow which will increase as the currency price rises. The option that rises in value as the underlying price rises is a call.

The Call

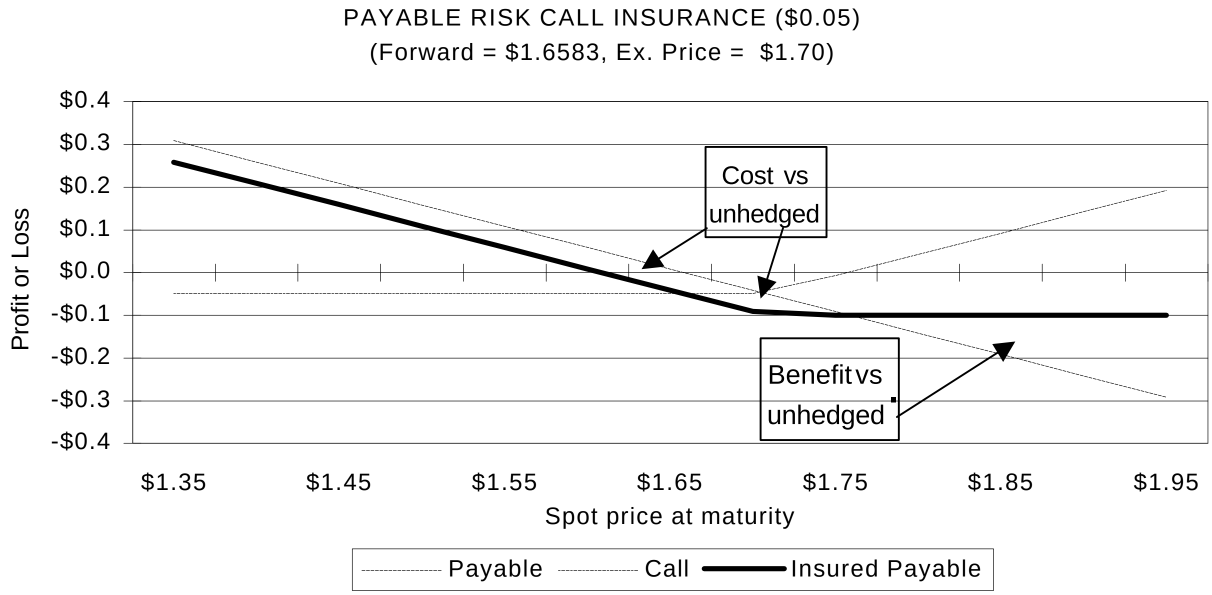
Let us assume that the call, which we are considering buying, costs five cents in future value terms, and is exercisable at a price of $1.7083. Call option pay outs are equal to the maximum of the currency price less the exercise price and zero. The net call option value at maturity is this pay out less the premium future value.

In a few scenarios, example call values are the following:

Underlying price	1.6083	1.6583	1.7083	1.7583	1.8083	1.8583
less Exercise price	1.7083	1.7083	1.7083	1.7083	1.7083	1.7083
Difference	-.10	-.05	0	.05	.1	.15
Max(difference,zero)	0	0	0	.05	.10	.15
less premium	-.05	-.05	-.05	-.05	-.05	-.05
Net	-.05	-.05	-.05	0	.05	.1

The net call pay out is depicted in Figure 2 by the long dash-short dash line. We next consider how this call will protect a floating position, which allows us to profit in a down market (relative to fixing).

Figure 2



If we buy this call, then the net of our floating short underlying exposure and call option cash flows is the following:

Underlying pay	-1.5583	-1.6083	-1.6583	-1.7083	-1.7583	-1.8083
Call Net	-.05	-.05	-.05	-.05	0	.05
Total pay	-1.6083	-1.6583	-1.7083	-1.7583	-1.7583	-1.7583
Relative to fix	.05	0	-.05	-.1	-.1	-.1

In Figure 2, the total insured payable exposure is plotted as the "Insured Payable" solid line.

To highlight the costs and benefits of the insured floating payable, three areas are noted in the figure. These areas are analogous to the receivable-put insurance case, and the extension is left to the reader.

The Dynamic Call

For our payable case, dynamic call-like insurance could be created by the following transactions: buy 30 percent of the position forward, as the currency rises buy more forward, and as the currency falls, sell off forward (max 30 percent).

If the currency runs up significantly, our net sequence of forward purchases will have built up a long hedge position by maturity. If the currency runs down significantly, our net sequence of forward sales will leave us with a short position by maturity.

The cost of these dynamic hedges arises because, effectively, we are trading after the market moves. In the cases in which usual option models are exactly right (never), the cost of maintaining the dynamic hedge will equal the option insurance premium. Except in cases of marked price changes, the dynamic hedge will, roughly, match the option protection. If market variation ends up being less than initially priced, then the dynamic hedging cost will be lower than the option cost.

Evaluation

To evaluate the dynamic hedge option, we return to basic risk concepts. Financial risks are largely related to price variability or volatility. The likely range of prices is a potential measure of this risk. Therefore, perceptions of wide potential price ranges should be associated with more volatility and risk. In terms of risk parameters, high standard deviation estimates imply the same view.

Insurance is valuable when we face risk. Option dealers charge higher prices for the insurance that they provide when their perceived level of risk is high. Equivalently, they charge higher prices when their expected price range widens.

If on average they are right, we should find that standard measures of variability, e.g. standard deviation, are higher in the periods that follow richly priced option insurance.

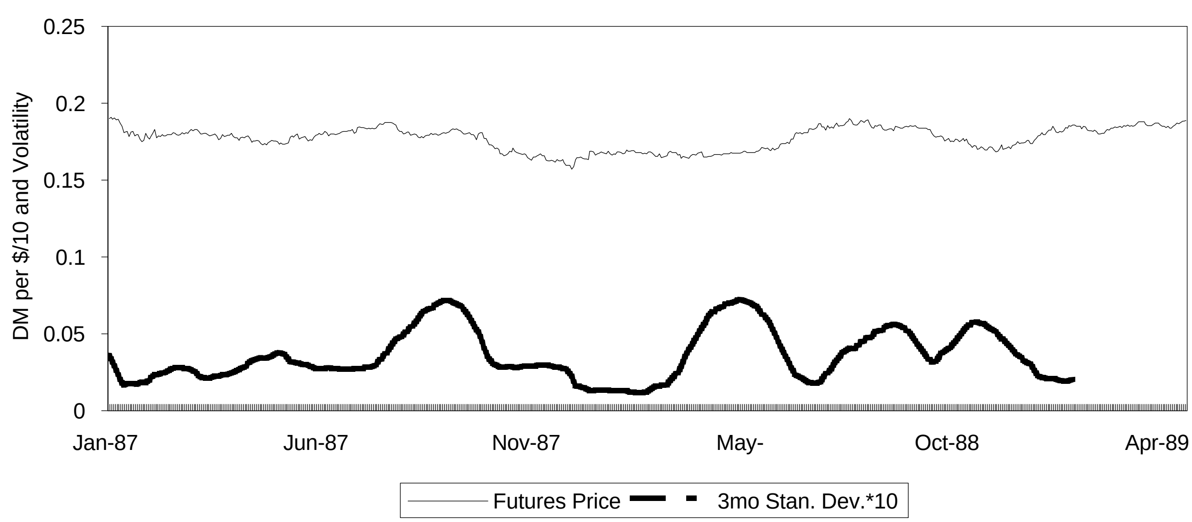
Nevertheless, we will sometimes disagree with the implicit option market pricing of risk. In those cases, we may want to dynamically hedge, and not buy options. If we are right, our hedging cost will be less than the option premium. If we are wrong, the high volatility will induce dynamic hedging costs above what we envisioned, and possibly well above the offered option premium.

Deutschemark Example

Figure 3 presents two series related to both hedging and insuring Deutshemark risk: futures price and three month forward-looking standard deviation estimates. The price series is of interest with regard to both the direction and variability of the underlying risk. The series direction is obvious, and the variability can be inferred from the vibrations in the series.

Figure 3

Deutschemark Values and Volatility (TOG, I.P. Sharpe and Optionomics)



The second series, "3 mo Stan. Dev., depicts the actual variability in the series. It is the sample standard deviation of price changes looking ahead three months. The first "Jan-87" observation is the Deutschemark price sample standard deviation from January through March 1987. For each trading day standard deviation observation, the three month sample window is moved forward by a day.

The valuation information in the standard deviation series provides an indication as to when insurance was valuable. For example, buying three months of insurance at the beginning of January 1987, was a more worthwhile than buying it at the end of the month.

We document this point in two ways. First, the sample standard deviation falls over the month. The source of this fall can be seen clearly in the price series. The Deutschemark's value rose a good deal in January, from over 1.90 Dm per dollar to less than 1.80 Dm to the dollar. It's value then stabilized through the end of April. In this four month (January to April) period, we needed insurance most (and particularly Dm payable insurance) in the early portion of January.

Looking further along the time series, we see standard deviation-variability peaks occur on September 25, 1987, May 12, 1988, September 14, 1988 and November 17, 1988. Subsequent to these dates, Deutschemark values varied greatly for three months.

Given the variability of price variability, potential interest in conditional insurance decisions arises. To state this point another way, our interest in insurance rises and falls with potential price volatility (e.g. high interest with high volatility). To illustrate the potential opportunities, we will make the strong assumption of clairvoyance. For once, we know infinitely more than everyone else. We consider three blissful examples (reality and associated pitfalls are discussed below).

Beginning in January 1987, we see that the Dm value is rising, and the forward-looking variability is falling. What should we do? If we have a receivable (long Dm exposure), we let our gains run, and do not sell forward. Simultaneously, our need for put insurance is declining, as variability falls. Hence, we do not combine floating with put insurance.

In May 1987, the Dm exchange rate is rising and its value is falling. Variability is relatively stable. We hedge our receivable by selling forward, and again do not insure. In August 1987, the Dm begins a marked and volatile appreciation. We do not want to fix in this case, and might want to insure given the high level of volatility.

Direction and Volatility

Generally, we can see that both direction and volatility affect our hedging and insuring decisions. Therefore, we must have views about both of these two quantities, if we are to manage our receipt and payment risks. For receivables,

Views - Volatility → and/or Direction ↓	Up	Stable	Down
Up	no forward (may buy put)	no forward (may buy put)	no forward or put
Stable	buy put	may sell forward or buy put	may sell forward
Down	buy put (may sell forward)	sell forward (may buy put)	sell forward

For payables,

Views - Volatility → and/or Direction ↓	Up	Stable	Down
Up	buy call (may buy forward)	buy forward (may buy call)	buy forward
Stable	buy call	may buy forward or call	may buy forward
Down	no forward (may buy call)	no forward (may buy call)	no forward or call

These summaries are relatively straight-forward. However, an important factor remains unaddressed. That factor is the cost of call and put insurance.

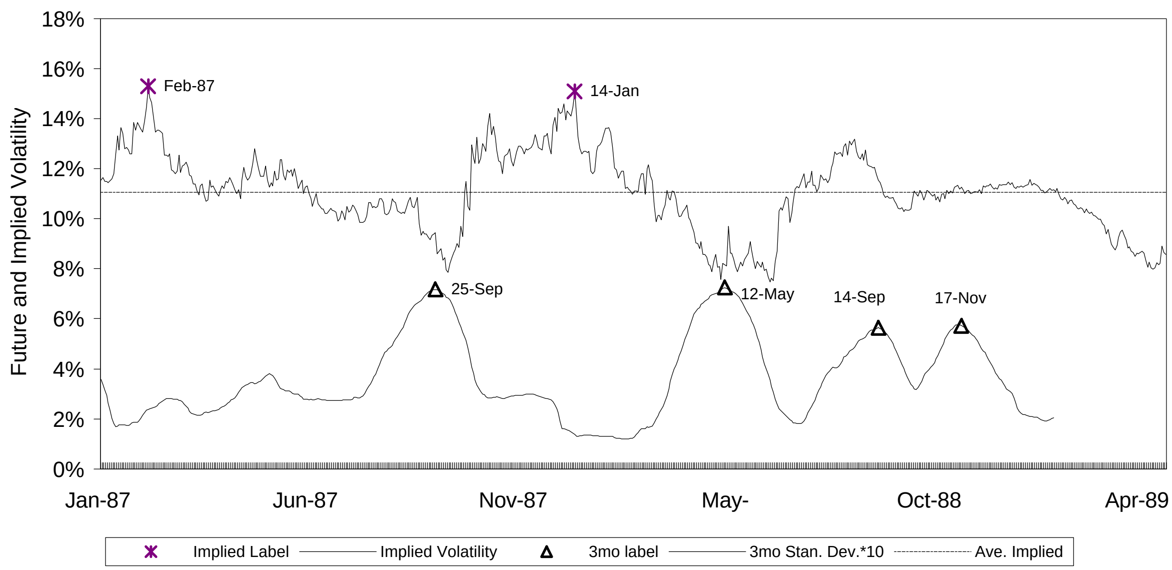
Option Insurance Cost, Implied Volatility and Actual Volatility

As already motivated, option premiums are directly related to the perceived level of future underlying price variability. In option markets, variability has come to be defined by the volatility that is consistent with market pricing and standard option pricing models. The way this volatility measure (or parameter) is calculated is by changing the option model standard deviation input until the model value equals a quoted option price. In standard option pricing models, the standard deviation is the only unknown parameter. Hence, stating an option price is equivalent to stating a standard deviation input (and vice versa). Though some markets are not as standardized as others in using this convention, currency option markets are so standardized. The standard deviation input is called "Vol". Vol moves up and down with option prices.

In Figure 4, we plot both forward-looking Deutschemark sample standard deviations and quoted option vols. The vol series averages a little over 11 percent, with a maximum around 15 percent and a minimum around 8 percent. As noted above, this implied volatility series indicates the richness and cheapness of option insurance. High (low) vol means high (low) insurance cost.

Figure 4

Deutschemark Values and Volatility (TOG, I.P. Sharpe and Optionomics)



If options are priced correctly (neither rich nor cheap), then there should be a strong relation between option cost and the uncertainty that results over the options life. We have focused on variability over a three month period, to roughly match a standard option maturity. If the options are priced correctly, then peaks in the vol series should be associated with peaks in the standard deviation series, and vice versa.

In the Figure 4 plots, we see that the sample standard deviation - vol match is awful from August 1987 through July 1988. Basically, option vols are low when future uncertainty is highest and highest when things remain relatively stable. Though the series are in sync in the May 1987 period and the period subsequent to July 1988, the out-of-sync phases are quite dramatic.

These observations highlight the importance of our discussion of synthetic option insurance alternatives. In periods like December 1987, option insurance ended up being a terrible purchase. Markets were quite nervous, but prices remained very stable over the life of a three month option contract.

Were we able to foresee this type of occurrence, while wanting option-like protection, the dynamic option replicating tactic would have saved us a good deal of money relative to the quoted option premiums. Analogously, the May 1988 period was one in which option insurance was very cheap. Subsequent market movements clearly exhibit significant volatility. In this type of situation, we should buy option insurance. The dealer will have sold us cheap insurance, and subsequently they, not us, will face significant dynamic hedging costs.

Of course, it is difficult to forecast market volatility. Nevertheless, evidence tends to indicate that volatility prediction is easier than price direction prediction. Particularly, volatility does appear to return toward its average value. When it gets very high or very low relative to the average, it seems to rebound. There are reasons behind this observation, which are related both to the way dealers, investment managers and funding managers make their money, and to the way other agents react to market developments.

From an insurance perspective, these activities imply that insurance fire sales, like on the Deutschemark at the eight percent level, do occur at times. Furthermore, exorbitant prices are charged from time to time. In these eventualities, it might well be better to self-insure with dynamic option-replicating insurance. These observations suggest the following initial rule.

Given an insurance demand,

Vol relative to average	well above	well below
"option" position	dynamic hedge	option

Conclusion

Though we have focused on currency risk management, the principles and strategies developed are relevant for managing other financial risks. For equities and commodities, the techniques translate directly. Wherever we have treated forward currency prices, we simply substitute forward stock or commodity price.

For interest rate-related risks, the approach can be applied directly to forward rates, yields and prices. However, the interest rate game is a bit more complicated than the currency-commodity-equity game due to the term structure relationships that must hold. For this reason, more sophisticated (though still forward rate-based) approaches are being applied. Nevertheless, the direction-volatility intution, which we have developed, is equally applicable in interest rate cases.

As the maturity of hedged and insured exposures lengthens, more sophisticated approaches are also required in the stock, commodity and currency cases. These approaches are just now being developed, and suggest that full risk management approaches across multiple currency, equity, bond, commodity or whatever will be developed and used. In these cases, the issues of underlying price correlation and transaction cost concerns grow in importance.

Risk Management Summary

Underlying Exposure	Forward Hedge	Insurance	
		Option	Dynamic
Receivable - long	Sell	Put	% sale
Payable - short	Buy	Call	% buy

Direction, Size and Volatility Trade-off

Relatively sure of direction and size -	Forward
Relatively unsure of direction and/or size	
Expect volatility above or near level implicit in option prices - (option prices are relatively cheap)	Buy options
Expect volatility below level implicit in option prices - (option prices are relatively rich)	Dynamic hedge

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