Financial Derivatives and Risk Management
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Lecture 10: Futures Hedging: Nuances

Hedging: better vs certain outcomes

It is sometimes perceived that hedging gives rise to better outcomes in the sense that it improves the profits of the enterprise of the entity undertaking hedging. It is actually not so. By the process of hedging, what we are ensuring is that the future cash flows will be more certain, we are not ensuring that the future profits will increase. When we hedge an exposure, we try to insulate the exposure from the effect of the risk factor, whatever that risk factor is. So, what we try to ensure by hedging is that the future cash flows relating to hedged account become more certain.

But that does not of itself imply that outcome is going to be more profitable. In fact, there may be a situation where at the lifting of the hedge, the hedger may realize that the prices have moved in such a pattern that had he not hedged the exposure, he would have made a higher profit. For example, consider an investor is long in an asset and he hedges against a future fall in prices by establishing a short futures hedge. Obviously, if the cash prices actually fall as per his perception, the futures prices will decline due to the positive correlation between spot and futures, whence he will make a profit on the short futures which will compensate his cash position losses. But if the prices actually rise contrary to his perception, he will gain on his cash position while the short futures hedge will yield a loss. Thus, in such a situation, the hedge will eat into his cash position profits. Thus, in retrospect, he would have been better off by not hedging. This state of affairs arises from the linearity of the futures payoff profile. If there is a rise in price, then the hedge eats into the profits on the long asset. As a result of this the profits of the hedged portfolio turn out to be less than the profits earned on the unhedged portfolio.

However, if the investor had not hedged his investment, he would have been exposed to the uncertainty due to the randomness of the price process. By instituting a hedge, he ensures that the unpredictable changes in prices of his holdings are counterbalanced by the reverse change in prices in the futures market. So, he gets a more certain outcome. Deviations are reduced, but hedging may result in loss of potential profit if the price flow is contrary to the direction envisaged when creating the hedge.

SPOT PRICE t=0	60	60	60
QUANTITY	100	100	100
SPOT PRICE t=T	50	60	70
FUTURES PRICE t=0	62	62	62
FUTURES PRICE t=T	50	60	70
FUTURES QUANTITY	-100	-100	-100
CHANGE IN SPOT VALUE	-1000	0	1000
CHANGE IN FUTURES VALUE	1200	200	-800
NET CHANGE	200	200	200

This issue is best illustrated with an example. We consider the data in the above table. We have an asset which is a currently (t=0) priced at 60, our holding is 100 units. We hedge our holding by a short futures hedge at the current (t=0) futures price of 62. The hedge ratio is taken as 1.00.

We take three scenarios for the spot price at hedge lifting (t=T) i.e. 50, 60 & 70. The futures price at hedge lifting is also taken at the same values i.e. 50, 60 & 70 respectively.

Now, if our asset holding is not hedged, the change in the value of the holding is -1,000, 0 and +1,000 in the three scenarios. If the price drops to 50, a loss of 1,000 is incurred and if the price rises to 70 a profit of 1,000 is realized.

The price of the futures also changes and the hedge realizes a profit of +1,200 in the first scenario and a loss of -800 in the third scenario.

As a result of this, the net change of the hedged exposure (exposure+hedge) in all the three cases turns out to be plus 200.

The interesting point is if the hedge was not undertaken, then there is ***a particular scenario***, viz the cash price of the asset goes up to 70 (third scenario) in which case the investor would have made a significantly higher profit than he makes on any scenario on the hedged asset. In that scenario (third scenario), out of the 1,000 profit on the unhedged asset, 800 is wiped out by the hedge (the hedge incurs a loss of 800).

The positive side, however, is that in scenario one, it is the other way round. The loss on the holdings (-1,000) is compensated by the profit on the hedge (+1,200). The net outcome is that in all the scenarios, the hedged asset does not show any fluctuation in value as its value change is fixed in all the scenarios at +200. This is what we mean when we talk about hedging. The value change of the hedged asset turns out to be 200 in whatever state the market evolves and the value of the spot price of the asset turns out to be. However, if the price does evolve as expected in scenario three, then the hedger loses out on potential profit.

Thus, when the exposure is incurring losses, the hedge compensates for the losses. But when the exposure yields profits, it also eats into those profits so that the investor ends up with a steady value of the exposure. That is what we mean by better versus certain. So, hedging may not result in better outcomes, but hedging does result in more certain outcomes.

Perfect vs imperfect hedge

A hedge is said to be perfect, if the price, value, cash flow or other attribute of an asset, liability or operating income is so fixed by the hedging process as to be absolutely certain, precisely predictable at the time of hedge inception (t=0). For example, a hedge of a purchase is perfect if the price to be paid by the hedger is fixed precisely by the hedge and is known at hedge inception at t=0. A forward contract provides a perfect hedge since it fixes the price at which the underlying is to be bought or sold.

However, futures do not provide a perfect hedge. The price payable/receivable under a futures contract contains a basis term b_N. This basis, being the difference of the spot price S_N and futures price F_N at t=N (hedge lifting), both of which being random variables, is itself a random variable. That being the case, the price payable/receivable cannot be precisely predicted and therefore creates a risk stimulus called basis risk. \

In addition, futures contracts are subject to marking to market on a daily basis. In case there is a change in the interest rates at which margin accounts are maintained during the period of holding futures positions, hedge imperfections will arise.

Basis risk itself can arise due to various factors viz the underlying asset may not be the same as the exposed asset, difference in maturity between the hedge and the futures, integral lot size of futures contracts etc.

Short & long hedge

We have two different types of hedging situations, a short hedge and a long hedge. A short hedge entails creation of a hedge by taking a short position in the futures market, a long hedge entails taking a long position in the futures market to create the hedge.

A short hedge is a hedge that involves a short position in futures contracts. A short hedge is appropriate when the hedger already owns an asset and expects to sell it at some time in the future. A short hedge can also be used when an asset is not owned right now but will be owned at some time in the future to be sold thereafter.

When would an investor create a short hedge? When he feels that by creating a short hedge he is able to make profits that would compensate him for the losses that he may make on his exposure due to adverse price movements. When will the investor make profits on a short futures position? When the price of the futures falls. Now, there is usually a positive correlation between spot & futures prices. Hence, the investor would make profits “on the hedge” when the spot prices fall. Since hedge is created to annul the adverse impact of prices on the cash market exposure, it follows that the investor would make a loss on his cash market exposure when prices fall. This implies that the investor is long in the asset i.e. he either owns the asset or is likely to own the assent in the future. By the short hedge, the investor wants to protect his long portfolio against fall in prices.

If there is a fall in the price of securities in the cash market and the value of the portfolio declines and the futures market mirrors the price pattern of the spot markets to some extent, then the futures markets should also show a price decline and because the short hedger has a short futures position, he makes a profit in the futures market.

The converse holds for a long hedge. Hedges that involve taking a long position in a futures contract are known as long hedges. A long hedge is appropriate when a company knows it will have to purchase a certain asset in the future and wants to lock in a price now.

Short hedging & basis

Let us work out the actual price that a short hedger receives when he sells an asset that is covered by a short hedge.

Price at which underlying is sold in the spot market at maturity of hedge period (t=N)= S_N
Profit from the short futures position, that was created at F_0 at t=0 and closed out at F_N at t=N is F_0-F_N
Net proceeds from the hedged transaction = $S_N+F_0-F_N= F_0+(S_N -F_N)=F_0+b_N$

While F_0 is known upfront, b_N being the basis at t=N, is not. It is b_T that captures the randomness element. Of course, if the maturity of the hedge coincides with the maturity of the futures i.e. T=N, then by convergence $b_N=b_T=0$ due to arbitrage considerations. Then, Net proceeds from the sale of the hedged asset $=F_0$.

S_N is price that the short hedger will receive when he lifts the hedge at t=N and sell the asset in the spot market at that point in time. Now, because he has a short position in the futures hedge, his profit on the short futures is F_0-F_N. Therefore, the net price that the hedger receives is $S_N+(F_0-F_N)=F_0+b_N$. Now, the important thing here is that F_0 is known t=0, it is the futures price at the time the hedge is instituted but b_N is a random variable, it depends on the spot price S_N and futures price F_N at the point at hedge lifting.

Contrast this with a forward hedge. In the case of a forward the price received at sale would have been precisely F_0, known upfront. Thus, forwards gives a perfect hedge since the value of the hedged asset is fixed and known precisely at hedge inception.

However, in the case of futures hedging, the price received contains a random term b_N. Of course, if the hedge lifting coincides with futures maturity, then convergence dictates that $b_N=0$. But that is a special case, when the hedge period coincides with the maturity of the futures contract, which need not necessarily be true. Indeed, in general, it is not true. Therefore, b_N may not take a zero value and indeed not even a predictable value. The presence of b_N the price received by the hedger and the fact of the basis evolving as a stochastic process so that b_N is a random variable implies that the price received on lifting the hedge at t=N is not precisely predictable at t=0. Thus, futures do not give a perfect hedge.

The risk generated due to the randomness embedded in the basis is called basis risk. It is a cardinal issue in the context of the use of futures for hedging.

Long hedge & basis

Similarly, the net price paid by a long hedger= $-S_N+F_N-F_0= -F_0-(S_N -F_N)=-(F_0+b_N)$

Thus, if the basis weakens unexpectedly, long hedger gains & short hedger loses & vice versa.

Use of futures for hedging

Notwithstanding that futures intrinsically are imperfect hedging devices, they have certain discrete and definite advantages over other hedging instruments. The advantages emanate primarily from the trade-ability of the futures; one can lift the hedge anytime one deems appropriate. Forward contracts are neither tradeable nor liquid and the contracting parties are bound by the contract between them. The tradability of futures provides liquidity and flexibility to the investor. These features are a very significant contributor to their popularity as hedging & speculating instruments. We will now take various issues one by one.

Choice of underlying asset

Choose either the same asset as the asset being hedged or an asset whose spot price has a high positive / negative correlation with the spot price of the asset to be hedged.

If the underlying asset is positively correlated with the exposed asset, the hedge must be opposite to the exposure i.e. long exposure to be covered by short futures hedge. If the underlying asset is negatively correlated with the exposed asset, the hedge position must be the same as the exposure i.e. long exposure to be covered by long futures hedge. The basic philosophy is that the effect of hedged risk on the exposure should be annulled by the effect of the risk on the hedging asset.

If futures on the exposed asset are trading and available for taking positions, then the hedge should naturally be created with these futures. However, if there are no futures contracts traded on the exposed asset, then the right thing to do is to look for futures on an underlying asset such that the prices of those futures have the closest correlation with the prices of the exposed asset to be hedged.

The hedger needs to look for an underlying such that the prices of futures thereon are closely correlated with the price process of the (hedged) asset. Of course, theoretically a significant negative correlation is equally good. If the hedged item and the hedging instrument are negatively correlated, the hedged position would be same as the hedged item. A long cash asset will be hedged by a long futures position and vice versa.

Normally, the correlation between futures prices and spot prices is positive.

Maturity of hedge

The maturity of the futures contract is standardized and formalized by the exchange as per a designed program. The maturity of the hedge is a totally private matter of the entity undertaking the hedge. The two need not necessarily coincide. They may or may not coincide. Indeed, it is usually the case that they do not coincide.

Thus, hedging may entail that the hedger may have to close out the futures hedge before the futures actually mature for delivery. In other words, the hedger initiates his hedge by trading the market and lifts the hedge again by a counter-trade, notwithstanding the fact that the futures continue to be traded, even after he lifts the hedge.

Now, we come to the choice of maturity month of hedging futures contract. The immediate reaction of the novice would be that the hedger should choose the maturity month which is closest to the maturity of the hedge. However, let us examine this issue with an illustration.

Illustration

Assume that today is February 28. You have just contracted a 3-month USD payable. It will mature for payment on June 1.

Let us assume that there is no USD futures contract maturing on June 1. Traded USD futures mature on the third Wednesdays of June, September, December & March.

Since you are short in USD, you need to buy USD, so you decide to hedge your payable by buying USD futures.

Suppose that on Feb 28, the spot USD rate is Rs 70 per USD and the futures rates are:

Maturity	Rate	Basis as on Feb 28
June	70.25	-0.25
September	70.75	-0.75
December	72.00	-2.00

The problem is to decide which maturity's futures should you buy.

How will the hedge operate

Since you have a USD payable on June 1, you will lose if the USD appreciates, so you will hedge against a price rise in USD i.e. the hedge must yield a profit if USD appreciates. Hence, you will buy USD futures on Feb 28 because you will make a profit if USD appreciates on this futures position. This profit will compensate you for the loss on your primary position if USD appreciates.

On the delivery date, you will make purchases of the USD in the spot market. At the same time, you will lift the hedge by closing out the futures position.

Any loss on the exposure (purchase of USD in the spot market on June 1) would be compensated by gains in the futures position and vice versa.

The quantitative analysis

Price change on the spot position $\Delta S = S_N - S_0$.
Price change on the futures position $\Delta F = F_N - F_0$
Hence, for an effective hedge, we must have: $\Delta F - \Delta S > 0$ or $F_N - F_0 > S_N - S_0$ or $S_0 - F_0 > S_N - F_N$
i.e. BASIS AT t=0 > BASIS AT t=N

We are given that on Feb 28, the spot USD rate is Rs 70 per USD and the futures rates are:

Maturity	Rate	Basis as on Feb 28
June	70.25	-0.25
September	70.75	-0.75
December	72.00	-2.00

Then, for hedge effectiveness, we want: BASIS AT t=0 > BASIS AT t=N

Since, the basis are all negative at t=0, it is reasonable to assume that they will continue to be negative at t=N.

Thus, we want, MAGNITUDE OF BASIS AT t=0 < MAGNITUDE OF BASIS AT t=N.

Now, as on June 1, the June futures contract would be very close to maturity. Hence, its price would be very nearly converging to the spot price, so that the basis of the June futures would be very small in magnitude and hence, undesirable from the hedge effectiveness point of view.

It would be more appropriate to go for a distant maturity contract e.g. the Sept/Dec futures rather than the June futures in this problem.

However, one needs to keep in mind that distant maturity futures tend to be less liquid and also have larger frictional losses e.g. bid-ask spreads etc.

The basis of the June, Sept & Dec contracts at Feb 28 (t=0) are all negative. It is logical to assume that when we work out the basis on June 1, they continue to be negative. Thus, for hedge effectiveness, larger the magnitude of the basis on June 1, the more effective the hedge is. In other words, we want the basis to widen, the more the basis widens, noting that it is negative, the better would be the performance of the hedge.

Now, the June contract would mature around 15th June. Hence, on 1st June, because this contract is very close to its maturity and because at maturity, the basis must converge to zero, its basis would be very small in magnitude, approaching zero.

But we want the basis to widen, wider the basis, better the hedge performance. But for the June contract, the basis seems to be narrowing to meet the convergence mandate.

Therefore, we should not choose the June contract, we should rather go for a September or December contract.

In other words, there can be situations where the immediately closest maturity contract to the hedge maturity may not be the optimal contract. However, there is a caveat.

As far as this analysis is concerned, it is perfectly correct, there is no dispute that the farther maturity contracts should be used for hedging as per this criterion in the given situation. But the caveat is, when we consider the farther maturity contracts (i) the liquidity of the contract decreases with a consequential increase in bid-ask spreads; and (ii) the basis risk increases i.e. the randomness in the basis increases. So, these are two factors, which are going to be counterproductive, if the hedger chooses a distant maturity contract.

	SHORT HEDGE	LONG HEDGE
POSITIVE BASIS	DISTANT	NEAR
NEGATIVE BASIS	NEAR	DISTANT

The above is a table which depicts what has been explained so far. A long hedge and a negative basis mandate choice of a distant maturity contract. For a short hedge with negative basis a near maturity contract would be optimal and so on.