Hedging Examples

Overview

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Using derivative securities for the purpose of hedging certain types of risk.

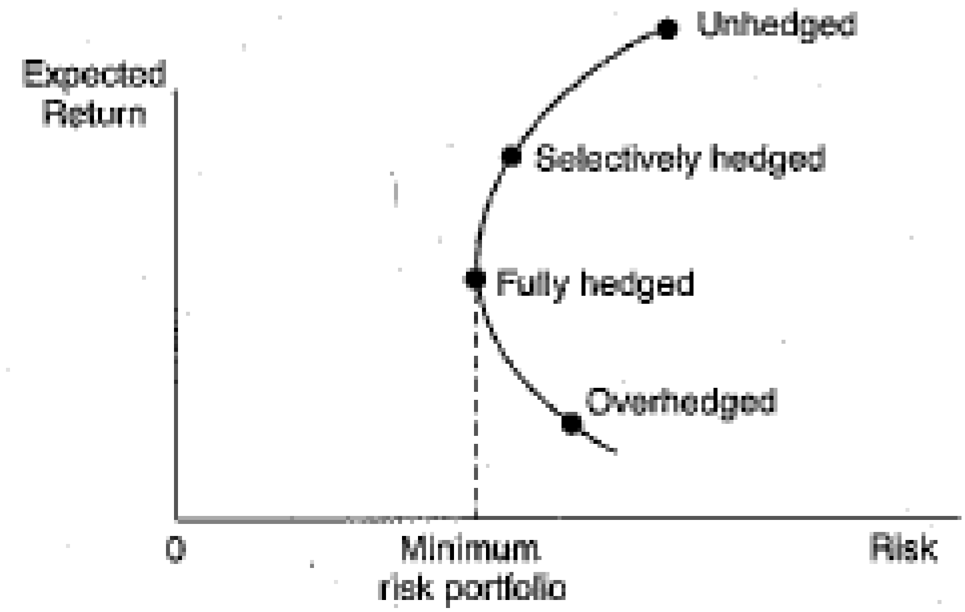
Macro vs. Micro Hedging

- ❑ Most FIs hedge risk either at the micro level (called **micro-hedging**) or at the macro level (called **macro-hedging**) using futures contracts
  - ∗ An FI is **Micro-hedging** when it employs a derivative contract to hedge a **particular** asset or liability risk (single asset or maybe a portfolio of similar assets such as a mortgage portfolio)
  - ∗ **Macro-hedging** occurs when an FI manager wishes to use derivative securities to hedge the **entire balance sheet** duration gap
- ❑ **Micro-hedging**
  - ∗ In micro-hedging, the FI often tries to pick a futures or forward contract whose **underlying deliverable asset is closely matched** to the asset (or liability) position being hedged. If I'm trying to hedge mortgages I would pick something similar like a 10 year futures contract or government security. Both driven by the same underlying macro-economics. Probably focused on one type of derivative.
- ❑ **Macro-hedging**
  - ∗ A macro-hedge takes a whole portfolio (the whole financial institution) view and allows for individual asset and **liability interest sensitivities or durations to net each other out**. It may be the case that a mix of securities best matches for hedging. Could be many types of derivatives.

Could use future contracts or ANY type of derivative contracts.

Routine Hedging versus Selective Hedging

- **Routine hedging** occurs when an FI **reduces its risk exposure to the lowest possible level** by entering into sufficient derivative positions to offset the risk exposure of its whole balance sheet or cash positions in each asset and liability. Trying to reach a risk-neutral position.
- An FI may choose to **hedge selectively**, the FIs choose to bear some interest rate risk as well as credit and FX risks because of their comparative advantage as FIs. Willing to bear some risk. Making predictions about the future and hedging selectively to try and benefit.



Un-Hedged: in the wind
Selectively Hedged: still have risk but earning more.
Fully Hedged: minimum risk
Over-Hedged: earning less return at greater risk.

Going beyond "Unhedged" in the above diagram would be a region of speculation, more risk.

EXAMPLE: Micro Hedging

- A mutual fund plans to purchase $500,000 of **30-year Treasury bonds** in four months
  - These bonds have a duration of 12 years and are priced at 96-08 (32nds) = 0.9625
- The mutual fund is concerned about interest rates changing over the next four months and is considering a hedge with T-bond futures contracts that mature in six months

- The **T-bond futures** contracts are selling for 98-24 (32nds) and have a duration of 8.5 years
  - If interest rate changes in the spot market exactly match those in the futures market, what type of futures position should the mutual fund create?
  - How many contracts should be used?

$500,000*.9625

$$N_F = \frac{D\,x\,P}{D_F\,x\,P_F} = \frac{12\,x\,\$481,250}{8.5\,x\,\$98,750} = 6.88\,contracts$$

$100,000*.9875

The mutual fund needs to enter into a contract to buy Treasury bonds at 98-24 in four months. The fund manager fears a fall in interest rates and by buying a futures contract, the profit from a fall in rates will offset a loss in the spot market from having to pay more for the securities.

The number of contracts can be determined by using the following equation:

Rounding this up to the nearest whole number is 7.0 contracts.

Above we are using a "duration approximation" given by:

$$\Delta B \approx D_B \times B \times \frac{\Delta r}{1+r} = \text{duration of bond * value of bond*}\frac{\text{interest rate shock}}{\text{1+market interest rate}}$$

$$\Delta F \approx D_F \times P_F \times \frac{\Delta r}{1+r} = \text{duration of futures contract * price of futures contract*}\frac{\text{interest rate shock}}{\text{1+market interest rate}}$$

$$P_F = \$100,000 * \text{current price}$$

$$\Delta B \cong \Delta F \times N_F \quad \text{this equation is used to hedge.}$$

To go long in the underlying asset then to hedge I go short in the futures contract and visa-versa. Buying something and going short to counter-effect the interest rate movement. If you end up paying more to buy the bonds you want the futures contract to pay off.

Now set $\Delta B = \Delta F$ to get: $N_F = \dfrac{D_B \times B}{D_F \times P_F}$

N_F is the number of hedge contracts required to hedge our exposure. Now, what is the price of the bond?

Price of the bond = Notional Value of futures contract * price of bond = $500,000 * 0.9625 = $481,250

Price of futures contract=notional value*contract price=$100000*0.9875=$98,750

So to hedge our position we need 6.88 futures contracts which we round up to 7.

I'm planning to by (4 months from now) $500,000 face value bond and I want to make sure the price doesn't go up too much. To hedge I use futures contracts.

Note: the notional value of the bond used is from the standardized table (in notes) where 2 year is $200,000 and 5 , 10, and 30 are $100,000 face value.

EXAMPLE: Macro Hedging

- Village Bank has \$240 million worth of **assets** with a **duration** of 14 years and **liabilities** worth \$210 million with a **duration** of 4 years (this means it must have \$30 million in equity in order for the left hand side of **balance sheet** to equal the right hand side of balance sheet).
- In the interest of hedging interest rate risk, Village Bank is contemplating a macro hedge with interest rate futures contracts now selling for 102-21 (32nds) **with duration of 9 years**.
  - If the spot and futures interest rates move together, how many futures contracts must Village Bank sell to fully hedge the balance sheet?

If I have assets or liabilities with duration D_1 to D_N then duration of the portfolio is equal to:

portfolio duration $= \sum_{i=1}^{n} w_i D_i$ where w_i is the weight of the i^{th} asset (or liability, if it is a liability the w will be negative. w is positive for assets).

For a bank: E = A – L, equity equals assets minus liabilities. If I'm the manager of the bank I'm interested in how equity changes given interest rate shocks, how much share holder wealth is effected by changes in market interest rates. This is the equity portion of the balance sheet.

The equity of the bank is simply a portfolio of its assets and liabilities. The duration of the equity of the bank is the duration of the assets minus kD_L times the size of the balance sheet where k is the liabilities/assets measured in market value terms.

$$D_E = (D_A - k * D_L)A \qquad k = \frac{L}{A} \qquad \frac{\Delta E}{\Delta R}$$

Duration of the equity is the leveraged duration of the bank (D_E) balance sheet, gives an idea of how sensitive the bank is to changes in interest rates. If the bank wants to reduce its exposure there are a number of ways it can do it, could decrease the duration of assets, increase duration of liability, change leverage, all of these would do the trick. Now we may be asked what the impact of an interest rate shock is on the equity of the bank…

change in equity, $\Delta E \approx -(D_A - kD_L) * A * \frac{\Delta R}{1+R}$ where $(D_A - kD_L)$ is the duration of the equity

A is the value of the assets, the size of the bank. exactly the same calculation as for an individual bond with some substitutions. Macro version of duration for a bank. Measure how exposed a particular bank is to interest rate shocks.

In this example we know **k = L/A = 210/240 = 0.875**. We know D_A and D_L. We do not know deltaR/(1+R) but we are assuming that interest rate shocks effect the futures price in exactly the same way as they will effect the equity. So what we do is set the effect of interest rates on my futures contract equal to our change in equity calculation:

Set th echange in F equal to the change in E:

$\Delta F \approx -D_F \times P_F \times N_F \times \frac{\Delta r}{1+r}$ = $-(D_A - kD_L)*A*\frac{\Delta R}{1+R}$ $\approx \Delta E$ we know everything except N_F so we can solve for it.

$$N_F = \frac{(D_A - kD_L)A}{D_F \; x \, P_F} = \frac{(14-(0.875)4)\$240m}{9 \, x \, \$102,656} = 272.75 \, or \, 273 \, contracts$$

Trying to benefit from changing interest rates is going to profit on the contract when it hurts my balance sheet, when my balance sheet profits I'm going to lose out on the contract. (the 9 in denominator is a duration from problem statement)

if (D_A-kD_L) is positive then interest rate shocks harm me (the bank). (D_A-kD_L) is sometimes called the duration gap, banks almost always have positive duration gaps because the maturity of their assets is greater than the maturity of their liabilities. They lend long term barrow short term.

Life insurance companies often have negative duration gaps because they have long term liabilities in terms of policies and they often invest in short term assets to finance.

So in our problem we are assuming that the futures markets and spot markets move the same so we can cancel the delta R over 1+R terms.

273 contracts are required to hedge.

How can a bank reduce its duration value other than hedging? Deleverage, take on more equity. Buy lower duration instruments. But to reduce the duration of mortgages they can … If a floating interest rate mortgage has its rate set every year (and duration is measured in 1 year units) so the bank can stop lending fixed rate mortgages and only lend floating rate mortgages.

In practice it is too expensive to use a futures contract to swap duration (?).

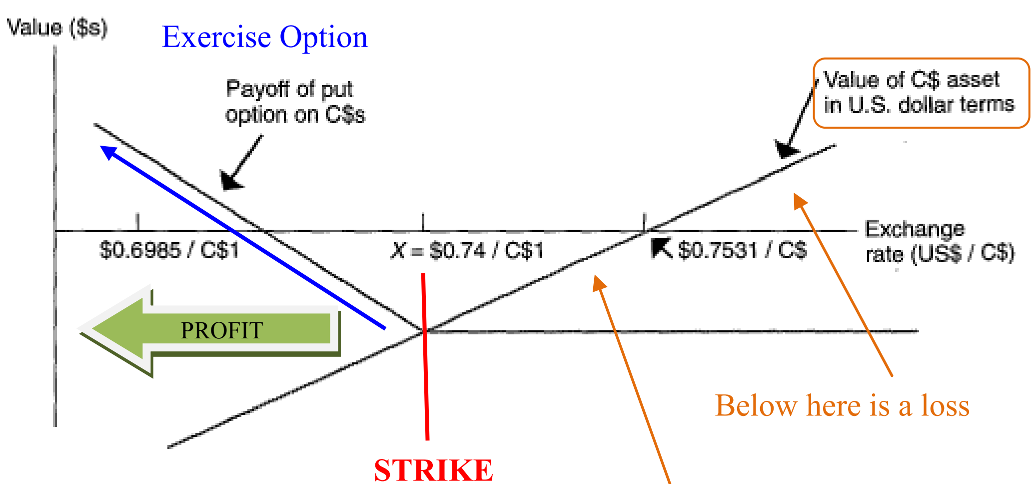
Using Options to Hedge Foreign Exchange Risk

- Suppose that an FI is long in a Canadian dollar (C$) asset in March 2008
  - This C$ asset is a one-month zero-coupon bond paying face value of C$100 million in April 2008
- Suppose the FI wishes to hedge the risk that the Canadian dollar will depreciate over the forthcoming month, will not buy as many US dollars with Canadian dollars. This is the risk. Appreciation of Canadian dollar is to their favor.

EXAMPLE (*Continued from last page)*

- For example, if the C$ depreciated **from $0.7531/C$** in March 2008 to **$0.7350/C$** in April 2008
  - The C$100 million asset would be worth only **$73.50 million** on maturity instead of the expected **$75.31 million** when it was purchased in March (potential to lose $2 million)
- To **offset this exposure**, the FI buys one-month **put options** on Canadian dollars at an **exercise price** of **$0.740/C$**
- Thus, if the **exchange rate falls** to $0.7350/C$ at the end of the month
  - The FI can put the C$100 million proceeds from the T-bill on maturity to the writer of the option, will do this because this is the going market rate, strike price is .74 so he is in the money if this happens. So will sell under option agreement instead of spot market. Will profit in this situation.
- If the **C$** actually **appreciates** in value, or does not depreciate below $0.74/C$
  - The option **expires unexercised** and the proceeds of the C$100 million asset will be realized by the FI manager by a sale of Canadian dollars for U.S. dollars in the spot foreign exchange market one month into the future, lose premium.

Hedged against depreciation but get the benefit of appreciation at the expense of the premium for the option.



This line is what I am expecting to get, anything below it is considered a loss.

EXAMPLE COLLAR

- ❑ An FI has purchased a \$200 million **cap** (i.e., call options on interest rates) of 9 percent at a premium of 0.65 percent of face value
- ❑ A \$200 million **floor** (i.e., put options on interest rates) of 4 percent is also available at a premium of 0.69 percent of face value

- ❑ If interest rates rise to 10 percent, what is the amount received by the FI? (at this point we have only bought the cap, have done nothing with the floor)
- ❑ What are the net savings after deducting the premium?
  - ∗ **Premium for purchasing** the (\$200 mil is the notional amount):

    cap premium = 0.0065 x \$200 million = \$1,300,000

  - ∗ If interest rates rise to 10 percent I am 100 bp above cap, exercise: receive 100 bp * notional value =

    cap purchasers receive \$200 million x 0.01 = \$2,000,000

The net savings is \$700,000

For our fee of \$1.3 million if interest rates rise 10% I receive \$2 million for a \$700,000 profit (savings). **10% - cap = 10% - 9% = 1% = 100 bp**

As insurance goes caps are usually pretty expensive. I can use a collar to help offset this expense. Hedging an increase in interest rates, will benefit from a decrease though I have decided to give up some of that benefit by writing a call (call or floor?)

- ❑ If the FI sells (writes) the floor, what are the net savings **if interest rates rise to 11 percent**?
- ❑ What are the net savings **if interest rates fall to 3 percent**?

The FI sells the floor so it receives the premium:

Premium = 0.0069 x \$200 million = **\$1,380,000**

Total Premium Cost = **-\$1,380,000** + **\$1,300,000** = **\$80,000 inflow**

So the FI actually ends up receiving \$80,000 for setting up the collar. Self financing.

- ❑ If interest rates rise to 11 percent: I'm 200 bp above the cap, the floor does not come in, the cap pays \$4 million:

  cap purchasers receive 0.02 x \$200m = \$4,000,000

- ❑ The net (we have not calculate TVM due to different payoff times):

  net cash inflow = \$4,000,000 + \$80,000 = \$4,080,000

- ❑ **If interest rates fall to 3 percent** (we are 100 bp below the floor):

  floor purchasers receive 0.01 x \$200 million = \$2,000,000

The net cash inflow to the FI = \$-2,000,000 + 80,000 = -\$1,920,000

We are buying cap to protect against rising interest rates.

Hedging with Swaps

Here we are calculating the **duration of a swap**.

In general

$$\Delta S = -\left(D_{Fixed} - D_{Float}\right) x\, N_S\, x \frac{\Delta R}{1+R}$$

ΔS = Change in the market value of the swap contract

N_S = Notional value of swap contracts

$\frac{\Delta R}{1+R}$ = Shock to interest rates

(D_{Fixed} – D_{Float}) = Difference in durations between:

Fixed: duration on an equivalent government bond that has the same maturity and coupon payments as the fixed-payment side of the swap. Example, if I have a 6% fixed payment then it is the duration on a 6% government bond with the same maturity.

Float: a government bond that has the same duration as the swap-payment interval (e.g., annual floating payments). This is basically the timing. If my swap is annual then the duration of the floating part is I year. If my swap is a six month swap then the duration of the floating part is 6 months.

(D_{Fixed} – D_{Float}) is the duration of the swap agreement.

The way to calculate the duration of a swap is the duration of the fixed component minus the duration of the floating component.

If interest rates go up who wins? It's the buyer of the swap, the buyer of the swap makes the fixed payments and receives the floating payments. If interest rates go up the fixed payer benefits.

THE FIXED PAYER BENEFITS FROM INTEREST RATES GOING UP!

Interest rate plus ΔS for the buyer, the fixed payer, is also a plus (?). It's logical!

Duration of the swap agreement times the notional amount times the interest rate shock. Back to our modified duration relationship.

EXAMPLE

- Suppose market yields are approximately 5%
- A **5-year swap** contract has a **fixed payment of 6%** and **floating rate of LIBOR + 200bp**
- The **duration** of the **equivalent coupon government bond is 4.2 years**
  - For the annual floating bond, the duration is 1 year
- If the **notional amount is $100 million**, what is the contract's DV01

What is the effect of a 1/100 of a percent change on the value of this contract?

$$\Delta S = -\left(D_{Fixed} - D_{Float}\right) x\, N_S\, x \frac{\Delta R}{1+R}$$

1 basis point = 1/100 of 1% = .01/100 = .0001

- So for 1 bp

DV01=ΔS=–(4.2 – 1)x$100 millionx0.0001/(1.05)=-$30,476

This is saying I can enter into a swap agreement and I can close it out by entering into another swap agreement. If I calculate the present value of the first compared to the second, I would actually profit by that amount from a 1 bp change (approximately).

EXAMPLE Macro Hedging

- An FI has **$500 million of assets** with a **duration** of nine years and $450 million of **liabilities** with a **duration** of three years
- The FI wants to **hedge** its **duration** gap with a **swap** that has **fixed-rate payments with a duration of six years** and **floating rate-rate payments with a duration of two years**
- What is the **optimal amount of the swap** to effectively **macro hedge** against the **adverse** effect of a **change in interest rates** on the value of the FI's **equity**?

$$\text{Notional Value} = \frac{(D_A - kD_L)A}{(D_{Fixed} - D_{Floating})} = \frac{(9 - 0.9*3)\$500 \text{ million}}{(6 - 2)} = \$787.5 \text{ million}$$

$$k = \frac{450}{500}$$

($D_{fixed} - D_{float}$) = Duration of swap contract.
($D_A - kD_L$) is the duration gap of the bank
A is the market value of the financial institution (left side of balance sheet)(size).

We are assuming that the interest rate on the banks equity is moving in the same direction as the interest rate of the swap so we can cancel the deltaR over 1+r.

Don't concentrate on minus signs, find out what your notional value needs to be and then try to logically reason weather you need buy the contract or sell the contract. Positive duration gap means bank is harmed by rising interest rates. This means that when interest rates go up the equity of the bank goes down. Therefore, which swap position increases in value when interest rates go up? I want to be the fixed payer, I want to receive the floating rate because when interest rates go up I will receive the higher differential. Therefore I want to buy the swap, I want to be the fixed payer.

Positive Duration gap → Bank is Long Bonds