Derivatives in Banking: A Platform for Teaching

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Risk management is the core business of a bank. The transformation of a riskless (to the customer) deposit account into a risky (to the bank) asset is how a bank adds value and earns a profit. Successfully managing this is risk is therefore vital to the success of a bank. Banks are subject to many forms of risk, including interest rate risk, credit risk, liquidity risk, funding risk, and others. While banks cannot eliminate risk, they can control certain areas of their exposure. This project describes an exercise that demonstrates a method of managing interest rate risk in an uncertain environment and the risk-reward tradeoff of using financial derivatives to reduce risk. The exercise is beneficial to students in the banking field as well as those interested in investments as it provides a method to actually see the advantages and disadvantages of the hedging process. This guided experiential learning process should better prepare both groups of students as they begin their chosen careers.

INTRODUCTION

A derivative is a financial security that derives its value from another underlying asset. For example, an investor can enter into an agreement to buy a treasury note at a future date. The value of that agreement is therefore based upon the value of the treasury note. An investor who believes that interest rates will fall and push bond prices higher would buy that contract and benefit from the higher price without actually owning the treasury. That investor will in essence buy the treasury for a price lower than the market price at the time of the actual future transaction. Since the investor is taking on new risk by entering into the contract, this is called speculation.

There is also the other party to this transaction; the party that agrees to sell the treasury in the future. For example, a bank may have fixed rate loans which decline in value if interest rise due to lower than market interest income. That bank would desire protection from that risk, so they agree to sell the treasury at the same future date as above. If rates do rise and the bank faces a loss in their net interest income, that loss if offset by the fact that the price of the treasury will fall. At the future date of the contract, they will sell the treasury for a price higher than the current market price. If rates happen to fall, the loss in the futures contract is offset by the increase in net interest margin. In essence, the bank locks in their future interest margins by entering into the contract. Since the bank is reducing risk, this transaction is called hedging.

It is important to note that the net effect of this transaction to all parties is zero; there is a winner and loser. Often banks will have both trading accounts and hedging accounts. The focus of this paper is the latter as we discuss how banks can use the hedging process to reduce risk.

THE SITUATION

First City Bank (FCB) has $1 billion of assets, composed of $400 million in fixed rate loans which are priced at 6.5% and $600 million in variable rate loans floating at 75 basis points over prime. The prime rate is currently 4.5%. FCB's liabilities include $590 million in fixed rate CDs at a rate of 2% and $320 million in variable rate jumbo CDs which pay 300 basis points less than prime. FCB's fixed expenses are $20 million annually, and we assume no taxes on income. The bank has 10 million shares outstanding, and their historic PE ratio is 10 times.

FCB's Asset/Lability Committee understands that interest rates may fluctuate over the next year, and they want to assess the impact this may have on net interest margin, net income, ROA, and ROE.

Question 1: Forecast the FCB's interest income, interest expense, net interest margin, net income, ROA, ROE, EPS, and expected stock price given the information above. Assume interest rates do not change and a constant PE.

Interest income = (400M * .065) + (600M * .0525) = 57.5M

Interest expense = (590M * .02) + (320M * .015) = 16.6M

NIM = net interest income / total assets = (57.5M – 16.6M) / 1,000M = .0409 = 4.09%

Net income = net interest income – fixed expenses = 40.9M – 20M = 20.9M

ROA = net income / total assets = 20.9M / 1,000M = .0209 = 2.09%

ROE = net income / equity = 20.9M / 90M = .2322 = 23.22%

EPS = 20.9M / 10M = $2.09

Price = 2.09 * 10 = $20.90

Note: the accompanying Excel worksheet with calculations is available from the upon request.

Question 2: To see the impact of changes in interest rates, calculate the net interest margin, net income, ROA, ROE,

EPS, and expected stock price under the following interest rates: prime at 3.5% and prime at 5.5%. Compare each to the base results of prime remaining constant for the year.

3.5% Prime Rate
NIM = net interest income / total assets = (38.1M) / 1,000M = 0.81 = 3.81%
Net income = net interest income – fixed expenses = 38.1M – 20M = 18.1M
ROA = net income / total assets = 18.1M / 1,000M = 0.0181 = 1.81%
ROE = net income / equity = 18.1M / 90M = 0.2011 = 21.11%
EPS = 18.1M / 10M = $1.81
Price = 1.81 * 10 = $18.10

5.5% Prime Rate
NIM = net interest income / total assets = (63.5M – 19.8M) / 1,000M = 0.0437 = 4.37%
Net income = net interest income – fixed expenses = 43.7M – 20M = 23.7M
ROA = net income / total assets = 23.7M / 1,000M = 0.0237 = 2.37%
ROE = net income / equity = 23.7M / 90M = .2633 = 26.33%
EPS = 23.7M / 10M = $2.37
Price = 2.370 * 10 = $23.70

Question 3: FCB faces risk if interest rates fall. To quantify this risk, calculate the dollar gap, relative gap ratio, and interest rate sensitivity ratio of FCB. What does this show about the relationship between dollar gap and interest rate movements?

Dollar Gap is simply the amount of rate sensitive assets minus rate sensitive liabilities, so in this case, the Gap$ is 600M – 320M = 280M. Since the dollar gap is positive, when interest rates rise, assets reprice to a greater degree than liabilities so profits will increase. The relative Gap ratio is Gap$ / total assets or 0.28. Finally, the interest rate sensitivity ratio is RSA$/RSL$, in this case 1.875.

All measures indicate that FCB is positioned to do well if interest rates rise but will underperform projections if interest rates fall. The risk to FCB is a decrease in interest rates, as shown by their positive dollar gap. Remaining in an unhedged position is a more aggressive stance if they believe rates will rise, or FCB can construct a hedge using derivatives

Creating the Hedge

Collaborating with FCB's investment team, the committee has determined that T-Bill futures contracts can be used as an instrument to hedge their interest rate risk. Each contract is for $100,000 of T-Bills, and the current price is $97. The investment team also estimates that a 10-basis point change in the prime rate will result in in a 0.25 percent change in T-Bill prices.

A second alternative is to hedge using options contracts. The options contracts available on the T-Bill futures described above are priced at $2.00 per T-Bill par value for either a put or a call for a total of $200,000 per transaction.

Question 4: How can FCB hedge its current position using futures? How many contracts would it have to buy to perfectly hedge the position based on the investment committee's estimate of the relation between the change in the prime rate and change in futures contracts?

The first step in this process is to use the dollar gap calculated above to determine the interest rate exposure of the bank, which in this case is 280M. We must also determine the hedge ratio, which is calculated by dividing estimated dollar change in futures contract price for a given level of prime interest rate change. In this example, we are given a $0.25 change in contract price per 10 basis point change in prime rate or 0.25/ .001 = 250. Dividing our dollar gap by the hedge ratio gives is 280M / 250 or 1.12M. Dividing that number by $100,000 T-Bills per contract gives us 11.2 contracts. The risk to FCB is falling interest rates, so they need to enter into a position in which they profit from the futures position when rates fall and prices rise. That would mean they would buy the contracts today or take a long position.

Question 5: Given the same prime rate scenarios as before (3.5% and 5.5%), calculate the resulting net interest margin, net income, ROA, and ROE using the hedge (not the option) calculated above. Compare each to the base results of prime remaining constant for the year.

Table 1: Performance Comparison Using a Hedge.

New Prime Rate	**3.5%**	Results	
		No Hedge	Futures Hedge
Amount to Hedge		(280,000,000)	
Hedge Ratio			250
Number of Contracts			11.2
Change in Futures Price			0.25
Hedge Gain or Loss			2,800,000
Net Income		18,100,000	20,900,000
NIM		3.81%	4.09%
ROA		1.81%	2.09%
ROE		20.11%	23.22%
EPS		1.81	2.09
Stock Price		18.10	20.90

New Prime Rate	**5.5%**	Results	
		No Hedge	Futures Hedge
Amount to Hedge		(280,000,000)	
Hedge Ratio			250
Number of Contracts			11.2
Change in Futures Price			0.25
Hedge Gain or Loss			(2,800,000)
Net Income		23,700,000	20,900,000
NIM		4.37%	4.09%
ROA		2.37%	2.09%
ROE		26.33%	23.22%
EPS		2.37	2.09
Stock Price		23.70	20.90

Each hedge position requires the students to project the results of the hedge. If done correctly, the students will see that the futures hedge position produces the same results regardless of the interest rate move. This is true because the bank is perfectly hedged. (We could take this a step farther and examine the results of partial hedging.) This perfect futures hedge always results in ROA of 2.09% and ROE of 23.22%, while results vary in the unhedged position, with some better (as rates rise) and some worse (as rates fall). The effects can also be seen in the projected stock price.

Question 6: Now use the option on the future, and again prime rates of 3.5% and 5.5% to calculate the resulting net interest margin, net income, ROA, ROE, EPS and stock price. Compare each to the base results and the futures hedge.

As an alternative to purchasing the actual futures contract, FCS can buy call options on the contract. The benefit is that the bank would not exercise the call if interest rates move significantly higher. They would then be able to receive the increased net interest income without the offsetting loss in the futures positions. However, options involve a cost, and the interest rate move may not be sufficient to cover that cost.

Table 2: Performance Comparison Using Options.

New Prime Rate	**3.5%**	Results		
		No Hedge	Futures Hedge	Options Hedge
Amount to Hedge		(280,000,000)		
Hedge Ratio			250	250
Number of Contracts			11.2	11.2
Change in Futures Price			0.25	
Hedge Gain or Loss			2,800,000	
Option Gain or Loss				560,000
Net Income		18,100,000	20,900,000	18,660,000
NIM		3.81%	4.09%	3.87%
ROA		1.81%	2.09%	1.87%
ROE		20.11%	23.22%	20.73%
EPS		1.81	2.09	1.87
Stock Price		18.10	20.90	18.66

New Prime Rate	**5.5%**	Results		
		No Hedge	Futures Hedge	Options Hedge
Amount to Hedge		(280,000,000)		
Hedge Ratio			250	250
Number of Contracts			11.2	11.2
Change in Futures Price			0.25	
Hedge Gain or Loss			(2,800,000)	
Option Gain or Loss				(2,240,000)
Net Income		23,700,000	20,900,000	21,460,000
NIM		4.37%	4.09%	4.15%
ROA		2.37%	2.09%	2.15%
ROE		26.33%	23.22%	23.84%
EPS		2.37	2.09	2.15
Stock Price		23.70	20.90	21.46

The calculations using call options are a bit more of a challenge because they will either be exercised (if interest rates fall and T-Bill prices rise), or they will expire worthless. The bank can effectively put in a net interest income floor if interest rates move against them (in this case down), but they also have the potential to still gain from rising interest rates just as in the unhedged position. The only cost then is the price of the option which will be lost since they become worthless. This is the idea of using options as insurance to cover an existing position. FCB's earnings and price are lower in the final example using the option because they pay the price of the option. If rates rise high enough, then the option position becomes and more profitable tool as the bank will not exercise, which can be seen in the rate move to 5.5%. Since rates moved in favor of bank on the operations side, they made a lower profit than they could have without purchasing the option. However, net income was higher than the futures purchase because they are not locked into the contract.

Question 7: If these interest rate scenarios have equal probability of occurring, what would you recommend to the bank management, and justify that position.

There is not necessarily a correct answer as there are benefits from each strategy depending on the move in interest rates. Students tend to struggle with this as they are usually taught to put numbers into a formula to obtain a correct answer. This leads to discussions of the risk/reward tradeoff.

The question of which to recommend leads naturally to a discussion of risk and return. With an uncertain future, FCB may be better off either with or without the hedge, so there needs to be some basis for making a recommendation. Looking at the averages of net income, net interest margin, ROA, and ROE, and well as the standard deviation of net income can provide some insights.

CONCLUSION

This exercise not only provides students the opportunity to discuss the theoretical benefits of using options to manage risk, but also demonstrates the actual results of not hedging, of hedging with futures, and of hedging with options on futures. Further, they can see the potential results on stock price given some simplifying assumptions concerning PE ratios. Providing a framework of using actual numbers about outcomes increases the likelihood of concept retention.

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