##### Solutions for End-of-Chapter Questions and Answers: Chapter Twenty-Six

1. What has been the effect of securitization on the asset portfolios of financial institutions?

In addition to serving as another mechanism to hedge interest rate exposure gaps, securitization has provided a method to make asset portfolios more liquid, has provided an important source of fee income, and has helped to reduce the effects of regulatory taxes.

1. What are the primary functions of GNMA? What is timing insurance?

GNMA sponsors mortgage-backed securities programs by FIs and serves as a guarantor to investors in mortgage-backed securities. Timing insurance guarantees that the holder of pass-through securities will receive interest and principal payments at the calendar date promised. This service is provided in many mortgage-backed securities offerings by GNMA.

1. How does FNMA differ from GNMA?

FNMA is a private corporation whose stock trades on major exchanges, while GNMA is directly owned by the government. However, on September 7, 2008, the Federal Housing Finance Agency (FHFA) placed Fannie Mae (and Freddie Mac) in conservatorship. As conservator, the FHFA was given full powers to control the assets and operations of the firms. Dividends to common and preferred shareholders were suspended, but the U.S. Treasury put in place a set of financing agreements to ensure that the GSEs continue to meet their obligations to bondholders. This means that the U.S. taxpayer basically was the guarantor behind about $5 trillion of GSE debt. This step was taken because a default by either of the two firms, which were battered by the downturn in housing and credit markets, could have caused severe disruptions in global financial markets, made home mortgages more difficult and expensive to obtain, and had negative repercussions throughout the economy. Whereas GNMA sponsors mortgage-backed programs, FNMA actually creates pass-through securities by buying and holding mortgages on its balance sheet. These mortgage purchases often are financed by the issuance of bonds in the capital markets. The securities that are created are called mortgage-backed securities (MBS).

1. How does FHLMC differ from FNMA? How are they the same?

The Federal Home Loan Mortgage Corporation performs duties similar to FNMA for the savings institution industry. Like FNMA, FHLMC is a private corporation whose stock trades on major exchanges. Also like FNMA, on September 7, 2008, the Federal Housing Finance Agency (FHFA) placed Freddie Mac in conservatorship. As conservator, the FHFA was given full powers to control the assets and operations of the firms. Dividends to common and preferred shareholders were suspended, but the U.S. Treasury put in place a set of financing agreements to ensure that the GSEs continue to meet their obligations to bondholders. FHLMC buys mortgage pools and swaps MBS for loans. FHLMC also sponsors conventional loan pools and FHA/VA mortgage pools, and provides timing insurance on the securities it issues.

1. What three levels of regulatory taxes do FIs face when making loans? How does securitization reduce the levels of taxation?

The three levels of taxes faced by FIs when making loans are; a) capital requirements on loans to protect against default; b) reserve requirements on demand deposits for funding the loans; and c) deposit insurance to protect the depositors. If the loans are securitized, FIs end up only servicing the loans since the loans no longer are on the balance sheet. As a result, no capital is required to protect against default risk. Further, reserve requirements and deposit insurance will be reduced if liabilities are also reduced. However, if the cash proceeds from the loan sales are used to invest in other assets, then the taxes will still remain in place.

6. An FI is planning to issue $100 million in BB-rated commercial loans. The FI will finance the loans by issuing demand deposits.

a. What is the minimum capital required under Basle III?

The minimum capital required on commercial loans = $100m x 1.0 x 0.08 = $8 million.

b. What is the minimum amount of demand deposits needed to fund this loan assuming there is a 10 percent average reserve requirement on demand deposits?

Since there is an interaction between the demand deposits and cash reserves held, the answer requires solving the following, assuming the $8 million is funded by equity and the reserve requirements are kept as cash:

$100m + (0.10 x *DD*) = *DD* + 8m => *DD* = 92m/0.9 = $102.22 million

c. Show a simple balance sheet with total assets, total liabilities, and equity if this is the only project funded by the bank.

Assets Liabilities

Cash $10.22m Demand deposits $102.22m

Loan 100.00m Equity 8.00m

Total $110.22m $110.22m

d. How does this balance sheet differ from Table 26-1? Why?

Since the loans are Category 1 residential mortgages with a loan-to-value ratio between 60 and 80 percent, the example in Table 26-1 has a capital requirement of only 4 percent (8% x 0.5) of the face value of the loan. Because the loans in this problem are BB-rated commercial loans, the bank must keep a full 8 percent of the loan to meet the risk-based capital ratio. Thus, the balance sheet is $0.45m less than the Table 26-1 example.

7. Consider the FI in problem (6).

a. What additional risk exposure problems does the FI face?

First, the commercial loans financed with demand deposits have a serious duration gap problem. Second, the loans are not very liquid. Under worst-case liquidity scenarios, the FI faces the possibility of having to sell the loans at distressed prices.

b. What are some possible solutions to the duration mismatch and the illiquidity problems?

The FI can lengthen the liability duration by issuing longer term CDs or capital notes, but this solution is difficult in that each time the FI issues a commercial or longer-term residential loan, it must rebalance the duration of the liabilities. A second solution is to use interest rate swaps or other derivative products to hedge the mismatch in cash flow streams. Neither of these techniques, however, resolves the problem of regulatory taxes.

c. What advantages does securitization have in dealing with the FI’s risk exposure problems?

The process of securitization removes the loans from the balance sheet. Thus, the problems of duration, liquidity, and regulatory taxes disappear. Further, the FI recovers the initial investment and can repeat the loan origination process with potential to earn additional fees on the new originations.

8. How are investors in pass-through securities protected against default risk emanating from the mortgagees and the FI/trustee?

Bondholders of residential mortgage pass-throughs are protected against mortgage default losses by the borrowers through FHA/VA housing insurance. In cases where the bank or the trustee defaults on the timely pass-through of the mortgage payments, GNMA will make the payments. For this insurance guarantee, GNMA receives an insurance premium on each payment.

9. What specific changes occur on the balance sheet at the completion of the securitization process? What adjustments occur to the risk profile of the FI?

At the conclusion of the securitization process, the FI will have (1) exchanged a loan balance for cash, (2) reduced significantly the duration of its assets, and likely the duration mismatch of the entire balance sheet, and (3) reduced the regulatory tax burden. The risk profile is potentially reduced in two ways. First, exchanging loans for cash removes any risk-based capital requirements for the FI. Second, if the cash is used to repay deposits, reserve requirements may be reduced.

10. Consider the mortgage pass-through example presented in Table 26-3. The total monthly payment by the borrowers reflecting a 12 percent mortgage rate is $1,028,610. The payment passed through to the ultimate investors reflecting an 11.5 percent return is $990,291. Who receives the difference between these two payments? How are the shares determined?

The difference in the two payments ($38,319) goes to the mortgage service provider and to GNMA for the insurance premium. If the total fee is 50 basis points, and GNMA receives 6 basis points for the insurance premium, GNMA would receive 12 percent (6/50) of the difference ($4,598) in the two payments, and the mortgage service provider would receive 88 percent (44/50) of the difference ($33,721) in the two payments.

11. Consider a GNMA mortgage pool with principal of $20 million. The maturity is 30 years with a monthly mortgage payment of 10 percent per year. Assume no prepayments.

a. What is the monthly mortgage payment (100 percent amortizing) on the pool of mortgages?

The monthly mortgage payment, PMT, is (the monthly interest rate is 0.10/ 12 = 0.00833):

$20m = PVAn=360, k=0.8333 x (PMT) => PMT = $175,514.31

b. If the GNMA insurance fee is 6 basis points and the servicing fee is 44 basis points, what is the yield on the GNMA pass‑through?

The GNMA's annual interest rate is 0.10 ‑ 0.0044 ‑ 0.0006 = 9.5 percent. The monthly interest rate is 0.095/12 = 0.0079167 or 0.79167 percent.

c. What is the monthly payment on the GNMA in part (b)?

The monthly GNMA payment, PMT, is: $20m = PVAn=360, k=0.79167% x PMT => PMT = $168,170.84

d. Calculate the first monthly servicing fee paid to the originating FIs.

The first monthly servicing fee, SF, is (the monthly fee rate is 0.44%/12 = 0.0367%):

*SF* = (0.000367)$20m = $7,333.

e. Calculate the first monthly insurance fee paid to GNMA.

The first monthly insurance payment, IP, is (monthly insurance rate is 0.06%/12 = 0.005%):

IP = (0.00005)$20m = $1,000

12. Calculate the value of (a) the mortgage pool and (b) the GNMA pass‑through in question 11 if market interest rates increase 50 basis points. Assume no prepayments.

a. The mortgage pool's value, PV, is (the monthly discount rate is 10.5%/12 = 0.875%):

PV = $175,514.31 x PVAn=360,k=0.875% = $19,187,359

b. The GNMA's value, PV, is (the monthly discount rate is 10%/12 = 0.8333%):

PV= $168,170.84 x PVAn=360,k=0.8333% = $19,163,205.

13. What would be the impact on GNMA pricing if the pass‑through was not fully amortized? What is the present value of a $10 million pool of 15-year mortgages with an 8.5 percent per year monthly mortgage coupon if market rates are 5 percent? The GNMA guarantee fee is 6 basis points and the FI servicing fee is 44 basis points.

a. Assume that the GNMA is fully amortized.

There are 180 monthly payments (15 years x 12 months). The GNMA monthly coupon rate is 8.5% ‑ 0.5% = 8 percent per year, and the monthly GNMA pass‑through payment is: $10m= PVAn=180, k=0.6667% x PMT => PMT = $95,565.21.

The present value of the GNMA at a 5 percent market rate is:

PV = $95,565.21 x PVAn=180, k=0.004167% = $12,084,721.63.

b. Assume that the GNMA is only half amortized. There is a lump sum payment at the maturity of the GNMA that equals 50 percent of the mortgage pool's face value.

If there is a 50 percent amortization, the monthly GNMA pass‑through payments are:

$10m = PMT x PVAn=180, k=0.6667% + $5m x PVn=180, k=0.6667% => PMT = $81,115.94

The present value of the GNMA at a 5 percent market rate is:

PV = $81,115.94 x PVA n=180, k=0.004167% + $5m x PVn=180, k=0.004167% = $12,623,051.35.

14. What is prepayment risk? How does prepayment risk affect the cash flow stream on a fully amortized mortgage loan? What are the two primary factors that cause early payment?

Prepayment is the process of paying principal on a debt before the due date. In the case of an amortized loan that has fixed periodic payments, prepayment means that the lender will receive fewer of the fixed periodic payments, one or more payments of extra principal, and the final payment will be made before the final payment due date.

The two primary factors that cause prepayment are (1) the refinancing of the loan by the borrower because of better interest rates and (2) the economic reality of having the cash to repay before maturity. In the case of residential mortgages, this economic reality usually occurs with the sale of a house because of relocation. In the first case, investors must reinvest at lower rates and thus realize lower rates of return over their entire investment horizon. Housing turnover risk may or may not translate into losses for pass-through holders because interest rates could remain the same, allowing them to reinvest the early payments in other instruments paying similar rates.

15. Under what conditions do mortgage holders have a call option on their mortgages? When is the call option in the money?

As interest rates fall, mortgage holders can refinance at lower rates. When the present value of the savings from refinancing is greater than the cost of refinancing, the mortgage holders in effect have a call option that is in the money. Under these conditions the mortgage should be called and refinanced.

16. What are the benefits of market yields that are less than the average rate in the GNMA mortgage pool? What are the disadvantages of this rate inversion? To whom do the good news and bad news accrue?

The two benefits of this economic effect are (1) that the value of the stream of mortgage cash flows is increased with the lower market discount rate, and (2) that repayment risk decreases because the principal is recovered more quickly. The disadvantages are (1) that prepayments reduce the amount of interest payments in absolute terms and (2) that payments must be reinvested at lower interest rates. The good news primarily accrues to the lender in that a greater value is beneficial in case the lender is willing to sell the loan portfolio and because the reduced repayment risk is helpful for the overall risk of the FI. The bad news accrues primarily to the borrower in that the cost of raising funds has decreased.

17. What is the weighted-average life (WAL) of a mortgage pool supporting pass-through securities? How does WAL differ from duration?

The weighted-average life is calculated as the product of the amount of principal payment times the timing of the payment divided by the total amount of principal outstanding. Duration differs from WAL by using the present value of cash flows relative to the current present value of the asset as the weights in calculating the average life.

18. If 150 $200,000 mortgages in a $60 million 15-year mortgage pool are expected to be prepaid in three years and the remaining 150 $200,000 mortgages are to be prepaid in four years, what is the weighted-average life of the mortgage pool? Mortgages are fully amortized, with mortgage coupon rates set at 10 percent to be paid annually.

The annual mortgage payment is $60 million = PVAn=15, k=10% x PMT => PMT = $7,888,426.61. Annual mortgage payments, with no prepayments, can be decomposed into principal and interest payments (in millions of $s):

Interest Principal Remaining

Year Balance Payment Payment Payment Principal

1 $60.000 $7.888 $6.000 $1.888 $58.112

2 58.112 7.888 5.811 2.077 56.034

3 56.034 7.888 5.603 2.285 53.749

4 53.749 7.888 5.375 2.513 51.236

The first year's interest is $6 million (0.10 x $60 million). Deducting this from the first year's mortgage payment yields a principal payment of $1,888,426.61 at the end of the first year, and an outstanding principal $58,111,573.39.

The second year's interest payment is 0.10 x $58,111,573.39 = $5,8111,157.34. Deducting this from the annual mortgage payment yields a second annual principal payment of $2,077,269.27, for a principal outstanding of $56,034,304.12.

The third year's regular interest payment is $5.603 million. Deducting this from the annual mortgage payment yields a third annual principal payment of $2.285 million for a principal outstanding of $53,749,307.92.

The principal outstanding at the end of the fourth year, without prepayments, is $51,235,812.10.

However, at the end of the third year, half of the mortgages in the mortgage pool are completely prepaid. That is, at the end of the third year, an additional principal payment of 50% x $53,749,307.92 = $26,874,653.96 is received for a remaining outstanding principal balance of $26.875 million. The total third year principal payment is therefore $29.16 million = the regular principal payment of $2.285 million plus an extra payment of $26.875 million.

The fourth year annual interest payment is 10% x $26.875 million = $2.687 million, leaving a regular fourth year principal payment of $7.888 million ‑ $2.687 million = $5,200,961.21. This end-of-fourth-year principal payment would have left an outstanding principal balance of $21,673,692.75, which is paid in full at the end of the year. Fourth year principal payments total $26.875 million = $5.201 million, plus $21.674 million.

Prepayments alter the annual cash flows for years 3 and 4 as follows (in millions of $s):

Year Balance Payment Interest Principal Balance

3 56.034 7.888 5.603 29.160 26.875

4 26.875 7.888 2.687 26.875 0

Calculating the weighted average life:

Time Expected Principal Payments Time x Principal

1 1.888m 1.888

2 2.077m 4.154

3 29.160m 87.48

4 26.875m 107.5

60.000m 201.022

WAL = 201.022/60 = 3.35 years

19. An FI originates a pool of 500 30-year mortgages, each averaging $150,000 with an annual mortgage coupon rate of 8 percent. Assume that the GNMA credit risk insurance fee is 6 basis points and that the FI's servicing fee is 19 basis points.

a. What is the present value of the mortgage pool?

PV = 500 x $150,000 = $75 million

b. What is the monthly mortgage payment?

There are 360 monthly mortgage payments (30 years x 12 months). Monthly mortgage payments are $75,000,000 = PVAn=360, k=0.6667% x PMT => PMT = $550,323.43.

c. For the first two payments, what portion is interest and what portion is principal repayment?

For the first monthly payment, the monthly interest is 0.08/12 x $75 million = $500,000. Therefore, for the first monthly mortgage payment, $50,323.43 is repayment of principal.

For the second monthly payment, the principal outstanding is $75m ‑ $50,323.43 = $74,949,676.57. The monthly interest payment is $499,664.51. The principal payment in the second month is $550,323.43 ‑ $499,664.51 = $50,658.92.

d. What are the expected monthly cash flows to GNMA bondholders?

The GNMA bond rate is 8% ‑ (0.06% + 0.19%) = 7.75 percent. GNMA bondholders receive monthly payments of $75m = PVAn=360, k=0.0775/12 x PMT => PMT = $537,309.18.

e. What is the present value of the GNMA pass‑through bonds? Assume that the risk- adjusted market annual rate of return is 8 percent compounded monthly.

The discount yield is 8 percent annually, compounded monthly. The present value of the GNMA pass‑through bonds is PV = $537,309.18 x PVA n=360, k=0.6667% = $73,226,373.05.

f. Would actual cash flows to GNMA bondholders deviate from expected cash flows as in part (d)? Why or why not?

Actual payments will equal expected payments if and only if no prepayments are made. If any mortgages are prepaid as a result of refinancing or homeowner mobility, then the monthly payments will change. In the month in which prepayments are made, monthly payments will increase to reflect the principal repayments. In all subsequent months, monthly payments will decline to reflect the lower face value of the pass‑through bonds.

g. What are the expected monthly cash flows for the FI and GNMA?

GNMA and the originating FI share the difference between the monthly mortgage payments and the GNMA pass‑through payments $550,323.43 ‑ $537,309.18 = $13,014.25. The originating bank gets 19 out of the 25 basis points (or 76 percent) for a payment of $9,890.83 monthly. GNMA receives the remaining 6 basis points (or 24 percent) for a payment of $3,123.42.

h. If all of the mortgages in the pool are completely prepaid at the end of the second month, what is the pool's weighted-average life? *Hint*: Use your answer to part (c).

Time Expected Principal Payments Time x Principal

1 mo. $50,323.43 $50,323.43

2 mo. $74,949,676.57 $149,899,353.10

$75,000,000.00 $149,949,676.53

WAL = (149,949,676.53/75 million) = 1.9993 months

The principal payment in the first month is $50,323.43. If the loan is paid off after month two, the principal payment in month two is $75 million ‑ $50,323.43 = $74,949,676.57.

i. What is the price of the GNMA pass‑through security if its weighted-average life is equal to your solution for part (h)? Assume no change in market interest rates.

The GNMA with a weighted average life of 1.9993 months has only two cash flows. The first month's cash flow is $537,309.18. The second month's cash flow is $537,309.18 plus the extra principal repayment of $74,899,017.65 = $75,436,326.83. The present value of the GNMA is PV = [$537,309.18/(1.006667)] + [$75,436,326.83/(1.006667)2] = $74,974,229.44, where the monthly discount rate is 0.08/12.

j. What is the price of the GNMA pass‑through with a weighted-average life equal to your solution for part (h) if market yields decline by 50 basis points?

If market yields decline 50 basis points, to 7.5 percent compounded monthly, the present value of the GNMA is PV = [$537,309.18/(1.00625)] + [$75,436,326.83/(1.00625)2] = $75,036,111.70, where the monthly discount rate is 0.075/12.

20. What is the difference between the yield spread to average life and the option-adjusted spreadon mortgage-backed securities?

The yield spread to average life is the difference between the yield on mortgage-backed securities and the U.S. Treasury bond. The option-adjusted spread (OAS) subtracts the yield on a matched maturity Treasury bond from a yield to maturity of the mortgage-backed security after it has been adjusted for estimated prepayment behavior. The prepayment behavior is estimated and valued by the Bear Stearns’ division of J.P. Morgan Chase.

21. Explain precisely the prepayment assumptions of the Public Securities Association prepayment model.

The Public Securities Association (PSA) model calculates an average rate of repayment based on past experience of prepayments on pools of mortgages. The model assumes a prepayment rate that increases 0.2 percent per month over the first 30 months, at which time the rate levels off at 6.0 percent per year.

22. What does an FI mean when it states that its mortgage pool prepayments are assumed to be 100 percent PSA equivalent?

Mortgage pool prepayments that are assumed to match exactly the PSA model are said to be 100 percent PSA equivalent.

23. What factors may cause the actual prepayment pattern to differ from the assumed PSA pattern? How would an FI adjust for the presumed occurrence of some of these factors?

The factors that are assumed to cause the prepayment pattern to differ from the PSA rate include (1) the pool’s coupon rate relative to the current mortgage coupon rate; (2) the age of the mortgage pool; (3) whether the payments are fully amortized; (4) whether the mortgages in the pool can be assumed by new home buyers; (5) the size of the pool; (6) the geographic location of the mortgages; (7) whether the mortgages are conventional or nonconventional; and (8) the age and job status of the mortgagees in the pool.

If the FI assumes that any or all of these factors may cause prepayment to differ from 100 percent PSA behavior, the FI can make adjustments to better reflect what the FI thinks will be more accurate behavior patterns, such as 80 percent or 110 percent prepayment. Note that any estimate of prepayment behavior may not be realized exactly.

24. What is the burnout factor? How is it used in modeling prepayment behavior? What other factors may be helpful in modeling the prepayment behavior of a given mortgage pool?

The burnout factor reflects the amount of the mortgage pool that has been prepaid prior to the month under consideration. The burnout factor is one of several factors that can be used to estimate a prepayment function. Other possible variables include age, collateral, geographic factors, and mortgage rate spread.

25. What is the goal of prepayment models that use option pricing theory? How do these models differ from the PSA or empirical models? What criticisms often are directed toward these models?

Option models attempt to determine the yield spread of pass-through bonds over Treasuries using prepayment risk as a primary factor. The OAS models often do not include nonrefinancing incentives to prepay as well as the transaction and recontracting costs involved in refinancing.

26. How does the price on a GNMA bond relate to the yield on a GNMA option from the perspective of the investor? What is the option-adjusted spread (OAS)?

The value of a GNMA bond is equal to the value of a standard Treasury bond of the same duration minus the value of the mortgage holder’s prepayment call option. The ability of the mortgage holder to prepay equals the bond investor writing a call option on the bond that is sold to the mortgagee. The option-adjusted spread between the GNMA bond and the T-bond should reflect the value of the option.

27. Use the options prepayment model to calculate the yield on a $30 million, three-year, fully amortized mortgage pass‑through where the mortgage coupon rate is 6 percent paid annually. Market yields are 6.4 percent paid annually. Assume that there is no servicing or GNMA guarantee fee.

a. What is the annual payment on the GNMA pass‑through?

The annual mortgage payment is $30m = PVAn=3, k=6% x PMT => PMT = $11,223,294.

b. What is the present value of the GNMA pass‑through?

The present value of the GNMA is PV = $11,223,294 x PVAn=3, k=6.4% = $29,779,354

c. Interest rate movements over time are assumed to change a maximum of 0.5 percent per year. Both an increase of 0.5 percent and a decrease of 0.5 percent in interest rates are equally probable. If interest rates fall 1.0 percent below the current mortgage coupon rates, all of the mortgages in the pool will be completely prepaid. Diagram the interest rate tree and indicate the probabilities of each node in the tree.

The probability tree is given below with the probability of each node followed by the corresponding interest rate.

t=0 t=1 t=2 t=3

p = 0.1250 7.5%

p = 0.25 7.0%

p = 0.5 6.5% p = 0.3750 6.5%

6% p = 0.50 6.0%

p = 0.5 5.5% p = 0.3750 5.5%

p = 0.25 5.0%

p = 0.1250 4.5%

d. What are the expected annual cash flows for each possible situation over the three-year period?

The annual mortgage cash flows are:

(Fixed) Interest Principal Remaining

Year Balance Payment Payment Payment Principal

1 $30,000,000 $11,223,294 $1,800,000 $9,423,294 $20,576,706

2 $20,576,706 $11,223,294 $1,234,602 $9,988,692 $10,588,014

3 $10,588,014 $11,223,294 $635,281 $10,588,013 $0

Year 1 Expected Cash Flows: There is a 50 percent chance of either a 5.5 percent or 6.5 percent market interest rate. Since neither rate triggers mortgage prepayments, a cash flow of $11,223,294 will be received with certainty.

Year 2 Expected Cash Flows: There is a 25 percent chance that interest rates will be 5.0 percent, a 50 percent chance that interest rates will be 6.0 percent, and a 25 percent chance that interest rates will be 7.0 percent. If interest rates are either 6 percent or 7 percent, no prepayments will be triggered, and the cash flow will be $11,223,294. If interest rates are 5.0 percent, all of the mortgages will be prepaid. Thus, the expected cash flows will be 0.75($11,223,294) + 0.25($11,223,294 + $10,588,014) = $8,417,470 + $5,452,827 = $13,870,297.

Year 3 Expected Cash Flows: Interest rates will be 4.5 percent with a 0.125 percent chance, 5.5 percent and 6.5 percent each with a 0.375 percent chance, or 7.5 percent with a 0.125 percent chance. Since there is a 25 percent chance that mortgages will be prepaid at the end of year 2, there is a 25 percent probability that investors will receive no cash flows at the end of year 3. However, there is a 75 percent chance that mortgages will not be prepaid at the end of year two, so the expected cash flow will be 0.25($0) + 0.75($11,223,294) = $8,417,470.

e. The Treasury bond yield curve is flat at a discount yield of 6 percent. What is the option-adjusted spread on the GNMA pass-through?

The present value of the GNMA is $29,779,354 = [$11,223,294/(1+*x*)] + [$13,870,297/(1+*x*)2] + [$8,417,470/(1+*x*)3] => x = 6.4167 percent. Therefore, the option-adjusted spread is 6.4167 – 6.00 = 0.4167 percent.

28. Use the options prepayment model to calculate the yield on a $12 million, five-year, fully amortized mortgage pass‑through where the mortgage coupon rate is 7 percent paid annually. Market yields are 8 percent paid annually. Assume that there is no servicing or GNMA guarantee fee.

a. What is the annual payment on the GNMA pass‑through?

The annual mortgage payment is $12m = PVAn=5, k=7% x PMT => PMT = $2,926,688.

b. What is the present value of the GNMA pass‑through?

The present value of the GNMA is PV = $2,926,688 x PVAn=5, k=8% = $11,685,418.

c. Interest rate movements over time are assumed to change a maximum of 1 percent per year. Both an increase of 1 percent and a decrease of 1 percent in interest rates are equally probable. If interest rates fall 3 percent below the current mortgage coupon rates, all mortgages in the pool will be completely prepaid. Diagram the interest rate tree and indicate the probabilities of each node in the tree.

t=0 t=1 t=2 t=3 t=4 t=5

p = 0.03125 13%

p = 0.0625 12%

p = 0.125 11% p = 0.15625 11%

p = 0.25 10% p = 0.2500 10%

p = 0.5 9% p = 0.375 9% p = 0.3125 9%

8% p = 0.50 8% p = 0.3750 8%

p = 0.5 7% p = 0.375 7% p = 0.3125 7%

p = 0.25 6% p =0 .2500 6%

p = 0.125 5% p = 0.15625 5%

p =0 .0625 4%

p = 0.03125 3%

d. What are the expected annual cash flows for each possible situation over the five-year period?

The annual mortgage cash flows are:

(Fixed) Interest Principal Remaining

Year Balance Payment Payment Payment Principal

1 $12.000m $2.927m $0.840m $2.087m $9.913m

2 9.913m 2.927m 0.694m 2.233m 7.680m

3 7.680m 2.927m 0.538m 2.389m 5.291m

4 5.291m 2.927m 0.370m 2.557m 2.734m

5 2.734m 2.927m 0.191m 2.734m 0.0

Year 1 Expected Cash Flows: There is a 50 percent chance of either a 9 percent or 7 percent market interest rate. Since neither rate triggers mortgage prepayments, a cash flow of $2,926,688 will be received with certainty.

Year 2 Expected Cash Flows: There is a 25 percent chance that interest rates will be 6 percent, a 50 percent chance that interest rates will be 8 percent, and a 25 percent chance that interest rates will be 10 percent. Since none of these rates triggers mortgage prepayments, a cash flow of $2,926,688 will be received with certainty.

Year 3 Expected Cash Flows: Interest rates will be 5 percent, 7 percent, 9 percent, or 11 percent. Since none of these rates triggers mortgage prepayments, a cash flow of $2,926,688 will be received with certainty.

Year 4 Expected Cash Flows: Interest rates will be 4 percent, 6 percent, 8 percent, 10 percent, or 12 percent. The only rate that triggers prepayments is the 4 percent rate, which occurs with a probability of 6.25 percent. At the end of year 4, loan prepayments (in excess of the regular annual mortgage payment) are equal to $2.734 million which is the remaining principal after the regular payment in year 4. Expected end-of-year-4 cash flows are 0.0625($2.734 + $2.927) + 0.9375($2.927) = $3.097875 million.

Year 5 Expected Cash Flows: Interest rates will be either 3 percent, 5 percent, 7 percent, 9 percent, 11 percent, or 13 percent. There is a 6.25 percent probability that investors will receive no cash flows (the event that interest rates will be either 3 percent or 5 percent), since all mortgages were prepaid at the end of year 4. Therefore, end-of-year-5 expected cash flows are 0.0625($0) + 0.9375($2.927) = $2.744 million.

e. The Treasury bond yield curve is flat at a discount yield of 6 percent. What is the option-adjusted spread on the GNMA pass-through?

The present value of the GNMA is $11,685,417 = [$2,926,688/(1+*x*)] + [$2,926,688/(1+*x*)2] + [$2,926,688/(1+*x*)3] + [$3,097,875/(1+*x*)4] + [$2,743,770/(1+*x*)5] => x = 8.0044 percent. Therefore, the spread is 8.0044 – 6.00 = 2.0044 percent.

29. What conditions would cause the yield on pass-through securities with prepayment risk to be less than the yield on pass-through securities without prepayment risk?

In situations where there is sufficient early prepayment, the yield on the pass-through securities with prepayment risk may be lower because the benefits of receiving the principal earlier offset the loss of interest income in a discounted cash flow analysis.

30. What is a collateralized mortgage obligation (CMO)? How is it similar to a pass-through security? How does it differ? In what way does the creation of a CMO use market segmentation to redistribute prepayment risk?

A CMO is a series of pass-through securities that have been allocated into different groups or tranches. Each tranche typically has a different interest rate (coupon), and any prepayments on the entire CMO typically are allocated to the tranche with the shortest maturity. Thus, prepayment risk does not affect the tranches with longer lives until the earlier tranches have been retired. Many of the tranches in the CMO receive interest rates that are lower than the average pass-through requirement because of the limited prepayment risk protection.

31. Consider $200 million of 30-year mortgages with a coupon of 10 percent per year paid quarterly.

a. What is the quarterly mortgage payment?

There are 120 quarterly payments over 30 years. The quarterly mortgage payments are $200m = PVAn=120, k=2.5% x PMT => PMT = $5,272,358.60.

b. What are the interest and principal repayments over the first year of life of the mortgages?

(Fixed) Interest Principal Remaining

Quarter Balance Payment Payment Payment Principal

1 $200,000,000 $5,272,359 $5,000,000 $272,359 $199,727,641

2 199,727,641 5,272,359 4,993,191 279,168 199,448,473

3 199,448,473 5,272,359 4,986,212 286,147 199,162,326

4 199,162,326 5,272,359 4,979,058 293,301 198,869,025

c. Construct a 30-year CMO using this mortgage pool as collateral. The pool has three tranches, where tranche A offers the least protection against prepayment and tranche C offers the most protection against prepayment. Tranche A of $50 million receives quarterly payments at 9 percent per year, tranche B of $100 million receives quarterly payments at 10 percent per year, and tranche C of $50 million receives quarterly payments at 11 percent per year.

Tranche A Tranche B Tranche C Total Issue

Principal amount $50 million $100 million $50 million $200 million

Interest rate 9 percent 10 percent 11 percent 10 percent

Quarterly interest on

initial balance $1,125,000 $2,500,000 $1,375,000 $5,000,000

Quarterly amortization $5,272,359

d. Assume non‑amortization of principal and no prepayments. What are the total promised coupon payments to the three classes? What are the principal payments to each of the three classes for the first year?

Regular tranche A interest payments are $1.125 million quarterly. If there are no prepayments, then the regular GNMA quarterly payment of $5,272,359 is distributed among the three tranches. Five million is the total coupon interest payment for all three tranches. Therefore, $272,359 of principal is repaid each quarter. Tranche A receives all principal payments. Tranche A cash flows are $1,125,000 + $272,359 = $1,397,359 quarterly. The cash flows to tranches B and C are the scheduled interest payments.

Tranche A amortization schedule:

Interest Principal Remaining

Quarter Balance Payment Payment Payment Principal

1 $50,000,000 $1,397,359 $1,125,000 $272,359 $49,727,641

2 49,727,641 1,397,359 1,118,872 278,487 49,449,154

3 49,449,154 1,397,359 1,112,606 284,753 49,164,401

4 49,164,401 1,397,359 1,106,199 291,160 48,873,241

Tranche B amortization schedule:

Interest Principal Remaining

Quarter Balance Payment Payment Payment Principal

1 $100.000m $2.500m $2.500m $0.0m $100.000m

2 100.000m 2.500m 2.500m 0.0m 100.000m

3 100.000m 2.500m 2.500m 0.0m 100.000m

4 100.000m 2.500m 2.500m 0.0m 100.000m

Tranche C amortization schedule:

Interest Principal Remaining

Quarter Balance Payment Payment Payment Principal

1 $50.000m $1.375m $1.375m $0.0m $50.000m

2 50.000m 1.375m 1.375m 0.0m 50.000m

3 50.000m 1.375m 1.375m 0.0m 50.000m

4 50.000m 1.375m 1.375m 0.0m 50.000m

e. If, over the first year, the trustee receives quarterly prepayments of $10 million on the mortgage pool, how are these funds distributed?

The quarterly prepayments of $10 million will be credited entirely to tranche A until tranche A is completely retired. Then prepayments will be paid entirely to tranche B. The amortization schedule for tranche A for the first year is shown below. This amortization schedule assumes that the trustee has a quarterly payment amount from the mortgage pool of $5,272,359.

Interest Principal Remaining

Quarter Balance Payment Payment Payment Principal

1 $50,000,000 $11,397,359 $1,125,000 $10,272,359 $39,727,641

2 39,727,641 11,397,359 893,872 10,503,487 29,224,154

3 29,224,154 11,397,359 657,543 10,739,816 18,484,338

4 18,484,228 11,397,359 415,898 10,981,461 7,502,877

However, since some of the mortgages will be paid off early, the actual payment received by the trustee from the mortgage pool will decrease each quarter. Thus, the payment for the second quarter will decrease from $5,272,359 to $5,008,381 (n = 119 quarters, i = 10 percent, mortgage principal = $189,727,641). The CMO amortization schedule for tranche A given that the mortgage payments decrease with the prepayments is given below. The revised mortgage payment for each quarter is shown in the last column.

Interest Principal Remaining Mortgage

Quarter Balance Payment Payment Payment Principal Payment

1 $50,000,000 $11,397,359 $1,125,000 $10,272,359 $39,727,641 $5,272,359

2 39,727,641 11,133,381 893,872 10,239,509 29,488,132 5,008,381

3 29,488,132 10,869,713 663,483 10,206,230 19,281,902 4,744,713

4 19,281,902 10,606,344 433,843 10,172,501 9,109,401 4,481,344

f. How are the cash flows distributed if prepayments in the first half of the second year are $20 million quarterly?

The amortization schedules for tranches A and B are shown below. Again the mortgage payments from the mortgage holders are assumed to decrease as the prepayments occur.

Amortization schedule for tranche A:

Tranche Interest Principal Remaining Mortgage

Quarter Balance Payment Payment Payment Principal Payment

5 $9,109,401 $20,342,263 $204,961 $20,137,301 -$11,027,900 $4,218,263

Amortization schedule for tranche B:

Tranche Interest Principal Remaining Mortgage

Quarter Balance Payment Payment Payment Principal Payment

5 $100,000,000 $13,527,900 $2,500,000 $11,027,900 $88,972,100 $4,218,263

6 88,972,100 23,689,967 2,224,302 21,465,665 67,506,435 3,689,967

g. How can the CMO issuer earn a positive spread on the CMO?

The way the terms of the CMO are structured, the average coupon rate on the three classes equals the mortgage coupon rate on the underlying mortgage pool. However, given the more desirable cash flow characteristics of the individual classes, the FI may be able to issue the CMO classes at lower coupon rates. The difference between the sum of all coupon payments promised on all CMO tranches and the mortgage coupon rate on the underlying mortgage pool is the FI's servicing fee.

32. Consider $100 million of 30-year mortgages with a coupon of 5 percent per year paid quarterly.

a. What is the quarterly mortgage payment?

There are 120 quarterly payments over 30 years. The quarterly mortgage payments are $100m = PVAn=120, k=1.25% x PMT => PMT = $1,613,350.

b. What are the interest and principal repayments over the first year of life of the mortgages?

(Fixed) Interest Principal Remaining

Quarter Balance Payment Payment Payment Principal

1 $100,000,000 $1,613,350 $1,250,000 $363,350 $99,636,650

2 99,636,650 1,613,350 1,245,458 367,891 99,268,759

3 99,268,759 1,613,350 1,240,859 372,490 98,896,269

4 98,896,269 1,613,350 1,236,203 377,146 98,519,123

c. Construct a 30-year CMO using this mortgage pool as collateral. The pool has three tranches, where tranche A offers the least protection against prepayment and tranche C offers the most protection against prepayment. Tranche A of $25 million receives quarterly payments at 4 percent per year, tranche B of $50 million receives quarterly payments at 5 percent per year, and tranche C of $25 million receives quarterly payments at 6 percent per year.

Tranche A Tranche B Tranche C Total Issue

Principal amount $25 million $50 million $25 million $100 million

Interest rate 9 percent 10 percent 11 percent 10 percent

Quarterly interest on

initial balance $250,000 $625,000 $375,000 $1,250,000

Quarterly amortization $1,613,350

d. Assume nonamortization of principal and no prepayments. What are the total promised coupon payments to the three classes? What are the principal payments to each of the three classes for the first year?

Regular tranche A interest payments are $250,000 quarterly. If there are no prepayments, then the regular GNMA quarterly payment of $1,613,350 is distributed among the three tranches. Five million is the total coupon interest payment for all three tranches. Therefore, $363,350 of principal is repaid each quarter. Tranche A receives all principal payments. Tranche A cash flows are $250,000 + $363,500 = $613,500 quarterly. The cash flows to tranches B and C are the scheduled interest payments.

Tranche A amortization schedule:

Interest Principal Remaining

Quarter Balance Payment Payment Payment Principal

1 $25,000,000 $613,500 $250,000 $363,500 $24,636,500

2 24,636,500 613,500 246,365 367,135 24,269,365

3 24,269,365 613,500 242,694 370,806 23,898,559

4 23,898,559 613,500 238,986 374,514 23,524,044

Tranche B amortization schedule:

Interest Principal Remaining

Quarter Balance Payment Payment Payment Principal

1 $50.000m $625,000 $625,000 $0.0m $50.000m

2 50.000m 625,000 625,000 0.0m 50.000m

3 50.000m 625,000 625,000 0.0m 50.000m

4 50.000m 625,000 625,000 0.0m 50.000m

Tranche C amortization schedule:

Interest Principal Remaining

Quarter Balance Payment Payment Payment Principal

1 $25.000m $375m $375m $0.0m $25.000m

2 25.000m 375m 375m 0.0m 25.000m

3 25.000m 375m 375m 0.0m 25.000m

4 25.000m 375m 375m 0.0m 25.000m

e. If, over the first year, the trustee receives quarterly prepayments of $5 million on the mortgage pool, how are these funds distributed?

The quarterly prepayments of $5 million will be credited entirely to tranche A until tranche A is completely retired. Then prepayments will be paid entirely to tranche B. The amortization schedule for tranche A for the first year is shown below. This amortization schedule assumes that the trustee has a quarterly payment amount from the mortgage pool of $1,613,350.

Interest Principal Remaining

Quarter Balance Payment Payment Payment Principal

1 $25,000,000 $5,613,500 $250,000 $5,363,500 $19,636,500

2 19,636,500 5,613,500 196,365 5,417,135 14,219,365

3 14,219,365 5,613,500 142,194 5,471,306 8,748,059

4 8,748,059 5,613,500 87,481 5,526,019 3,222,039

However, since some of the mortgages will be paid off early, the actual payment received by the trustee from the mortgage pool will decrease each quarter. Thus, the payment for the second quarter will decrease from $1,613,350 to $1,532,385 (n = 119 quarters, i = 5 percent, mortgage principal = $94,636,500). The CMO amortization schedule for tranche A given that the mortgage payments decrease with the prepayments is given below. The revised mortgage payment for each quarter is shown in the last column.

Interest Principal Remaining Mortgage

Quarter Balance Payment Payment Payment Principal Payment

1 $25,000,000 $5,613,500 $250,000 $5,363,500 $19,636,500 $1,613,350

2 19,636,500 5,532,385 196,365 5,336,020 14,300,480 1,532,385

3 14,300,480 5,451,342 143,005 5,308,337 8,992,143 1,451,342

4 8,992,143 5,370,210 89,921 5,280,289 3,711,854 1,370,210

f. How are the cash flows distributed if prepayments in the first half of the second year are $10 million quarterly?

The amortization schedules for tranches A and B are shown below. Again the mortgage payments from the mortgage holders are assumed to decrease as the prepayments occur.

Amortization schedule for tranche A:

Tranche Interest Principal Remaining Mortgage

Quarter Balance Payment Payment Payment Principal Payment

5 $3,711,854 $10,288,986 $37,119 $10,251,867 -$6,540,013 $1,288,986

Amortization schedule for tranche B:

Tranche Interest Principal Remaining Mortgage

Quarter Balance Payment Payment Payment Principal Payment

5 $50,000,000 $7,165,283 $625,000 $6,540,013 $43,459,987 $1,288,986

6 43,459,987 11,817,739 543,250 11,274,489 32,185,498 1,817,739

33. How does a class Ztranche of a CMO differ from a class R tranche? What causes a Z class to have characteristics of both a zero-coupon bond and a regular bond? What factors can cause an R class to have a negative duration?

The Z class tranche has a stated coupon rate, but the accruing interest is not paid until all other classes of bonds have been paid. Thus, the tranche is like a zero-coupon bond. The R class tranche receives no interest or distribution until all other classes have been retired. At the time that all other tranches are paid off, the R class investors receive the remaining funds in the tranche. The reinvestment income can be quite large, and further, the value of the reinvested income grows as interest rates increase. Therefore, the duration can be negative.

34. Why would buyers of class C tranches of collateralized mortgage obligations (CMOs) be willing to accept a lower return than purchasers of class A tranches?

Buyers of CMOs incur prepayment risks depending upon the class of tranches they have purchased. Purchasers of Tranche A incur the most risk because all prepayments will be passed on to them. Prepayments usually occur when interest rates are low and thus, pose high reinvestment risks to this group of buyers. On the other hand, Tranche C purchasers are protected from prepayment until Tranche B is exhausted and as a result are less likely to incur early prepayments unless interest rates reach so low as to create above-average levels of refinancing.

35. What are mortgage-backed bonds (MBBs)? How do MBBs differ from pass-through securities and CMOs?

MBBs, or covered bonds, are bonds issued by FIs that have a block of assets, usually mortgages, serving as collateral against, or covering the payment on, the bonds. Contrary to CMOs and pass-through securities, the issuance of MBBs does not remove the mortgage assets from the balance sheet. Rather, the MBB bondholders have a first claim on the specific mortgage assets. The MBB bondholders receive a stated rate of interest that is not tied to the cash flows of the mortgage assets.

36. From the perspective of risk-management, how does the use of MBBs by an FI assist the FI in managing credit and interest rate risk?

The MBBs usually are over collateralized and therefore, may have a higher credit rating than the FI as a whole. As a result, the MBB may have a lower interest rate than uninsured deposits. Further, the normally positive duration of the FI will be reduced because of the long-term, fixed-rate nature of the bonds.

37. Consider a bank with $50 million in long-term mortgages as assets. It is financing these mortgages with $30 million in short-term uninsured deposits and $20 million in insured deposits. To reduce its interest rate risk exposure and to lower its funding costs, the bank can segregate $35 million of the mortgages on the asset side of its balance sheet and pledge them as collateral backing a $30 million long-term MBB issue. Because the $30 million in MBBs is backed by mortgages worth $35 million, the mortgage-backed bond issued by the bank costs less to issue, in terms of required yield, than uninsured deposits. Thus, the FI can then use the proceeds of the $30 million bond issue to replace the $30 million of uninsured deposits. Show the bank’s balance sheet before and after the issue of the MBB.

Bank’s balance sheet of before issue of MBB

(in millions of dollars)

Assets Liabilities

Long-term mortgages $50 Insured deposits $20

Uninsured deposits 30

$50 $50

Bank’s Balance sheet after issue of MBB

(in millions of dollars)

Assets Liabilities

Collateral = (market value of MBB issue $30

segregated mortgages) $35

Other mortgages 15 Insured deposits 20

$50 $50

38. What are four reasons why an FI may prefer the use of either pass-through securities or CMOs to the use of MBBs?

First, MBBs freeze mortgages on the FI’s balance sheet for an extended period of time. Second, the amount of mortgages that are put up as security for the MBBs exceeds the amount of MBBs because of the overcollateralization requirements to improve the credit rating of the MBBs. Third, the continued existence of the mortgages on the balance sheet requires capital adequacy and reserve requirement taxes for the FI. Finally, regulatory discouragement and the potential for regulatory intervention are becoming undesirable aspects of the use of MBBs.

39. What is an interest only (IO) strip? How do the discount effect and the prepayment effect of an IO create a negative duration asset? What macroeconomic effect is required for this negative duration effect to be possible?

A mortgage pass-through that has a claim only to the interest payments of underlying mortgages is an interest only strip. These IO strips are sensitive to two factors: the level of interest rates (discount effect) and the prepayment of mortgages. If market interest rates are above coupon rates, then the present value of the stream of interest payments declines. However, when rates decline, especially below coupon rates, it is quite likely that the prepayment effect may dominate and therefore the value of the instruments may also decline. When the value of a fixed-rate asset decreases as interest rates are declining, the duration of the asset is negative. If IO strips are created out of nonmortgage instruments, such as Treasury bonds, then the likelihood of prepayment is low and the relationship will be in one direction. That is, as interest rates rise, the present value of the income streams will decrease.

40. What is a principal only (PO) strip? What causes the price-yield profile of a PO strip to have a steeper slope than a normal bond?

The holder of a principal only strip is entitled to the portion of the mortgage payments that reflects the payment of principal. As interest rates decrease, the discount effect will cause the value of the PO strip to increase. Further, as interest rates decrease, the prepayment effect also has a positive impact on the value of the PO strip. Thus, the double effect causes the rate sensitivity of a PO strip to be higher than that of a normal bond that is not subject to the prepayment effect.

41. An FI originates a pool of real estate loans worth $20 million with maturities of 10 years and paying interest rates of 9 percent per year.

a. What is the average payment received by the FI, including both principal and interest, if no prepayment is expected over the life of the loan?

The average payment is $20,000,000 = PVAn=10, k=9% x PMT => PMT = $3,116,401.80

b. If the loans are converted into pass-through certificates and the FI charges a servicing of 50 basis points, including insurance, what is the payment amount expected by the holders of the pass-through securities if no prepayment is expected?

$20,000,000 = PVAn=10,k=8.5% x PMT => PMT = $3,048,154.10

c. Assume that the payments are separated into interest only (IO) and principal only (PO) payments, that prepayments of 5 percent occur at the end of years 3 and 4, and that the payment of the remaining principal occurs at the end of year 5. What are the expected annual payments for each instrument? Assume discount rates of 9 percent.

Interest Principal Remaining

Year Balance Payment Payment Payment Principal

1 $20,000,000.00 $3,116,401.80 $1,800,000.00 $1,316,401.80 $18,683,598.20

2 18,683,598.20 $3,116,401.80 $1,681,523.84 $1,434,877.96 $17,248,720.24

3 17,248,720.24 $3,978,837.81 $1,552,384.82 $2,426,452.99 $14,822,267.25

4 14,822,267.25 $3,857,515.16 $1,334,004.05 $2,523,511.11 $12,298,756.14

5 12,298,756.14 $13,405,644.19 $1,106,888.05 $12,298,756.14 $0.00

d. What is the market value of IOs and POs if the market interest rates for instruments of similar risk decline to 8 percent?

The market value of the IO is found by discounting the interest payment column in part (c) at 8 percent. The PV = $6,074,497.66.

The market value of the PO is found by discounting the principal payment column in part (c) at 8 percent. The PV = $14,600,446.52.

Note that the PV of the total payments is $20,674,944.18 which is the sum of the PV of the IO and the PV of the PO.

42. What are the factors that, in general, allow assets to be securitized? What are the costs involved in the securitization process?

In general the easiest assets to securitize are those that are homogenous and that can be valued with relative precision. The homogeneity involves the characteristics of the contracts, such as maturity, payment schedule, etc., while the valuation process is easiest if the underlying assets are traded in the market. The costs of the securitization process include credit risk insurance, guarantees, overcollateralization, valuation and packaging costs.

43. How does an FI use securitization to manage interest rate, credit and liquidity risks? Summarize how each of the possible methods of securitization products affects the balance sheet and profitability of an FI in the management of these risks.

In the process of intermediation on behalf of its customers, the FI assumes risk exposure. The FI can reduce that risk exposure by altering its product base, thereby affecting the portfolio mix obtained in the course of intermediation. However, this is likely to be quite costly in terms of customer good will and loss of business. Securitization enables FIs to manage risk exposure by changing their portfolio mix without alienating customers or changing the customer base and mix. That is, customers are still serviced and the FI continues to intermediate. Balance sheet alterations are made subsequent to and independent of the intermediation activity. Thus, the FI can make portfolio changes and still fulfill the function of the intermediary.

Interest rate risk exposure is reduced by matching the durations of assets and liabilities. Securitization enables the FI to accomplish this since the FI can determine which loans to package and sell off. Credit risk exposure is minimized by selling loans without recourse. Foreign exchange rate risk exposure is reduced by matching the foreign currencies in which the assets and liabilities are denominated. Securitization allows the FI to sell off unmatched assets. Finally, securitization reduces liquidity risk, since the FI does not have to fund the asset.