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Introduction to OTC Options on Mortgage-Backed Securities

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Executive Summary

The market in over-the-counter (OTC) options on mortgage-backed securities (MBS) is well developed, and offers many hedging and trading opportunities. (In this report, we will refer to options on mortgaged-backed securities as either "mortgage options" or "OTC mortgage options.") Market making in mortgage options is one of the many services Salomon Smith Barney offers to its customers. The purpose of this report is twofold. Our first objective is to provide an overview of mortgage options for fixed-income investors who are new to this market. Our second objective is to describe various methods of analyzing these securities.

This report is organized as follows:

- ***Section I reviews the specifications, cashflow mechanics, and liquidity in the mortgage options. We also compare mortgage options to other interest-rate options.***
- ***Section II examines the different trading and relative value opportunities available in the mortgage options markets by investor type.***
- ***Section III discusses the complexity of mortgage options' valuations, including their dependence on interest rate levels, prepayment rates, and various characteristics of underlying collateral.***

I. Conventions, Liquidity, and Advantage

- **OTC options on mortgage-backed securities, commonly referred to as mortgage options, are extremely flexible in how the underlying security, strike, and expiration are specified. In the section below, we describe the most common conventions in selecting these items.**
- **OTC mortgage options are frequently substituted with exchange-traded options on US Treasury futures or OTC Treasury options. We use history to illustrate that these strategies may result in a significantly increased mortgage/Treasury basis risk.**

Market Conventions

Underlying Security and Settlement

The security underlying a mortgage option is almost always a TBA[1] mortgage-backed security (MBS), usually a 30-year conventional mortgage. Next, in order of decreasing liquidity, would be options on 30-year Ginnie Maes and 15-year conventionals. Although less common, options on specified pools (TBA-like) and "pools stips" are also traded.

The delivery date for the underlying security must be specified and is always after the option's expiration date. The settlement of the passthroughs, generally, follows BMA[2] settlement guidelines. While the underlying security can settle any time after the option's expiration, it usually settles in the same month or the month following the expiration.

The option premiums on mortgage option contracts settle (i.e., premiums are paid) on the next business day.

Expiration Date

The option expiration date can be any day prior to the "48-hour day" of the underlying security without loss of liquidity. However, about half of all traded options expire one week before the underlying security's settlement date. For example, if the BMA settlement date of Fannie Mae 8s were May 14, the conventional expiration of the option would be on May 7. As the underlying security prices forward delivery, this convention allows dealers enough time to adjust their roll[3] exposure before settlement.

The option expiration date can be set anywhere from one day to over one year in the future. Most options, however, expire in two weeks to four months. Longer-dated

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[1] For a description of TBA mortgage-backed securities, please see the November 1999 Salomon Smith Barney publication, *The Mechanics of Investing in Mortgage and Asset-Backed Securities*, R. Young, L.Hayre and S. Chaudhary.

[2] Bond Market Association, formerly known as the PSA (the Public Securities Association).

[3] Roll is a common trading strategy that involves buying and selling the same TBA for different settlement dates with the goal of obtaining financing via the mortgages.

options are less liquid and have wider bid/ask spreads because of the difficulties in pricing and hedging of passthroughs settling after four months.

The expiration time is almost always 4:00PM EST, as with Treasury and agency options. However, any reasonable time can be chosen.

OTC mortgage options are designated to be European because the forward delivery of the underlying mortgages will always make them suboptimal to exercise early. Figure 1 illustrates the cashflow mechanics of a call written on a conventional MBS.

Strike Price

The strike price is always set relative to the underlying security's forward price for the settlement date. For example, an at-the-money option would have the strike set at the forward price of the underlying mortgage security, a half point out-of-the-money (OTM) call has the strike price a half point above the security's forward price.

The reference for the strike depends upon whether the option position will allow the dealer to ultimately have a long or short position in the underlying security. For example, if a dealer is buying a call or selling a put, he/she would ultimately have a long position in the underlying and will have to sell the underlying security to hedge the option position. The strike, therefore, is set relative to the bid side of the mortgage market. On the other hand, if a dealer is selling a call or buying a put, then he/she is short the underlying security and would have to buy it back to hedge the option position. Therefore, the strike would be set on the offer side of the mortgage market. In addition, a customer can always ask for a specific strike.

Figure 1. Cashflow Mechanics of Purchasing a Call on a 30-Year Conventional

Date	Transaction
2/20/01	Client purchases a call on $100 million of Fannie Mae 6.5s May settle (5/14/01), 5/7/01 expiration, 99-28 strike
2/21/01	Option contract is settled; premium paid
5/7/01	Call is exercised; client purchases $100 million of Fannie Mae 6.5s, May settle at 99-28
5/10/01	"48-Hour" day begins for Fannie Mae 6.5s
5/14/01	Fannie Mae TBA settles. Client delivers $100 million current face of Fannie Mae 6.5s

Source: Salomon Smith Barney.

Advantages of Using OTC Mortgage Options Versus Other Interest-Rate Options

In many instances, OTC mortgage options enable mortgage market participants to more effectively manage their risk and returns than other interest-rate options. In Section 2, we describe in detail appropriate strategies for various players in the mortgage markets. Here we would like to mention the overall advantages of using OTC mortgage options versus exchange-traded options on US Treasury futures or OTC Treasury options.

CBOT-Traded Options on US Treasury Futures

Frequently, mortgage investors use options on Treasury futures as a vehicle to trade volatility because of the perceived liquidity and transparency in the futures markets.

The disadvantage of using these options to manage mortgage market risks and volatility arises mainly from differences in the underlying securities and their preset strikes and expiration dates.

The Treasury futures contract is an underlying security in the CBOT-traded options. This means that a position in options on futures against mortgage-backed securities includes the mortgage/Treasury basis risk and cash/futures risk. Using mortgage options eliminates these risks. In addition, CBOT-traded options on futures have preset strikes and expirations dates, which may prove to be too rigid for a mortgage market participant. As we described above, mortgage options are highly flexible in terms of possible strikes and expirations dates. Furthermore, liquidity for block-size option trades is better in the OTC markets.

OTC Treasury Options

OTC Treasury options allow the same flexibility as mortgage options in setting up strikes and expiration dates and constitute a fairly liquid market. In fact, bid/ask spreads and liquidity for mortgage options are similar to the OTC options on ten-year Treasuries. However, trading OTC Treasury options against mortgage securities entails mortgage/Treasury basis risk and, possibly, curve risk. The changing shape of the Treasury curve (even if overall yield levels remain stable) may have a significant effect on mortgages, which would not be reflected in the Treasury options position.

In fact, during periods of high interest rate and spread volatility, increases in mortgage/Treasury basis risk can be quite significant. A dramatic example of such a divergence was observed in 1998. In the fall of 1998, the market turmoil and the liquidity crisis led to a dramatic increase in interest rate and spread volatility, making it difficult to replicate the changes in MBSs with Treasury products. By the end of the third quarter of 1998, fixed income markets experienced a sharp rally, steeper yield curve and wider spreads. In the beginning of October, however, interest rates backed up, but spreads kept widening, driven by liquidity concerns. Overall, yields remained very volatile through the end of 1998 with rallies and selloffs interchanging.

Replicating the performance of MBSs with Treasury products was extremely difficult during this period. Figure 2 compares the performance of $100,000 par of 7% 30-year Fannie Mae versus duration-matched positions in ten-year Treasury note and December ten-year Treasury futures between October 2, 1998 and December 1, 1998. By October 8, 1998, the duration of the ten-year note had not changed much, but the estimated effective duration of the 7% Fannie Mae increased from 0.4 to 1.9 (an increase of 375%) because overall yields rose. The original Treasury position was no longer tracking Fannie Mae 7s. The par amount of Treasuries needed to keep up with the changing Fannie Mae duration increased by 377%, the number of futures contracts rose by 385%. As we approached the futures delivery month, yields rose more and the curve flattened. Again, the hedge had to be changed significantly.

Figure 2. Performance of US Treasury Note and 10-Year Treasury Futures Hedges of an MBS

	FNMA 7s		10-Year Note		FNMA 7s - 10-year Note				10-Year Futures		FNMA-10-Year Futures	
	Duration	Change (%)	Duration	Change (%)	Spread (bp)	Change (%)	Hedge ($M)	Change (%)	Duration	Change (%)	Hedge (# contracts)	Change (%)
10/2/98	0.4	—	7.33		116.8	—	5	—	69.4	—	6	—
10/8/98	1.9	375	7.30	-0.4	179.7	54	26	377	68.0	-2	28	385
12/1/98	1.4	250	7.13	-2.7	142.4	22	20	260	65.9	-5	21	269

Source: Salomon Smith Barney.

Liquidity in OTC Mortgage Options

Liquidity in the OTC mortgage options market is very deep and comparable to the liquidity in the options markets we have described above. In most cases, the underlying issue, strike, and expiration of an OTC mortgage option can be set to the exact specifications that fit the mortgage investor's needs with no or little loss of liquidity. Trades of $10 million–$250 million face amount usually get round-lot execution without loss of liquidity, although the market can absorb larger trades with modest concessions for size.

Bid/ask spreads are similar to those charged in the OTC Treasury option markets and average about 1.0–1.5 tick in normal market conditions.

Options written on current-coupon MBSs are the most liquid. The liquidity of options on premium- and discount-coupon MBSs usually depends on market conditions. However, in general, one should expect good liquidity trading options on one coupon above and one coupon below the current coupon.

II. Trading Strategies

➤ **Depending on their specific goals, mortgage markets participants should consider different strategies when trading OTC mortgage options.**

Why Use OTC Mortgage Options?

Mortgage options enable portfolio managers to more effectively manage their risk and enhance returns. Mortgage originators can buy puts and calls to accurately hedge the fallout risk of their pipeline. Money managers can protect their portfolio returns from mortgages underperforming other securities. Banks can enhance returns by writing covered calls to generate premium income. Arbitrage accounts can express their views regarding the relative value of various option products and mortgage hedge ratios.

Main Strategies in Trading OTC Mortgage Options

Mortgage Originators

Mortgage originators can use mortgage options to effectively manage the fallout risk in their pipeline. After reviewing a mortgage application, a mortgage banker issues a commitment letter to a mortgagor guaranteeing a firm rate for a period of time (usually 60 days). The mortgagor is not obligated to accept the mortgage rate at the end of this period. The ultimate goal of many mortgage originators is to accumulate an inventory of loans and sell it at a future date as soon as the inventory is large enough. Mortgage bankers usually estimate the size of their inventory and sell it forward, agreeing to deliver at a future date. This strategy, however, can have a significant downside. For example, if the market rallies and mortgages do not close at the rate that was anticipated by the originator he/she will not be able to build the expected inventory. Therefore, there is a risk of not being able to deliver and, in a worst-case situation, the mortgage banker would have to buy loans for delivery at a much higher price. The mortgage originator can hedge his forward sale of the loan by buying calls. If rates rise or remain stable, the banker will have little trouble building up the inventory. If rates fall, the offsetting long call position will give the originator the right to buy the mortgages for the forward delivery at an agreed price below the spot.[4]

Consider the following simplified example. Suppose a mortgage bank receives applications for 100 loans with an average loan balance of $100,000. Anticipating that rates remain stable, the originator expects 75% of the loans to close by March 13, 2001.The bank sells forward (to March 13, 2001) $7.5 million of loans at par. If the bank did not hedge its fallout risk and all the loans closed, as was expected, there were no losses. However, not hedging fallout risk can become costly, if market

[4] Suppose an originator did not sign forward delivery contracts and was holding loans for his/her own inventory. Buying an ATM put would provide an originator with a protection against a decline in his portfolio if interest rates were to rise. By call-put parity this is equivalent to being long an ATM call and a forward contract on mortgage inventory.

conditions change. Let us assume that by March 13, rates declined, making the same loans cost $102. In this scenario, it is also likely that the fallout might be higher than expected and, for example, only $5.5 million of loans actually close. The bank still has to deliver loans for $7.5 million face value, so it has to buy $2.0 million worth of loans. However, the market price of these loans increased $2.04 million. Thus, the bank lost $40,000. To hedge this risk, the bank could have bought ATM mortgage call options with an expiration on the same date as the loans had to be delivered. In our example, the originator could buy $2.0 million face amount of OTC calls that expire on March 6. If rates declined, the originator would exercise his calls and would only pay $2.0 million for the needed loans. The only loss in this case, is the premium paid for the calls, which is significantly lower than a considerable loss that an originator can face without hedging the fallout risk. Figure 3 summarizes the P/L of a hedged position. Note that the originator would make additional profit if the realized fallout were not as strong. In this case, buying $2.0 million face amount of calls would be an overhedge.

Figure 3. P/L Summary of Using an OTC Mortgage Call to Hedge the Fallout Risk on $10 Million Mortgage Collateral

Date	Transaction	Settlement	Face value, $	P/L
February 19, 2001	Loan rates locked	March 13, 2001	$10,000,000	
February 19, 2001	Loans sold forward	March 13, 2001	$7,500,000	
February 19, 2001	3 week Fannie Mae ATM call bought at 14 ticks	March 13, 2001	$2,000,000	-$8,750
March 6, 2001	Option exercised and collateral sold	March 13, 2001	$2,000,000	$40,000
March 13, 2001	Loans delivered	March 13, 2001	$7,500,000	-$40,000
	Total			**-$8,750**

Source: Salomon Smith Barney.

Money Managers (Total Rate of Return Accounts)

Money managers whose goal is to maximize their portfolios' total rate of return are likely to be interested in relative value opportunities. The most common strategy is to implement conditional mortgage-Treasury basis trades. For example, the most popular trade is a "calls-calls" trade using mortgage and Treasury options. In anticipation of a rally or a refinancing wave, a money manager can sell calls on mortgages and buy calls on Treasuries as protection against mortgage spreads widening beyond the market's expectation. It is convenient to enter the trade at no cost by adjusting the notional sizes of the options by the ratio of corresponding premiums. This trade is especially popular during times of high refinancing activity.

Figure 4 delineates an example of this trade. One can sell $100 million ATM forward calls on 6.5% Fannie Maes for 24 ticks, and buy $50 million ATM forward calls on ten-year Treasuries at 1-16 ticks, which is fee neutral. Both options expire on June 6, 2001, and both ATM forward strikes are 100–00.

Figure 4. Example of a Calls-Calls Trade

	Collateral	Amount, MM	Strike	Expiry	Premium	Price
Buy	30-yr FNMA 6.5	100	$100	June 6, 2001	0-24	$750,000
Sell	10-year Treasury	50	$100	June 6, 2001	1-16	$750,000

Source: Salomon Smith Barney.

If interest rates go up, then both options expire worthless. If the expected rally is realized, then the outcome of the trade depends on the mortgage performance relative to the ten-year Treasuries. Figure 5 shows three scenarios in which the mortgage's performance varies. In each case, mortgage performance can be measured by a realized hedge ratio,[5] i.e., the more spreads widen, the lower the realized hedge ratio.

Figure 5. Profit/Loss Scenarios

	Scenario 1 Breakeven		Scenario 2 Loss		Scenario 3 Profit	
Collateral	Collateral Price at Expiration	Option Pay-off	Collateral Price at Expiration	Option Pay-off	Collateral Price at Expiration	Option Pay-off
30-year FNMA 6.5	$100-16	$0.50	$100-24	$0.75	$100-8	$0.25
10-year Treasury	101	$1.00	$101	$1.00	$101	$1.00
Realized Hedge Ratio		50%		75%		25%
Profit/Loss		$0		-$250,000		$250,000

Source: Salomon Smith Barney.

In the first scenario, the calls-calls trade will result in a breakeven outcome. If the realized hedge ratio is higher than the breakeven hedge ratio, i.e. mortgages outperformed expectations, then the trade results in a loss, as in the second scenario. If the realized hedge ratio is smaller than the breakeven hedge ratio, which means that mortgage spreads widen more than was implied at the trade date, then the calls-calls trade results in a profit, as in the third scenario. The breakeven hedge ratio can easily be determined from the market prices of the mortgage call and the Treasury call at the inception of the trade. It is just the ratio of the price of the mortgage call to the price of the Treasury call. The breakeven hedge ratio is often called the market-implied hedge ratio.

This trade is recommended if the mortgages trade rich to Treasuries and the expected hedge ratio of Fannie Mae 6.5s to the ten-year Treasuries is less than the market-implied hedge ratio.

[5] The realized hedge ratio can be computed by the following formula

$$h = \frac{P_f - P_0}{T_f - T_0},$$

where P_f and P_0 are the mortgage prices at the option expiration date and the original trade date, respectively.

T_f and T_0 are the ten-year Treasury prices at the option expiration date and the original trade date, respectively.

Because mortgages are negatively convex and Treasuries are positively convex, being short on a mortgage call and long on a Treasury call implies a convexity advantage. In a strong rally, mortgage prices are likely to underperform a fixed hedge ratio. Consequently, the calls-calls trade is likely to be profitable.

The risk of a calls-calls trade is that mortgages tighten against the market-implied hedge ratio in either a rally or unchanged interest rate scenario. The tightening can occur for many reasons. Some of these reasons are a drop in implied volatilities, steepening of the yield curve, or increased demand for mortgages.

The trade described above is only one example of possible directional basis trades. In anticipation of a market sell-off, one can sell mortgage puts and buy Treasury puts to be long the mortgage/Treasury basis. In addition, similar directional trades can be done using mortgage options on one side and either swaptions or agency options instead of Treasury options on the other.

Banks

Banks can use mortgage options to generate additional income for their portfolio. This is similar to income generation using other options, such as exchange-traded options on futures or OTC Treasury options. One possible strategy is to write covered calls. If rates remain at the levels where the trade was initiated or rise, the call expires worthless and the writer profits from the premium. If interest rates decline, the call can be exercised and the writer can deliver the mortgage, while still enjoying the premium. The premium is booked as income immediately and flows through the income statement, helping to manage the bank's earnings.

Similarly, banks can sell puts as a targeted buying strategy. For example, instead of buying premium-coupon mortgages, a bank can sell a put. If the put is exercised (as in the case of a market decline), the bank receives a mortgage and enjoys the option premium. If the put expires out-of-the-money, the banker simply collects the option premium.

Mortgage Servicers

Mortgage servicers derive their profits from the servicing fee on their mortgage portfolio. To effectively manage their profits, mortgage servicers have to hedge out the prepayment risk imbedded in servicing IO. Indeed, if prepayments speed up because of declining interest rates, the value of the servicing may decline because of its negative convexity. Buying calls on mortgages will offset the declining value of servicing.

Other

There are many other strategies involving OTC mortgage options that can be profitable under specific market conditions. Some of the strategies might only be suitable for more aggressive investors. Arbitrage accounts can use mortgage options to trade their views on volatility. For example, if the view is that the options' implied volatility is too high and upside price potential in mortgages is limited, one may want to sell calls on mortgages. It is also possible to speculate on relative volatility pricing among various options markets. If the mortgage options' volatility is perceived to be cheap versus volatility on swaptions or Treasury options, the potential profit can be obtained from buying mortgage options and selling an implied volatility-weighted number of swaptions or Treasury options.

III. Valuation

➤ **OTC Mortgage options have many characteristics that differ from standard bond options and it is essential to understand the complexities and unique features of these contracts.**

Option Pricing and Mortgage Prepayments

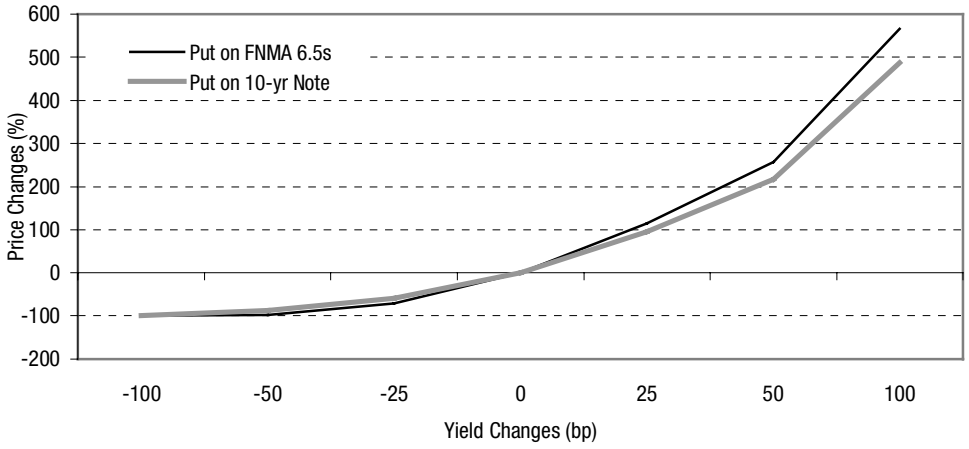
Option pricing methods that offer closed-form solutions, such as Black-Scholes or Black model, make assumptions about the underlying security price distribution that are not very suitable for interest rate securities and for MBSs especially. For example, the constant-volatility assumption is, in general, not appropriate for interest rate options. However, if the underlying security is a bond without an embedded option (such as Treasuries or agency bonds and notes) and options on such a bond are short, closed-form solutions may give an acceptable option price approximation. The Black model is often used by the Street to price interest-rate options, including mortgage options, because the interest rate mean reversion can be accounted for and because of the options' short expiration. But, the constant-volatility assumption may imply the wrong distribution of mortgage prices at option expiration, even for short expirations, because it does not account for changes in volatility implied by varying prepayments. Just as the dependence of mortgage cashflow on interest rates through prepayments makes traditional bond analysis ill-suited for mortgages, mortgage options cannot be priced using the methods popular for other bond options.

More appropriate are term structure models that allow enough flexibility to model mortgage prices as they are being affected not only by varying interest rates, but also by varying mortgage spread volatilities and prepayments.

One way of looking at the prepayment-dependent behavior of the mortgage options is to compare them with similar OTC options on Treasury notes. Let us consider an OTC ATM put on the ten-year Treasury note and an OTC ATM put on 6.5% 30-year Fannie Mae. Figure 6 illustrates relative percentage price changes of these puts under instantaneous changes in interest rate levels.

As interest rates rise, the put on Fannie Mae increases in price faster relative to its original price than the put on the ten-year note. When yields rise, prepayments on mortgages decline and mortgages extend in duration. As a result, prices on MBSs decline more than prices on Treasuries, which do not depend on prepayments. Therefore, the mortgage put becomes more valuable than the put on Treasuries as yields rise. Similarly, as yields decline, the mortgage put experiences a larger price decrement than the Treasury put. As interest rates fall, mortgage prepayments speed up, the durations of MBSs shorten and put prices decline. The bottom line is that the more significant the change in duration, the larger the change in a price of a mortgage put. Unlike durations of Treasuries, mortgage durations change not only because of varying interest rates, but also because of changing prepayments.

Figure 6. Price Changes (%) of Three-Week OTC ATM Puts on 6.5s Fannie Mae and 10-Year Treasury Note



Source: Salomon Smith Barney.

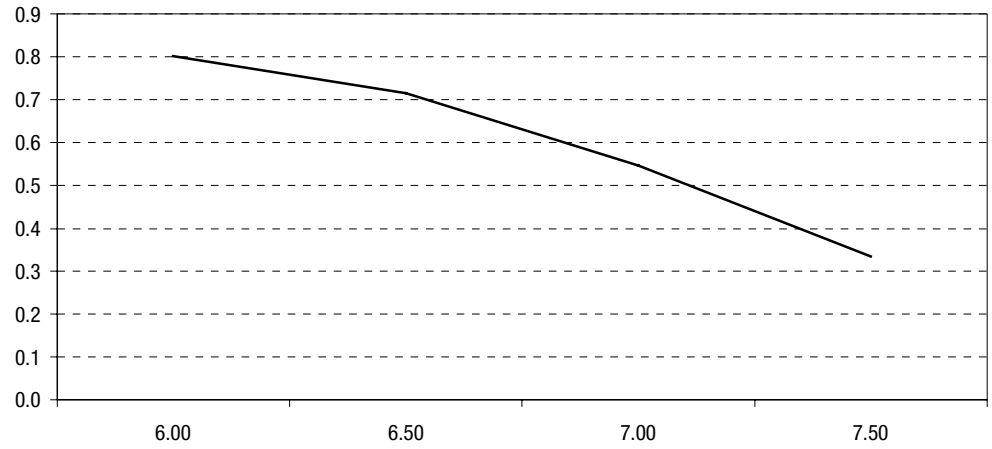
Note that the prepayment-affected behavior of mortgage options is more evident when interest rates are volatile and options are long in expiration.

Guidelines for Pricing OTC Mortgage Options

As we illustrated above, mortgage option pricing is very sensitive to the underlying mortgage prepayments. Here we describe rules of thumb that can be used when assessing this effect.

- The higher the price of an underlying mortgage security, the shorter its duration. The shorter its duration, the lower its volatility. The lower its volatility, the lower the price of the option. As yields decline and prepayments speed up, the prices of MBSs increase, their durations shorten, and options on these mortgages become less valuable. In other words, the faster the underlying mortgage is expected to prepay, the lower the price of an option.
- MBSs priced below or above par are likely to prepay at different rates. Discount MBS issues (with the coupon below the current coupon) will have lower prepayment expectations and higher volatility. The options on these underlying securities will, therefore, have higher prices than options on current-coupon mortgages. The exact opposite is true for MBSs traded at a premium (with coupons higher than the current coupon). Figure 7 compares the prices of OTC at-the-money (ATM) puts on 30-year conventional mortgages with different coupons. At the time of pricing, the current mortgage coupon was 6.5%. As a result, 7.5% mortgages are expected to prepay faster than 6% mortgages. Therefore, the options on 7.5% conventionals will be less valuable than options on 6% conventionals.

Figure 7. Prices (in Dollars) of OTC ATM Puts on 30-Year Mortgages for Selected Coupons, 16 Feb 01



Source: Salomon Smith Barney.

➤ The easiest way to compare similar options on different collateral is to compare collateral durations. Since 15-year mortgages usually have shorter durations than 30-year mortgages, an ATM option on 15-year collateral will be less costly than an ATM option on 30-year collateral. It is less straightforward to compare an option on conventional collateral to an option on Ginnie Maes. Again, the determining factor is duration. The collateral with shorter duration will have the less expensive option. Figure 8 shows prices of ATM call options on different collateral. All options illustrated here expire on April 9, 2001 (despite the different TBA settlement dates).

Figure 8. Prices of OTC ATM Calls on Various Mortgage Collateral

Collateral	Strike (dollars)	Call Price (dollars)	Collateral	Strike (dollars)	Call Price (dollars)
Fannie Mae 30-year, 6.5s	$98.75	$0.65	Ginnie Mae 30-year, 6.5s	$98.94	$0.75
Fannie Mae 30-year, 7s	100.34	0.49	Ginnie Mae 30-year, 7s	100.66	0.62
Fannie Mae 15-year, 6.5s	98.84	0.61	Ginnie Mae 15-year, 6.5s	99.53	0.68
Fannie Mae 15-year, 7s	100.31	0.47	Ginnie Mae 15-year, 7s	101.00	0.56

Source: Salomon Smith Barney.

➤ Out-of-the-money (OTM) puts on mortgages usually have higher price-implied volatilities. Because of prepayment dependent behavior of MBSs, their prices decrease faster as yields rise than they increase as yields fall. Therefore, OTM puts are more likely to become in-the-money than OTM calls. As a result, OTM puts have higher implied volatility than OTM calls.

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