

Jumbo Hybrid ARM Securities: A Comprehensive Introduction

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A hybrid adjustable-rate mortgage (ARM) combines the characteristics of fixed- and adjustable-rate mortgages. It initially fixes the borrower's rate for a set time (typically three, five, seven, or ten years), and then floats it at a fixed spread to an index. For example, the mortgage rate on a 5/1 (or 5×1) hybrid ARM is fixed for five years, and then annually resets to the one-year constant-maturity Treasury (CMT) rate plus a margin.

As with any ARM, several contractual features are worth noting:

- **Index.** The ARM index has typically been the one-year CMT, but this is likely to be replaced by one-year LIBOR in the future.
- **Margin:** The margin is typically 275 basis points over the one-year CMT or 225 basis points over one-year LIBOR.
- **Interest rate caps.** The caps are 5 percentage points (i.e., 500 basis points) above the initial fixed rate on the first adjustment (the initial cap) and 2 percentage points on subsequent adjustments (the periodic cap). All adjustments are subject to a life cap of 5 percentage points. This cap structure is often described as a 5-2-5.
- **Interest rate calculation.** The interest rate adjustment periods are 59 months after the first payment due date and every 12 months thereafter. On each interest

adjustment date, the reset of the borrower's rate is based on the index rate available 45 days before the adjustment date (the look-back period). The actual adjustment is calculated by adding the margin to this index rate and then rounding to the next highest 0.125%. The borrower's monthly payment adjusts in the month after each rate change.

A survey of ARM lenders conducted annually by Freddie Mac shows that, as of the end of 1993, only about one-third of the lenders offered 3/1 hybrid ARMs; virtually none of them offered hybrids with a longer fixed-rate term. The Freddie Mac survey in 2000 finds that 77% of the surveyed ARM lenders offer 3/1s, and 83% offer 5/1s. Hybrid ARMs with even longer fixed-rate terms are also easily available; 61% of the ARM lenders offer 7/1s, and 37% offering 10/1s.

Other statistics also attest to the current popularity of hybrid ARMs. A frequently cited statistic from a Federal Housing Finance Board (FHFB) survey is that hybrid ARMs represent about 50% of all ARM originations in 2000. The 5/1 hybrid ARMs are the most popular ARM, representing a quarter of all ARM originations in the FHFB survey. Recent data from Bank of America's origination channels also indicate that 5/1 hybrids remain the overwhelmingly popular choice for ARM borrowers, constituting 75% to 95% of the ARM application volume.¹

What has led to such strong demand for hybrid ARMs? First, a hybrid ARM appeals to borrowers with relatively short-term horizons who are uncomfortable with the payment uncertainty associated with the traditional one-year ARM, or with the lump-sum payment due in five or seven years on a balloon mortgage.

Second, and perhaps most important, declines in the slope of the yield curve during the past five years have made the rates available on hybrid mortgages steadily more attractive. For example, results from Freddie Mac's ARM surveys show the fixed-rate portion of a 5/1 hybrid mortgage was priced at a modest teaser of 13 basis points below the prevailing 30-year mortgage rates at the end of 2000, compared to 1996 when the teaser was 54 basis points. Over the same period, the spread between fixed-rate and 1/1 ARM rates contracted from an average of 211 basis points to 37 basis points.

Finally, one-year CMT ARMs have become less attractive to borrowers as lenders have steadily limited teaser offerings over the past few years to discourage "teaser junkies."

The popularity of hybrid ARMs with borrowers has only recently translated into the issuance of hybrid ARMs deals in the private-label mortgage-backed securities (MBS) sector. Historically, ARMs, and in particular non-agency ARMs, have been a portfolio product that lenders choose to retain on their balance sheets as a good match for their funding costs. ARM issuance has risen dramatically over the past three years as lenders started limiting the extent to which they portfolio this product.

Private-label ARM production totaled \$7 billion in 1998, \$9 billion in 1999, and \$17 billion in 2000, representing 5%, 10%, and 23%, respectively, of the total private-label MBS market.² A number of hybrid ARM deals came to market in 2000, the lion's share of the collateral as 5/1 CMT-based product.³

Exhibit 1 provides a snapshot of hybrid collateralized ARM deals from 1998 through April 2001.

A number of signs indicate that the hybrid ARM securitization market will continue to develop. The continuing popularity of hybrid ARMs among borrowers, coupled with structural shifts in how banks use their balance sheets, should continue to be important drivers of this development. We expect issuance volume and liquidity to improve dramatically as the hybrid ARM securitization program of the large banks continues to mature.

We believe most of the originated hybrid ARMs will be LIBOR-based, as issuers have become increasingly dependent on LIBOR-based funding, making it more

desirable for them to originate LIBOR-indexed mortgages. The resulting integration of the issuers in the capital markets along with the issuance of standardized hybrid ARM products should contribute to more consistent pricing in the sector.

I. PREPAYMENTS ON HYBRID ARMS

The prepayment experience of the past several years suggests that baseline prepayment speeds on ARM-backed securities are typically much faster than on comparable fixed-rate bonds. Understanding this difference turns out to be equivalent to understanding which borrowers prefer ARMs.

An ARM makes sense for borrowers who know they are likely to relocate soon and are therefore willing to trade off uncertainty about future monthly payments for a lower monthly payment now—in a positively sloped yield curve environment. Other reasons driving the choice of an ARM might be an inability to afford the higher payments on a fixed-rate mortgage, or a belief that rates will head lower soon. In both cases, the borrower will likely refinance into a fixed-rate mortgage as soon as it is economically viable. Thus, as a result of self-selection, ARM borrowers tend to have higher mobility rates and a more dynamic refinancing profile than the average fixed-rate borrower.

These characteristics are somewhat tempered for the hybrid ARM borrower. When they select a mortgage whose rate is fixed for a set period of time (three, five, seven, or ten years), these borrowers indicate they have longer holding periods for their housing and are more risk-averse than the typical ARM borrower. Clearly, the longer the term of the fixed-rate portion of the hybrid mortgage, the more closely the hybrid ARM borrower resembles the fixed-rate borrower in terms of motivation.

In practice, hybrid ARM and ARM prepayment models remain works in progress, and many investors still doubt the predictive power of ARM prepayment models, given the complex and dynamic nature of ARM prepayments. Indeed, the jumbo 5/1 hybrid ARM market simply uses a life speed of 18% constant prepayment rate (CPR) as a pricing speed assumption.

Several questions naturally occur (and indeed, may be posed for any MBS):

- What are the prepayment speeds we can typically expect for in-the-money (ITM), at-the-money (ATM), and out-of-the-money (OTM) jumbo 5/1 hybrid deals?

EXHIBIT 1

Summary of ARM Securitizations with Hybrid ARM Collateral: 1998-2001

Issuer	Originator	Series	Size (\$ millions)	Settle Date	Collateral	WAC	WAM
Mellon Residential Mellon	Boston Safe	MRFC 1998-TBC1	306.9	Dec-98	5/1	6.683	26-09
Residential Mellon	Boston Safe	MRFC 1999-TBC1	251.5	Mar-99	5/1	6.810	27-04
Residential Bear Stearns	Boston Safe Various	MRFC 1999-TBC2 SAMI 2000-1	543.4 447.7	Jun-99 Jan-00	5/1 5/1 and other ARM products	6.940 8.767	21-03 21-11
Mellon Residential	Boston Safe	MRFC 2000-TBC1	448.9	Feb-00	3/1, 5/1, and 10/1	7.080	27-06
Harborview	Various	HVMLT 2000-1	217.9	Jul-00	15-yr and 30-yr FRMs; 3/1, 5/1, 7/1 and 10/1	8.358	28-11
PNC Mortgage Lehman	PNC Mortgage Various	PNCMS 2000-7 SASC 2000-5	163.7 284.7	Sep-00 Oct-00	5/1 NA	7.905 8.976	29-05 29-04
Salomon BAS	Bank of America Bank of America	SBM7 2000-BOA1 BOAMS 2000-A	392.5 224.1	Nov-00 Dec-00	5/1 5/1	8.228 8.030	29-03 29-06
Bear Stearns Fifth Third	Bank of America Fifth Third	BS ARM Trust 2000-1 FTMLT 2000-FTB1	1,056.5 582.6	Dec-00 Dec-00	5/1 5/1, 3/1, 5/5, and 3/3	8.083 7.178	29-01 27-08
PNC Mortgage Harborview	PNC Mortgage WAMU, Bank of America, MLCC	PNCMS 2000-9 HVMTL 2000-2	258.8 370.7	Dec-00 Dec-00	5/1 5/1 and 7/1	8.042 8.201	29-05 29-05
Bear Stearns	ReliaStar, Roslyn, American Home Mortgage, First Horizon	BS ARM Trust 2001-1	366.2	Jan-01	Various hybrid and other mortgage products	8.794	21-05
Harborview	Bank of America, MLCC	HVMLT 2001-1	269.4	Feb-01	5/1	7.569	29-02
Bear Stearns Lehman	Bank of America, Wells Fargo, Bank of America ABN AMRO, WAMU	BS ARM Trust 2001-2 SASC 2001-4A	1,807.2 512.2	Mar-01 Mar-01	5/1, 7/1, 10/1 5/1	7.756 7.742	29-02 29-08
WMMSC BAS	PNC Bank Bank of America	WMMSC 2001-2 BOAMS 2001-A	971.3 275.3	Mar-01 Apr-01	5/1, 7/1, 10/1 5/1	7.643 7.268	28-05 29-10

Private-label deals for which 3/1 or longer hybrid ARMs make up at least 10% of the original balance of the deal.

Source: Banc of America Securities LLC and Bloomberg LLP.

- How do prepayment speeds on jumbo 5/1 hybrids compare with speeds on five-year balloons? What is the typical factor on a 5/1 hybrid pool at reset?
- Is the market's pricing speed convention for jumbo 5/1 hybrids reasonable? Is it possible to specify a prospectus prepayment curve (PPC) curve for hybrids?

The Hybrid ARM Data Set

As the list of deals in Exhibit 1 indicates, there is barely a year's worth of prepayment data available on hybrid ARM transactions. To address the questions posed above, we use an extensive data set of prepayment observations on hybrid ARM loans originated or purchased by a major hybrid ARM lender, Bank of America (BOA).⁴ Although our conclusions on the prepayment behavior of hybrid ARMs are in some sense obviously specific to this data set, we feel the depth and breadth of the data set suggest this is a representative sample of the hybrid ARM market.

The BOA hybrid ARM data set includes prepayment observations on hybrid loans with a number of different fixed-rate terms (three, five, seven, and ten years), conforming and jumbo balances, and with and without prepayment penalties. The ARM index on all these hybrids is almost always one-year CMT. Although our focus is the prepayment behavior of jumbo 5/1 hybrids, some of this behavior is best illustrated by comparing it with that experienced on one-year ARMs or hybrids with different terms.

The jumbo 5/1 hybrid data set we analyze to reach our conclusions has characteristics as follows:

- Approximately 26,500 prepayment observations were made from January 1991 through December 2000.
- All the loans in the data set had non-conforming loan balances at the time of origination.
- None of the loans carries a prepayment penalty (loans with prepayment penalties are separately identified in our data set).
- The data set is geographically biased in that the pre-1998 loans were primarily originated on the West Coast.

To present a profile of the collateral characteristics of our data set, we aggregate our observations by coupon and origination year as shown in Exhibit 2.⁵ One of the

most important features of the data set is that few cohorts are sufficiently seasoned for us to have prepayment observations around the reset date of 60 months. In fact, there are only two cohorts in the data set that have observations beyond the first reset at 60 months: 1991 9s and 9.5s.

Seasoning Patterns on Hybrid ARMs

The first and most important issue in understanding prepayments on hybrid mortgages is to link observed prepayment rates to the appropriate measure of refinancing incentive. The correct incentive would compare the hybrid borrower's note rate to the market rates available on mortgage products that the hybrid borrower would typically refinance into. Data on the choice of refinance product for the hybrid ARM borrowers in our data set are not available.

Freddie Mac does publish data on a quarterly basis that show the most popular refinance products for ARM borrowers are 30-, 20-, and 15-year fixed-rate mortgages. The ARM borrower has refinanced into another ARM less than 10% of the time in recent years, although the percentage has been higher when the yield curve was steeper. Therefore, to compute the refinance incentive for our loans, we take the loan rate corresponding to a cohort and subtract from it a weighted average of prevailing jumbo mortgage rates (lagged by 1.5 months) on 30-, 20-, and 15-year fixed-rate mortgages and one-year ARMs.⁶

Given this measure of refinancing incentive, we partition our data set into four subsets:

1. In-the-money (ITM) loans with refinance incentive between 50 basis points and 150 basis points.
2. At-the-money (ATM) loans with refinance incentive between -50 basis points and 50 basis points.
3. Out-of-the-money (OTM) loans with refinance incentive between -150 basis points and -50 basis points.
4. No-refi loans with refinance incentive below -150 basis points.

Exhibit 3 shows the dollar volume of observations in each of these incentive buckets as a function of age. All four buckets show the same trend visible in Exhibit 2. The number of prepayment observations rapidly diminishes as a function of seasoning.⁷

In fact, the prepayment data after about month 36 are so volatile it is difficult to reach any clear conclusions about how prepayments season as a function of age by

EXHIBIT 2

Characteristics of BOA Jumbo 5/1 Hybrid ARM Data Set, December 2000

Coupon	Origination Year	WAC	Age	Number of Loans	Average Loan Size (\$000)	Factor (%)	Life Speed (%CPR)
5.5%	1998	6.02%	24	64	532	84	7
	1999	5.97	20	29	460	78	14
6.0%	1996	6.55	56	170	411	43	15
	1998	6.47	25	671	491	77	10
	1999	6.50	18	1,517	443	88	10
6.5%	1995	6.99	59	25	423	34	21
	1996	6.87	56	372	439	31	21
	1997	6.99	37	122	342	51	20
	1998	6.92	30	1,198	446	63	17
	1999	6.92	16	3,198	422	91	9
	2000	7.00	10	268	425	97	4
7.0%	1996	7.50	54	47	349	19	30
	1997	7.40	37	163	350	27	30
	1998	7.34	32	109	312	27	37
	1999	7.39	13	2,572	414	93	6
	2000	7.47	9	1,795	425	97	4
7.5%	1996	7.91	53	35	323	10	39
	1999	7.79	13	155	417	87	15
	2000	7.85	9	965	414	96	8
8.0%	2000	8.32	9	90	453	88	19
9.0%	1991	8.59	116	3	281	1	35
9.5%	1991	8.40	117	10	331	5	25

CPR: Constant prepayment rate. WAC: Weighted-average coupon.

Source: Banc of America Securities LLC.

EXHIBIT 3

Dollar Volume of Prepayment Observations

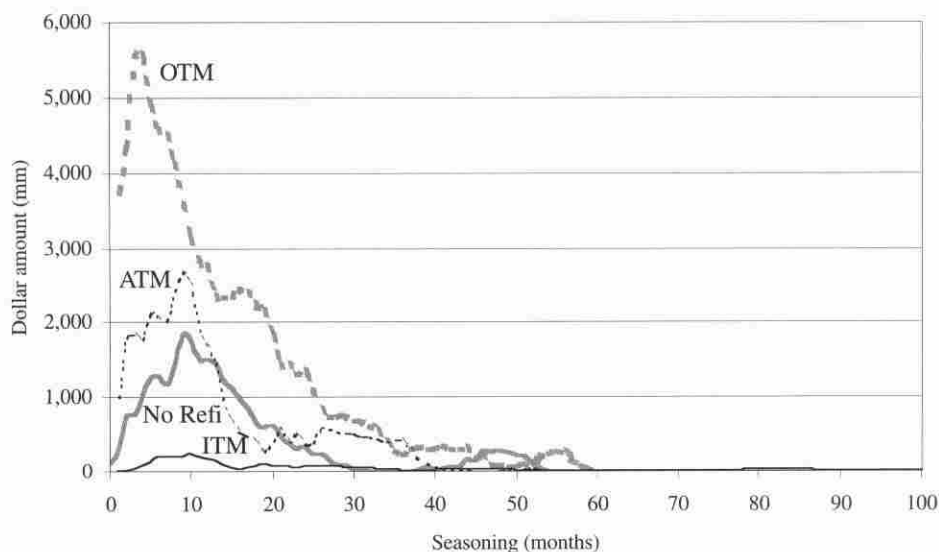
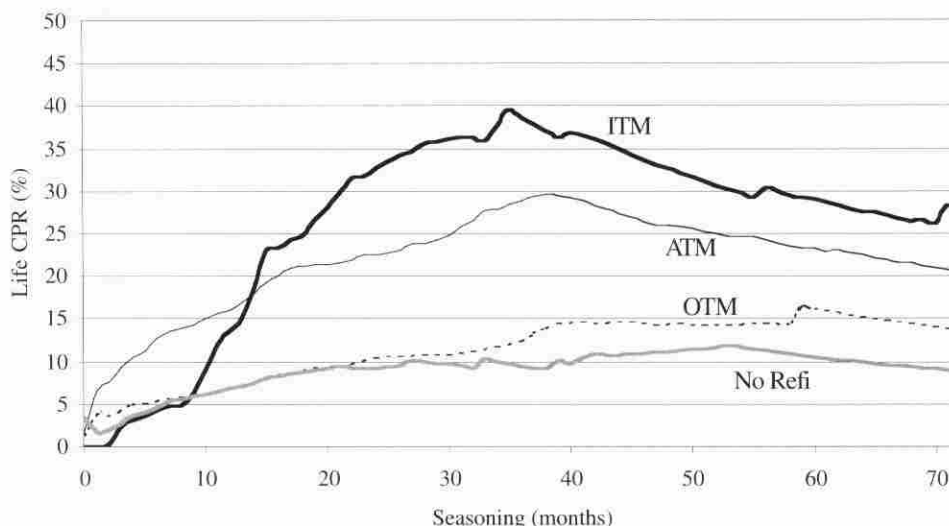


EXHIBIT 4

Jumbo 5/1 Hybrid Life CPRs as a Function of Seasoning



looking at monthly data. To smooth the observations, we compute life CPRs for the incentive buckets as a function of age. The results in Exhibit 4 clearly show the different refinance responsiveness of the incentive buckets.⁸

While there is less information supporting the results after three years of seasoning, the general trends are clear:

- Prepayments on hybrid ARMs tend to season rapidly during the first three years of the life of a mortgage and reach a life speed of about 25%–30% CPR in about three years for an at-the-money (ATM) collection of loans. For in-the-money (ITM) loans, life speeds appear to reach 30%–35% CPR, while out-of-the-money (OTM) loans reach life CPRs of 10%–15%. During this period, borrowers are gradually increasing the rate at which they either relocate or refinance their mortgages.
- Prepayments tend to stabilize between Years 3 and 4 before spiking again at reset. A typical hybrid pool is fully seasoned now, and borrowers leave at a steady rate until just before their mortgage note resets, at which point prepayments ramp up again.
- After reset, life speeds demonstrate a gradual decline, although the trendlines are somewhat less reliable because of the scarce data.
- The market convention of pricing ATM hybrid deals at a life CPR of 18%–20% is consistent with estimates obtained from our data set by extrapolating observed trends.

- CPRs of 10%–15% [167–250 Public Securities Association (PSA)] can be taken as a reasonable floor speed for jumbo 5/1 hybrid deals. In fact, these percentages are similar to observed floor speeds on jumbo relocation loans. This is not surprising, as many 5/1 hybrid borrowers will be similar to relocation borrowers in terms of their horizon for holding housing.

Comparing 5/1 Hybrids to Other ARMs

Some of the characteristics of hybrid ARM prepayment behavior can be further clarified by studying the prepayment behavior of hybrid ARMs with different initial fixed-rate periods. For example, the relationship between borrowers' mobility rates and the term of the initial fixed-rate period on their hybrid ARMs is clearly brought out by comparing seasoning patterns on ATM hybrid ARMs with different fixed-rate terms.

Exhibit 5 shows that the seasoning curves for hybrid ARMs are rank-ordered by the length of the fixed-rate period. In other words, the less likely borrowers are to move in the near future, the more likely they will choose a longer fixed-rate period on their hybrid mortgage.

Exhibit 6 presents another perspective on the prepayment behavior of ARMs by graphing prepayment speeds on selected ARM cohorts across time. Some noticeable trends are as follows:

EXHIBIT 5

Jumbo Hybrid Seasoning Ramps for ATM Mortgages

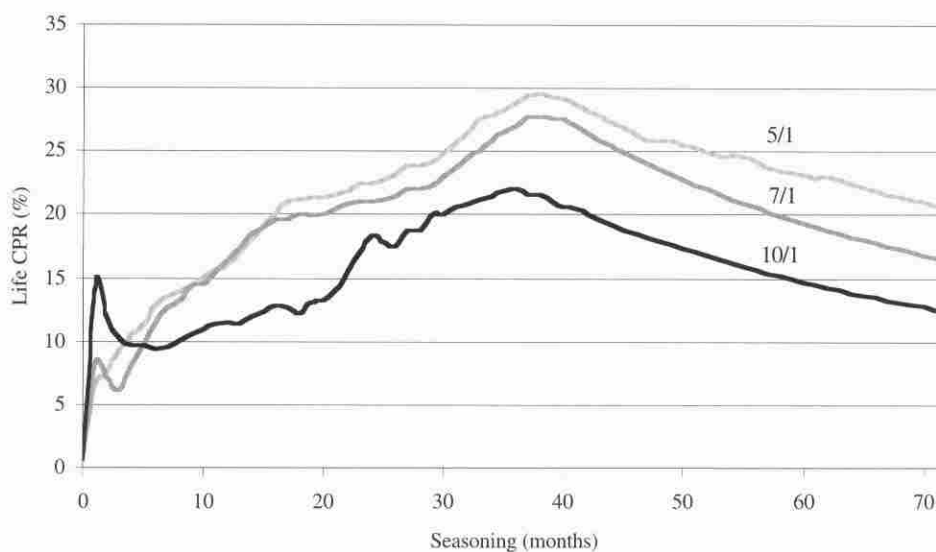
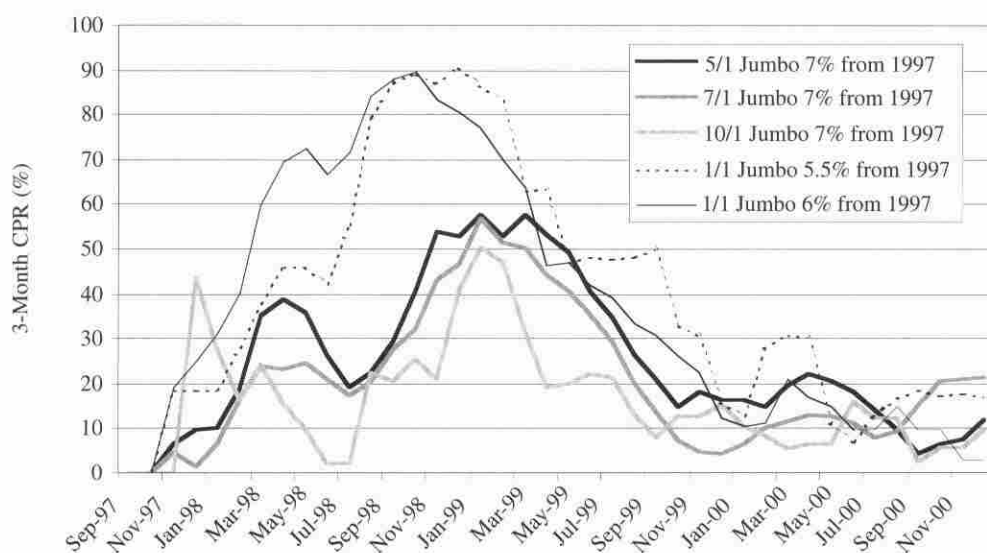


EXHIBIT 6

Historical Prepayment Comparison



- As expected, one-year CMT (or 1/1) ARMs season the most rapidly, followed by 5/1, 7/1, and 10/1 ARMs.
- The shorter ARMs show greater refinancing responsiveness, although at high incentives (such as in October 1998) differences tend to narrow. The 1/1 ARMs are the exception, and prepay significantly faster over a variety of difference refi incentives.
- Baseline prepayment speeds on the different ARM cohorts show a noticeable convergence as the loans continue to season. The division between different cohorts is harder to distinguish now because of the noisiness in speeds.

EXHIBIT 7

Reset Factors on Conforming and Jumbo 5/1 Hybrid ARMs by Refinance Incentive

Incentive Bucket	Average Factor at Reset	
	Conforming Balance Loans	Jumbo Balance Loans
OTM	0.42%	0.34%
ATM	0.40	0.15
ITM	0.30	0.13

OTM: Out-of-the-money. ATM: At-the-money. ITM: In-the-money.

Source: Banc of America Securities LLC.

Comparing 5/1 Hybrids to Five-Year Balloons

It is natural to compare 5/1 hybrid and five-year balloon-backed securities because both securities are collateralized by mortgages that are attractive to borrowers with short housing tenures, and the cash flows on both securities jump significantly around 60 months. The comparison is unreasonable, however, in the sense that, although balloon mortgages are paid off at the end of the balloon term, hybrid pools still have outstanding balances at reset.

Exhibit 7 presents the data that form the basis for this statement. It shows the average factor on both conforming and jumbo 5/1 hybrid pools around the reset date as a function of the refinancing incentive experienced by these pools over history. Even after experiencing significant amounts of refinance incentive over an extended period, at least 10% of the original balances on conforming and jumbo 5/1 hybrid pools remain outstanding. We also conclude that jumbo 5/1 hybrid mortgage pools are much more depleted around reset than conforming pools, but still have outstanding balances that are not negligible.

The prepayment behavior of five-year balloons establishes a useful worst case boundary condition for prepayments on 5/1 hybrids. Empirical data indicate that, so far, this worst case scenario is rarely if ever realized.

II. RELATIVE VALUE

Structuring Conventions in the Hybrid Sector

Specific deal structures have been designed to take advantage of the fact that the fixed- and adjustable-rate

parts of the hybrid cash flow are attractive to different sets of investors. The typical structure separates the fixed-rate part (the front end) of the hybrid ARM cash flows up to a few months before the reset date from the adjustable-rate part (variously referred to as the back end, the ARM residual, or the tail cash flow), thus creating a fixed-rate balloon-like security and an ARM-like security.

The limited extension risk of hybrid collateral and the defined maturity of the front tranche in such a structure make it an attractive investment for numerous investors. The back end of the cash flows may be kept by the issuer as a good match for funding costs. In some instances, the back-end piece is bought by a third party and not by the issuer.

For example, PNC Mortgage Securities Corp. 2000-9 is structured so that CDC Financial Products, and not PNC Mortgage, would receive the back-end cash flows. Another example is Harborview Mortgage Loan Trust 2000-2. In this case, the senior tranches can be called by a non-affiliated third party and the subordinated tranches can be called by the deal underwriter.

Bifurcating the cash flows at a given cutoff date (slightly before the average reset date on the collateral, for example) is usually accomplished in one of three ways:

1. The front tranche is necessarily paid off at par through the mandatory exercise of an option. In this case, the issuer or a third party has a forward agreement on an ARM-like security.
2. The holder of the front tranche has a put option that can obligate the issuer or third party to buy back the remaining cash flows at par.
3. The issuer or third party has a call option and can buy the remaining tranches at par.

In numerous cases, the exercise of the call or put options mentioned in Cases 2 and 3 is defined as mandatory, and these options are exactly equivalent to forward agreements. These forwards are structured as options for the purposes of receiving favorable accounting treatment.⁹

Valuing the Derivatives on a Hybrid Deal

One of the most interesting aspects of evaluating hybrid ARM deals is valuing the put/call/forward claims. We will focus on Case 1, where the issuer is long a forward on the adjustable-rate cash flows of the hybrid

EXHIBIT 8

Cash Flow Structure for Jumbo 5/1 Hybrid Collateral

Cash Flow	Description
PT	Pass-through cash flows on the hybrid pool
FR	Pass-through cash flows until reset (at 60 months); at reset a lump cash flow equal to the remaining balance of the hybrid pool
BK	Pass-through cash flows on the hybrid pool after reset (i.e., the adjustable-rate cash flows on the hybrid pool)
EX	A single cash flow at reset date equal to the remaining balance of the hybrid pool at that time

Source: Banc of America Securities LLC.

EXHIBIT 9

Valuing ARM Forward on Jumbo 5/1 Hybrid ARMs—February 22, 2001

LIBOR					
OAS	PT	FR	BK	EX	Forward
0	103-21+	102-22+	19-11	18-12	0-31
25	102-27	102-02	18-30+	18-05+	0-25
50	102-01+	101-14	18-18	17-30+	0-19+

OAS: Option-adjusted spread.

Sample deal: 7.375% gross WAC newly issued jumbo 5/1 collateral.

Source: Banc of America Securities LLC.

EXHIBIT 10

Impact of Life Cap on Jumbo 5/1 Hybrid ARMs—February 22, 2001

Life Cap	PT	FR	Forward
11.375%	103-17+	102-22+	0-27
12.375% (base)	103-21+	102-22+	0-31
No cap	103-27	102-22+	1-04+

OAS of zero.

Sample deal: 7.375% gross WAC newly issued jumbo 5/1 collateral.

Source: Banc of America Securities LLC.

ARM. To value the forward, consider the cash flows in Exhibit 8. All the cash flows are structured on the same underlying 5/1 hybrid ARM pool.

Let PT , FR , BK , and EX represent the value of these cash flows. If we denote the value of the forward contract by FOR , then:

$$FOR = PT - FR = BK - EX$$

Indeed, $PT - FR$ represents the difference in value between the cash flows on the hybrid pool with no option or forward and the cash flows if there is a forward. Consequently, the difference equals the value of the commitment to buy the outstanding balance of the hybrid pool at reset at par. Similarly, BK is the value of the adjustable-rate cash flows after reset, and EX represents how much the issuer will pay for these cash flows. Consequently, the difference represents the net gain or loss taken by the buyer of the back-end hybrid cash flows at reset, and is therefore the value of the forward.

Exhibit 9 shows the value of the forward under different option-adjusted spread (OAS) assumptions. At an OAS of 50, the forward is valued at 21/32nds versus 31+/32nds for an OAS of 0, illustrating the sensitivity of its valuation to spread assumptions.

The valuation of this forward does not include any premium for its risk profile. Indeed, from a risk management perspective, the amount on which the forward is written cannot necessarily be assumed to be paid down through prepayments. Under the stress assumption of no prepayments, this forward would initially require a provision equal to the amortized value of the front tranche at reset. Even though this provision could be rebalanced every month according to received prepayments, it would be expensive to carry. Consequently, the owner of the forward should be remunerated for this implicit cost.

When the hybrid converts into an ARM, the interest payments are subject to a life cap, typically 5 percentage points above the original rate (12.375% = 7.375% + 5.000% in our example). This cap affects the value of the back-end piece and therefore the value of the forward.

Exhibit 10 shows how the valuation of the forward is affected by different levels on the hybrid life cap. In our example, the life cap has a negative impact of about 5/32nds on the values of the collateral and the forward. If we reduce the cap by 100 bp to 11.375%, keeping all else equal, the negative impact increases by another 4+/32nds. This illustrates how asymmetric the effect of the life cap can be.

EXHIBIT 11

Relative Value—Selected Fixed-Rate Agency and Non-Agency Cash Flows—April 6, 2001

Deal	Structure	Cpn	WAC	WALA	WAL	OC	EDur	ECnvx	CCDur	PPDur
FHR 2304	PC PAC	6.00	7.25	2	3.5	52	1.6	0.6	-0.011	-0.002
FHR 2304	PD PAC	6.00	7.25	2	4.5	57	1.9	-2.5	-0.014	-0.004
FHR 2253	A Sequential	7.00	7.75	13	3.5	106	1.0	-2.1	-0.014	0.004
WMM 2001-2	A1F 5/1 Hybrid	5.68	7.64	19	0.7	33	0.5	-0.9	-0.003	0.001
WMM 2001-2	A2 5/1 Hybrid	6.04	7.64	19	2.5	61	1.6	-1.0	-0.006	0.007
WMM 2001-2	A3 5/1 Hybrid	6.01	7.64	19	3.9	19	2.8	-0.7	-0.005	0.014
PNC 2000-9	A2 5/1 Hybrid	6.85	8.06	5	1.8	47	0.3	-1.7	-0.011	0.013
BOAMS 2000-A	A1 5/1 Hybrid	7.00	8.04	3	3.4	44	0.6	-1.1	-0.014	0.030
PNC 2000-9	A3 5/1 Hybrid	7.19	8.06	5	4.0	53	1.8	-1.1	-0.013	0.031

Cpn: Coupon. WAC: Weighted-average coupon. WALA: Weighted-average loan age. WAL: Weighted-average life.

OC: Option cost. EDur: Effective duration. ECnvx: Effective convexity. CCDur: Current-coupon duration. PPDur: Prepay duration.

Source: Banc of America Securities LLC.

EXHIBIT 12

Relative Value—Selected Floating-Rate Agency and Non-Agency Cash Flows—April 6, 2001

Deal	Structure	Cpn	WAC	WALA	OC	EDV	ECVDV	CCDV	PPDV
5/1 Hybrid		1-yr LIBOR +183 bp	1-yr	1	1-16	-0.003	-0.002	-0.004	0.020
Forward		1-yr LIBOR + 225 bp							
FNR 1994-36	FG Floater	1-mo LIBOR + 100 bp	7.08	84	2-25+	-0.007	-0.005	-0.014	0.015

Cpn: Coupon. WAC: Weighted-average coupon. WALA: Weighted-average loan age. OC: Option cost. EDV: Effective DV01.

ECVDV: Effective convexity DV01. CCDV: Current-coupon DV01. PPDV: Prepayment DV01.

Option cost calculated as difference between zero-OAS price of the bond at a constant speed assumption on all interest rate paths

(18% CPR for hybrid, 200% PSA for floater) and the zero-OAS price of the bond using the prepayment model to project speeds on the paths.

Source: Banc of America Securities LLC.

Option-Adjusted Analysis of Hybrid ARM Tranches

As the jumbo hybrid ARM market matures, the non-agency jumbo market is still in the process of determining what the appropriate spread and speed pricing conventions for representative hybrid deals should be. Thus, high OAS on hybrid deals may simply indicate liquidity, prepayment, or issuer-specific concerns. Our focus here is general, and compares the optionality of jumbo 5/1 hybrid tranches and tranches from suitably chosen agency collateralized mortgage obligations (CMOs).

The differing option costs and prepayment model sensitivities (as captured by current-coupon durations and prepayment durations) of a number of agency and hybrid ARM CMOs are presented in Exhibits 11 and 12. We price all these cash flows at 0 LIBOR OAS so their zero volatility spreads are equal to their option costs.

Although the OAS approach is heavily model-dependent, and we have concerns about the accuracy of jumbo hybrid ARM models, given the relative lack of prepayment data, we find that on average our jumbo hybrid ARM prepayment model agrees with observed prepayments in many important aspects. These aspects

include expected speeds around reset, impact of refinancing incentives during the fixed-rate period, and projected floor speeds in bearish interest rate scenarios. Thus, we feel that our approach provides reasonable results. It offers the most complete relative value comparison, in any case.

Speeds on hybrid ARMs have a very specific profile: a steep seasoning ramp similar to that for balloon or relocation mortgages, refi sensitivity similar to fixed-rate collateral except for a jump around the reset date as the hybrid mortgage becomes indexed and the rate paid by the borrower jumps, and minimal extension risk. This last point is especially important; floor speeds for hybrids are probably in the 200% PSA range, compared to jumbo fixed-rate collateral, which levels off at 100% PSA.

As a result of these attributes, option costs on hybrid tranches are significantly lower than on jumbo fixed-rate sequential tranches, and are comparable to those on agency Planned Amortization Class (PACs). This is clearly brought out in Exhibit 11, since even though the agency CMOs in the table have low coupons and therefore low refinancing incentives, their option costs are similar to those on the jumbo hybrid tranches. Hybrid tranches are more price-sensitive to changes in prepayment assumptions (as measured by current-coupon durations and prepayment durations) than the agency CMOs. We attribute this difference to the greater refinancability of jumbo hybrid collateral in falling interest rate environments.

There are some complications involved in calculating risk measures on the back-end tranche because we do not know its balance in advance. It is easier to calculate these measures with respect to the forward on the back end since, as discussed earlier, being long the forward is equivalent to being long hybrid collateral and short the front tranche. As the forward can potentially have a negative or zero value, duration or convexity calculations with respect to its price do not make much sense. Instead,

we believe it is more logical to calculate the risk measures in dollars, and focus on the dollar value of 1 basis point (DV01s) instead of durations.

Exhibit 12 compares risk measures on the forward to a CMO floater based on seasoned collateral, since at forward exercise the underlying hybrid collateral is also seasoned.

A final valuation-related issue is that CMT-indexed cash flows have basis risk when we use the swap curve as our benchmark (as is the case in our LIBOR OAS calculations). This basis risk affects the valuation of the derivatives embedded in hybrid ARM deals. Because our interest rate models do not account for this basis risk, it is not priced in our OAS analyses.

III. CREDIT ANALYSIS

Default Data

Due to the relative youth of the jumbo hybrid sector, default and loss data on hybrid ARM transactions are sparse. To find an appropriate benchmark for this experience, we have examined data on the losses experienced on 30-year non-conforming fixed- and adjustable-rate mortgages owned and originated by BOA. The losses experienced by the fixed-rate loans serve as an appropriate reference point, as most mortgage investors will be familiar with the credit performance of these loans from their knowledge of the jumbo MBS sector. Generally speaking, most of the loans in the data sample are non-conforming with respect to loan size, not underwriting standards.

Some characteristics of the data set used in our analysis are summarized in Exhibit 13. The ARM loss data aggregate one-year ARMs and 3/1, 5/1, 7/1, and 10/1 hybrid ARMs, all with a 30-year term (loss data for jumbo 5/1 hybrid loans only are not available). The losses

EXHIBIT 13

Characteristics of BOA Non-Conforming 30-Year Loss Data Set—December 2000

	Total Originated Balance in Sample (\$ billion)	Number of Loans Originated	Total Loss Amount (\$000)	Number of Defaults
Fixed-Rate Mortgages	\$10	53,332	1,359	21
Adjustable-Rate Mortgages	\$66	164,085	7,064	94

Source: Banc of America Securities LLC.

EXHIBIT 14

Cumulative Losses by Vintage on 30-Year Non-Conforming Fixed-Rate Mortgages (BOA owned and originated)

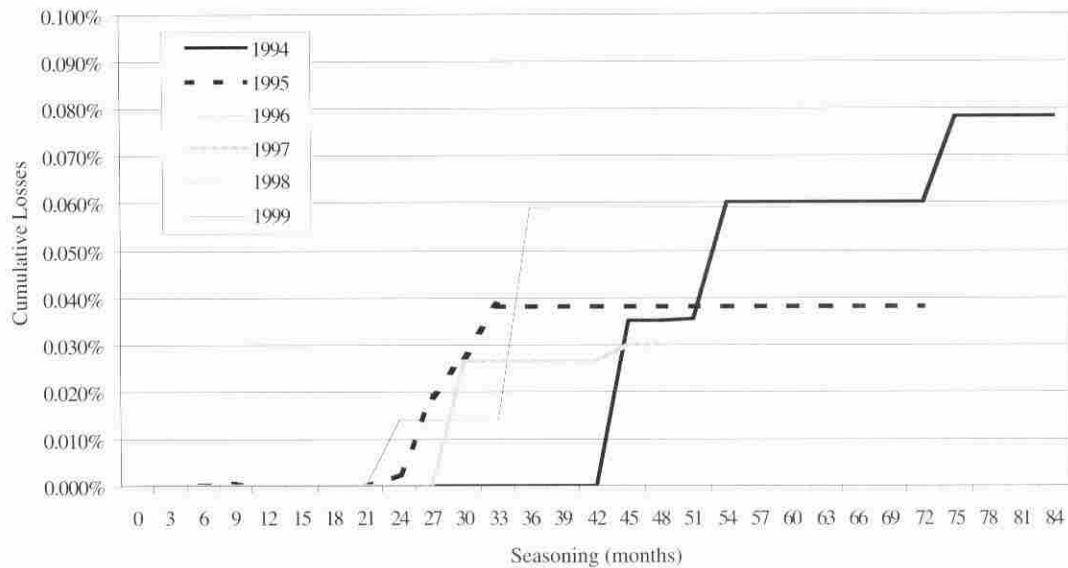
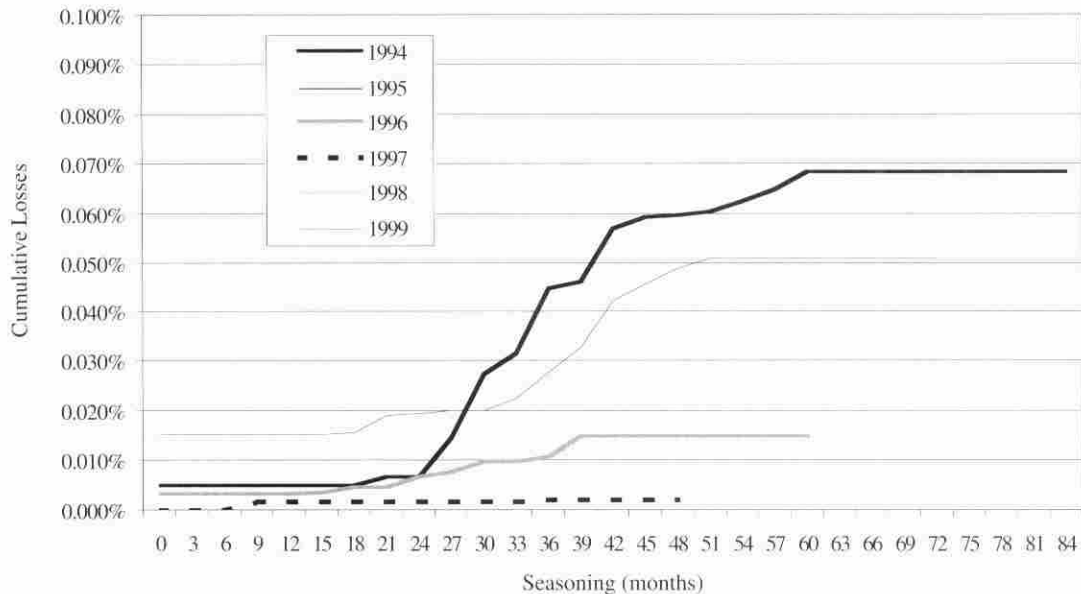


EXHIBIT 15

Cumulative Losses by Vintage on 30-Year Non-Conforming ARM (BOA owned and originated)



experienced by these loans are graphed as a function of the vintage of these loans in Exhibit 14 (jumbo fixed-rate loans) and Exhibit 15 (jumbo adjustable-rate loans).

Clearly, there are some issues to be mindful of in drawing general inferences from this information. First, aggregating all the ARM loans gives us at best a partial

glimpse into the credit performance of hybrid ARM loans. Second, the losses experienced by the ARM loans may not be representative of a generic hybrid transaction as current data show that the credit performance on BOA-originated loans is better than industry averages. Given these caveats, we note some trends:

EXHIBIT 16

Credit Enhancement on Selected Hybrid ARM Transactions

Issuer	Series	Size (\$ millions)	AAA Subordination Levels	Additional Credit Enhancement	Call/Put/Forward
Bear Stearns	SAMI 2000-1	447.7	5.20%	-	
Harborview	HVMLT 2000-1	217.9	5.00%	-	Call option on Class IA and IIIA by 3rd party
PNC Mortgage	PNCMS 2000-7	163.7	6.75%	-	Call on all offered tranches by 3rd party
Bear Stearns	BS ARM Trust 2000-1	1,056.5	2.00%	MGIC insurance down to 60%	-
Salomon	SBM7 2000-BOA1	392.5	4.50%	-	-
Fifth Third	FTMLT 2000-FTB1	582.6	5.00%	-	Put option on senior front tranches
PNC Mortgage	PNCMS 2000-9	258.8	1.25%	GEMIC mortgage insurance down to 40%	Mandatory purchase of front tranches by 3rd party
Harborview	HVMLT 2000-2	370.7	5.25%	-	Call options on classes A and B by 3rd parties

Private-label deals for which 3/1 or longer hybrid ARMs make up at least 10% of original balance of deal.

Source: Banc of America Securities LLC.

- The maximum loss rate for a vintage of more than 90 months of seasoning is about 0.06% for ARMs and about 0.08% for fixed-rate mortgages.
- The highest loss rates are exhibited by 1994-1996 vintages, and are attained after approximately 50 months of seasoning.
- At about 50 months of seasoning, loss rates range from 0.015% to 0.06% for ARMs and from 0.035% to 0.06% for fixed-rate mortgages.

Credit Risk on Hybrid ARM Tranches

Jumbo hybrid ARM securities often use subordination as a credit enhancement method, sometimes in addition to an insurance wrap. Many recent transactions have included six pro rata paying subordinated tranches. In some instances, the subordinated tranches can be called/put along with the senior tranches around the ARMs' reset date (Exhibit 16). In this case, the credit characteristics of the collateral play an important role in assessing the value of the put/call option. Without additional insurance, the subordination levels to reach AAA rating on the senior tranches average about 5% on the

transactions in Exhibit 16. This subordination level represents 50 to 100 times the amount of losses observed in our sample data.

The credit exposure of the senior and subordinate tranches on a hybrid deal is materially influenced by the presence of options on these tranches. For instance, consider the most common situation, in which the derivative ensures that the front senior tranche is paid off at par around reset. In this case, the front senior tranche implicitly benefits from credit insurance that has the same rating as the optionholder. Even if deteriorating credit performance of the collateral forces the value of the senior tranche below par by the call/put date, the option ensures that investors get their principal back at par and thus provides insurance against credit risk.¹⁰

The same arguments apply to subordinated tranches with embedded options, although the exercise price of the option is usually below par in these cases. Since the underlying credit risk is not traded, the evaluation of these credit options remains difficult.

ENDNOTES

The authors thank Yong Cai, Lee Godfrey, Mark Ryan, and Antoine Schettritt for their constructive comments on this analysis. They also warmly thank Letitia Lai for her unique support with all the data.

¹This figure overstates the popularity of 5/1 hybrid ARMs as it is computed on a dollar-volume basis. Jumbo 5/1 hybrids have average loan balances in excess of \$400,000.

²The figure for 2000 includes a \$6 billion cost of funds index adjustable-rate mortgage (COFI ARM) transaction issued by Lehman with products from Washington Mutual.

³Although the hybrid loans collateralizing the Mellon deals shown in Exhibit 1 are substantially LIBOR-based, they have a number of unusual features including: 1) more than 20% of the loans have balances greater than \$1 million; 2) the collateral for certain loans includes securities, mutual funds, or other assets in addition to the residence; and 3) more than 95% of the mortgage loans do not require principal payments for ten years (the borrower is required to make monthly payments for only the accrued interest for ten years, after which the payment increases to cover both principal and interest). Consequently, we should not expect the prepayment or credit experience on these deals to be representative of generic 5/1 hybrid ARM securities.

⁴Banc of America Securities LLC has served as an underwriter for the Bank of America Mortgage Company.

⁵The coupon rate is calculated by taking the original loan note rate and subtracting the servicing fees (typically 25 basis points for 5/1 ARMs), then rounding down to the nearest 50 basis points.

⁶The weights vary as a function of the slope of the yield curve. Details are available from the authors.

⁷There are three reasons so few data are available on loans with more than three years of seasoning: 1) 5/1 ARM issuance has gradually been ramping up and only really took off starting in 1996; 2) rapid prepayment speeds on hybrid ARMs ensure the factor on hybrid pools is often less than 50% after three years of seasoning; and 3) only data on pre-merger Bank of America loans were stored prior to 1998.

⁸Because computing life CPRs is equivalent to taking the geometric average of a series of observations, the calculation has a considerable smoothing effect.

⁹A forward is an agreement to buy (or sell) an asset at a specified future date for a specified price. The specified price in the forward contract is referred to as the delivery price. In the situation we are considering, the delivery price is par (100).

¹⁰One could argue this mechanism would work both ways because better-than-expected credit performance of the collateral increases the value of the senior tranche and hurts its owners, who receive only par for the principal. Yet the fact that most jumbo borrowers have excellent credit suggests senior tranches are more likely to experience price decreases than price increases due to credit events.

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