MIMs™ - Mortgage Industry Medians

The New Daily Prepayment Forecast Consensus

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Mortgage investors need to make assumptions about the anticipated prepayment speeds of specific mortgage assets in order to effectively price and value mortgage assets. Wall Street dealers provide long-term prepayment forecasts to assist investors in determining what prepayment speeds to use in their valuations. However, the Wall Street long-term prepayment forecasts were never intended or designed to be used as the essential market pricing assumptions that many mortgage investors would utilize to determine market values of mortgage assets.

An Illustration of the Problem

A mortgage banker needs to demonstrate the effectiveness of their hedges to a basket of mortgage servicing assets. The value of the servicing assets is determined on 4/14 to be 160 bps. The UST, MBS, and Swaps markets do not move on 4/15, but the Bloomberg Medians are updated. As a result of the changes in the prepayment forecasts from the previous period, the market value of the servicing assets is now 166 bps. This six basis point change is a 3.75% change in the market value of the servicing asset. Roughly speaking, this is equivalent to how much a MBS pass-through would change in value for a 80 – 100 bps movement. This risk is basically impossible to hedge. This price change is the result of the market pricing convention within the mortgage banking industry.

Under FAS 133, mortgage bankers are going to need to demonstrate hedge effectiveness and show that the market value changes of their mortgage servicing rights ("MSRs") offset by the market value changes of their hedges. Utilizing Bloomberg Medians as the market pricing convention will make this task exceptionally difficult, if not impossible.

Background

Initially, the **Bond Market Association** (previously called the Public Securities Association or PSA) organized a regular survey of Wall St. dealers to provide forecasts. As mortgage investor requirements changed, the BMA survey has evolved to providing more complete and useful prepayment information to investors. In addition, **Bloomberg** decided to create its own survey and provide their information. The results of this survey are referred to as the Bloomberg Medians. Because of the form and wide acceptance of the Bloomberg survey, the Bloomberg Medians have become widely used in the mortgage banking industry for pricing mortgage servicing rights.

Although the Bloomberg Medians provide a useful tool for mortgage investors, they still have some significant shortcomings as a market prepayment model. These shortcomings cause enormous problems for mortgage companies trying to value mortgage servicing rights that are highly sensitive to underlying prepayment assumptions. The principal shortcoming is a result of Bloomberg Medians being used in a manner that they were not designed to address. Both the Bloomberg Medians and the Bond Market Association

surveys are designed to provide an accurate and current consensus of Wall St. prepayment forecasts. They were not designed as a prepayment model to determine the market price of mortgage assets. However, this is how they are most often used in the mortgage banking industry.

The Mortgage Industry Medians ("MIMs") were created to try to be as consistent as possible with the information and methodology utilized by the Bond Market Association and Bloomberg, but also to mortgage investors, the users of this information. The Mortgage Industry Medians take the additional small step of adjusting the survey results, addressing the problems of reporting consensus prepayment on a bi-weekly schedule, to make a useful tool for pricing mortgage assets. *These corrections will enable mortgage servicers and mortgage investors to utilize Mortgage Industry Medians as the market pricing tool for mortgage servicing assets.*

This paper will describe the MIMs and why they should be utilized in pricing mortgage assets. However, one first needs to review in detail the current information that is available and how it is being used. Let's begin with a discussion on how Bloomberg Medians differ from the Bond Market Association information. The two surveys differ in a number of ways:

- Number of Survey Participants
- The Mortgage Assets being Forecasted
- Update Frequency of Forecasts Provided
- Age Categories and Inconsistencies
- Directed PSAs

Number of Survey Participants

Bloomberg Median survey participants include:

Bear Stearns
CS First Boston
DLJ
Lehman Brothers
Merrill Lynch
Paine Webber
Prudential Securities
Salomon/SmithBarney

The Bond Market Association survey participants include all of the above and additionally:

Chase Securities
Goldman Sachs
Morgan Stanley

The Bond Market Association is a non-profit trade group established by the broker dealers to address common concerns of the dealers and investors. The results of the Bond Market Association survey are available on Reuters, Telerate, Bridge, and

http://www.servicing.com. The Bond Market Association established the PSA model in 1986 and began publishing dealer prepayment forecasts in 1987. Bloomberg began their survey several years after the BMA.

The Mortgage Assets being Forecasted

The specific assets to be forecasted by BMA participants are defined each year by the Bond Market Association and are selected because of the large outstanding supply of mortgages in those Product Type, Issue Years, and Coupon buckets. Each dealer is allowed some leeway within an Issue Year Category to determine the Weighted Average Maturities ("WAM"), and Weighted Average Loan Age ("WALA"), but the variation is restricted because the forecasts are for specific Issue Years.

The Bond Market Association Dealer Forecasts

05/18/1999 THE BOND MARKET ASSOCIATION MORTGAGE PREPAYMENT TABLES															
GN I 30-YR	MED	MED	MED												
COUP- ISSUE	+300	-300	BASE	LOW-HIGH	BS	CHS	CSFB	DLJ	GS	LB	ML	MS	PSI	PW	SAL
6.0 1993	93	726	130	109- 173	128	173	123	144	140	136	132	122	115	109	
6.0 1996	82	777	122	108- 160	108	160	119	133	125	126	127	120	111	109	
6.0 1998	71	960	115	98- 152	98	152	113	121	114	116	116	117	107	103	
6.5 1993	98	784	148	140- 192	147	192	142	155	159	143	147	149	140	150	
6.5 1996	86	810	142	134- 180	136	180	138	151	134	137	144	146	140	150	
6.5 1998	75	1041	134	122- 173	122	173	131	140	125	131	136	143	129	141	
7.0 1993	106	812	176	164- 238	172	238	167	164	180	198	168	180	170	201	
7.0 1996	90	842	168	144- 231	166	231	162	164	144	199	167	179	169	200	
7.0 1998	78	1065	164	142- 229	158	229	155	149	142	201	162	180	166	189	
7.5 1977	168	410	240	206- 380	207	380	218	235	360	206	251	244	227	278	
7.5 1993	116	782	214	195- 344	205	344	206	215	195	212	229	220	203	260	
7.5 1997	90	870	215	184- 352	205	352	197	205	184	217	234	235	213	250	
8.0 1977	180	396	261	213- 477	243	477	244	257	340	213	263	259	273	465	
8.0 1987	140	570	236	207- 449	232	449	230	242	207	217	239	253	219	401	
UPDATE:'99'	05/18/1999				5/17	5/17	5/14	5/14	5/14	5/14	5/15	5/17	5/17	5/17	4/30

Table 1

For example, for 30-Year GNMA 6s, 6.5s, and 7s, the Issue Years are 1993, 1996, and 1998. For 30-Yr GNMA 7.5s, the Issue Years are 1977, 1993, and 1997. For 30-Yr GNMA 8s, the Issue Years are 1977, 1987, 1992, and 1997. Some coupon buckets have one Issue Year category and others have four coupon buckets. These coupons correspond to outstanding supply of mortgages in the market today.

The forecasts are done on business days on or slightly after the 1st and 15th of the month. As one can see from Table 1, four forecasts were done on the 14th, five forecasts were done on the 17th, and one was even done on Saturday the 15th. Investors would greatly benefit by knowing the market conditions at the time the forecasts were created.

Another deficiency with the BMA is the absence of Weighted Average Coupon ("WAC") information of the underlying mortgage. This is clearly the most important parameter in a prepayment forecast. Users are required to estimate what the dealers used in their individual forecasts.

Bloomberg DPEs

The Bloomberg DPE or Dealer Prepayment Estimate screen (Figure 1) has five participants and includes the date of each forecast. Because the DPEs are available on Bloomberg, they are often confused with Bloomberg Medians. This brief description of

DPEs is included for user clarification. The DPE screen is updated semi-monthly and provides the mean or average rather than the median. The Bloomberg DPE differ from the BMA forecasts in the number of participants, the number of Issue Year categories, and the aggregate computation. The DPE do not have any age categories newer than 1997. This means that the DPE pages have fewer forecasts than the BMA for any loans categorized as New.

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GNMA I DEALER PREPAYMENT ESTIMATES -- PSA RATES Page 1 of 8

CPN	ISSUE	AVG	05/01 MERRILL LYNCH	05/01 PAINE WEBBER	05/01 LEHMAN BROS	05/01 PRU SEC's	05/01 CSFB		
6.0	1993	132	137	124	138	128	132		
6.0	1996	127	133	123	129	124	128		
6.5	1993	156	154	170	160	155	149		
6.5	1996	155	152	170	156	156	144		
7.0	1993	195	178	222	217	185	182		
7.0	1997	193	176	221	216	185	177		
7.5	1977	251	274	345	210	250	230		
7.5	1993	241	271	311	224	226	226		
7.5	1997	255	285	299	242	239	224		
8.0	1977	279	263	582	215	324	250		
8.0	1987	248	239	478	225	265	241		
8.0	1992	274	278	416	272	273	264		
8.0	1997	333	332	431	368	298	283		
8.5	1978	289	270	593	210	338	259		
8.5	1987	273	256	440	249	306	257		

Figure 1

Bloomberg Medians (VMED)

The Bloomberg Medians are different than the Bloomberg DPE screens. The number of participants in the Bloomberg Median survey varies by the asset being forecasted as illustrated in these sample screens. The next screen (Figure 2) has the forecasts for GNMA 6.0% for the Moderately seasoned loans. The subsequent screen (Figure 3) has the forecasts for the GNMA 6.0% for the TBA market on the same date as the prior screen. Each dealer provides their estimate of what the WAC and WAM are for the asset being forecasted. As one can see, only three dealers are providing forecasts for this asset category. The consensus Bloomberg Medians screens do not explicitly disclosure how many dealer participants provide data to determine a specific forecast.

The subsequent Bloomberg Median screen (Figure 3) has seven participants for TBA GNMA 6.0%. On this screen, a user can not determine the date and market condition that each forecast was made, but on individual dealer forecasts, one can see the date but not the market condition the dealer provided the forecast.

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Bloomberg DEALER PREPAYMENT FORECASTS Pg 1 of 2

For: [redacted] [redacted] M MOD GNMA Single Famil 6.00% as of: [redacted]

Firm	OBP PSA	WAM Yr	Mo	WAC	-300	-200	-100	-50	+0	+50	+100	+200	+300
					---------basis point shift--------								
FBC				n/a for this ticker/coupon/age									
DLJ				n/a for this ticker/coupon/age									
UBS				n/a for this ticker/coupon/age									
PW				n/a for this ticker/coupon/age									
BS				n/a for this ticker/coupon/age									
PRU				n/a for this ticker/coupon/age									
ML	129	26	2	6.50	710	384	168	145	129	116	111	105	100
LB	129	27	0	6.50	853	580	222	156	129	120	113	101	92
SAL	127	27	3	6.50	875	671	202	135	127	121	116	105	90
Avg	128				813	545	197	145	128	119	113	104	94

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Bloomberg DEALER PREPAYMENT FORECASTS Pg 1 of 2

For: [redacted] [redacted] T TBA GNMA Single Famil 6.00% as of: [redacted]

Firm	OBP PSA	WAM Yr	Mo	WAC	-300	-200	-100	-50	+0	+50	+100	+200	+300
					---------basis point shift--------								
FBC	113	29	3	6.50	1129	375	158	131	113	91	79	70	67
DLJ	130	29	7	6.50	1519	1109	185	151	130	111	96	77	70
UBS				n/a for this ticker/coupon/age									
PW	103	29	0	6.50	1086	605	188	140	103	80	75	75	75
BS	98	29	3	6.50	908	407	157	122	98	82	76	70	68
PRU	121	29	10	6.50	717	371	174	143	121	96	69	52	46
ML	116	29	7	6.50	1026	425	162	135	116	102	97	90	85
LB				n/a for this ticker/coupon/age									
SAL	99	29	9	6.50	1249	817	170	104	99	94	90	81	69
Avg	111				1091	587	171	132	111	94	83	74	69
MED	113				1086	425	170	135	113	94	79	75	69

Figure 3

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Mortgage Ticker: FNCL Age:Seasoned

5/ 3/99 LAST UPDATE — LEHMAN BROTHERS PREPAYMENTS — Page 2 of 2

PAGE for Graph

CPN	PSA	WAM YR	WAM MO	WAC	TRSRY SPRD	-300	-200	-100	-50	+50	+100	+200	+300
5.500	158	24	4	6.160	5	809	467	203	169	151	145	137	131
6.000	173	24	6	6.690	5	906	680	310	211	162	154	143	136
6.500	199	24	5	7.070	5	938	751	412	263	174	163	149	141
7.000	251	24	3	7.500	5	962	797	535	365	192	177	158	148
7.500	294	24	1	7.940	5	891	755	564	411	228	190	168	156
8.000	305	23	11	8.450	5	837	718	559	442	224	199	174	161
8.500	296	17	11	9.120	5	645	557	448	375	245	215	193	184
9.000	348	23		9.410	5	660	580	479	420	263	213	181	169
9.500	388	23	10	9.910	2	631	568	486	439	324	251	193	177
10.000	360	20	3	10.640	2	516	473	421	391	324	280	213	195
10.500	359	20	2	11.100	2	487	452	409	385	331	300	230	201
11.000	321	16	4	11.740	5	416	389	356	339	301	279	230	199
11.500	310	16	3	12.140	5	388	366	339	325	294	278	238	206
12.000	298	16	1	12.680	5	359	341	321	310	286	274	246	213
12.500	280	14	2	13.270	5	328	314	297	288	270	261	240	215
13.000	269	14	3	13.680	5	308	297	283	276	261	253	237	218

Figure 4

Bloomberg also offers users the ability to view the forecasts for a variety of assets by the individual firms. The next two screens are from individual dealers for seasoned FNMA 30-year product.

These screens (Figure 4 and Figure 5) reflect how the number of forecasts vary from different dealers. One firm provides 16 forecasts on different coupon categories while the other firm provides just one.

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Mortgage Ticker: FNCL Age:Seasoned

5/ 3/99 LAST UPDATE — DLJ Prepayments — Page 2 of 2

PAGE for Graph

CPN	PSA	WAM YR	WAM MO	WAC	TRSRY SPRD	-300	-200	-100	-50	+50	+100	+200	+300
9.500	385	23	8	9.920	2	633	613	530	403	370	321	199	158

Figure 5

Age Categories and Inconsistencies

As described previously, the BMA survey requires that all participants forecast twice monthly on a specific set of mortgage assets. The BMA selects these categories based upon the outstanding supply of mortgages.

The Bloomberg survey requests that dealers partition their forecasts into TBA, New, Moderate, and Seasoned categories. Bloomberg defines the Age categories as 1-29 Months, 30-60 Months, and 61 and greater months. However, within these general categories, dealers provide forecasts for whatever specific age and WAC they believe are correct.

In practice, each dealer defines the attributes of WAC and WAM within the asset category in a different way. For seasoned 30-Yr FNMA 9.5s, the WAMs vary from 18 years 5 months for Merrill Lynch to 23 years 8 months for DLJ and 23 years 10 months for Lehman Brothers. In this same asset class, the WACs vary from 10.11%, 9.92% and 9.91% from the same respective dealers.

These variations in WAM are particularly important for the "New" category assets. In practice, Wall St. dealer's prepayment models produce a vector of monthly prepayment estimates that must then be translated into a single long-term PSA number. This causes problems translating complicated prepayment vectors into single long-term PSA forecasts.

For example, if one were to assume that the same prepayment model was utilized on the same mortgage assets with the only difference the assets' age, then one would expect the long-term prepayment forecast to be the same. However, for the same monthly prepayment vector, a different PSA forecast will be produced if two different age assumptions are employed. For example, a dealer prepayment model produced a forecast of 0% CPR to 6.0% CPR over 20 months and then 6.0% CPR thereafter. If one asset being forecasted had an age of 10 months and the other asset had an age of 20 months, the weighted average life PSA of the first asset would be 104% PSA and the weighted average life PSA of the second asset would 101% PSA. The sample example would result in a different weighted-average life CPR. This example illustrates the necessity to have a consistent age utilized by each forecaster.

Moreover, the explicit assumption of 30-month aging in the PSA curve is not consistent with current mortgagor behavior nor with any of the Wall St. prepayment models. By reporting all forecasts in PSA and then using these in pricing MSR assets, mortgage bankers are adopting this 30-month aging assumption in their pricing of MSRs.

Bloomberg
MEDIAN PREPAYMENTS

Source: [redacted] FBC PW ML DLJ BS LB UBS PRU SAL For: [redacted]

HISTORICAL PREPAYMENT FORECASTS

[redacted]	Base	---------- basis point shift ----------								
	PSA	-300	-200	-100	-50	+0	+50	+100	+200	+300
5/27 Thu	190	1259	1068	529	287	190	153	142	131	122
5/26 Wed	190	1259	1068	529	287	190	153	142	131	122
5/25 Tue	190	1259	1068	529	287	190	153	142	131	122
5/24 Mon	190	1259	1068	529	287	190	153	142	131	122
5/21 Fri	189	1270	1074	529	287	189	153	142	130	122
5/20 Thu	195	1270	1074	536	291	195	153	142	130	122
5/19 Wed	195	1270	1074	536	291	195	153	142	130	122
5/18 Tue	195	1270	1074	536	291	195	153	142	130	122
5/17 Mon	213	1283	1108	552	295	213	160	143	132	123
5/14 Fri	220	1286	1141	639	369	220	160	143	132	123
5/13 Thu	223	1286	1141	639	382	223	161	143	132	123
5/12 Wed	223	1286	1141	639	382	223	161	143	132	123
5/11 Tue	223	1286	1141	639	382	223	161	143	132	123
5/10 Mon	223	1286	1141	639	382	223	161	143	132	123
5/ 7 Fri	223	1286	1141	639	382	223	161	143	132	123
5/ 6 Thu	223	1286	1141	639	387	223	164	143	132	123

Figure 6

Directed PSAs

One of the primary benefits of the Bloomberg Medians is the inclusion of several rate shocks in their survey. These forecasts are called the Directed PSAs. Figure 6 displays the historical forecasts of the Directed PSAs on FNMA 7.0% over a several week period. As mortgage companies increase their focus on hedging the market value risk in MSRs, consensus forecasts over a spectrum of rate shocks will likely play a role.

This screen also illustrates some of the deficiencies of both the Bloomberg Medians and the BMA survey. The primary problem is the discrete jumps in forecasts from one day to the next. The largest jumps occur shortly after updates on the 1st and 15th of the month.

For example, if one were to price a newly created MSR asset on a FNMA 7.0% with some standard MSR pricing assumptions and the 213% PSA Bloomberg Median assumption on 5/17/99, the price of the MSR asset would be 133.877 bps or a 5.355 multiple. On the 5/18/99, without any other assumption changing other than the PSA to 195%, reflecting the Bloomberg Median change, the price is 139.297 bps or 5.572 multiple. This is 3.89% price change. The most recent price movements of FNMA 7.0% pass-throughs have empirical durations of 3.1%. This means that interest rates would have to change 125 basis points before FNMA 7.0% pass-throughs would change to the same degree.

MIMs™ - Mortgage Industry Medians

The Mortgage Industry Medians were created to provide mortgage servicers a useful tool for pricing MSR assets every day and to be as consistent as possible to the Bloomberg Medians and the BMA survey. The Mortgage Industry Medians are not a prepayment model derived from historical prepayment information, but are a modification of current survey information to create a set of current consensus prepayment assumptions adjusted for the difference in the recent changes in market conditions.

Two Types of Adjustments for Market Changes

One of the shortcomings of both these surveys is that the dealers provide the forecasts on different dates. Another problem is, as the market changes between prepayment forecasts, each dealer's prepayment forecasts will also change but this is not reflected in the surveys.

The BMA forecasts are only updated semi-monthly. The forecasts must be within a day or two of the 1st or 15th or the late forecasts are excluded from the survey. Some Bloomberg Median participants update more frequently than other participants do. Some participants update weekly while other participants update semi-monthly. This irregular update frequency distorts the survey because the forecasts are done under different market conditions. In order for a set of consensus prepayment assumptions to be useful, they must be done under consistent market conditions from all participants.

Once a consensus forecast is created, the forecasts need to change to adjust effectively as the market conditions change. Figure 6 illustrates the problems with having a consensus survey that does not update more regularly. On April 30, 1999, the current coupon yield for 30-Year conventionals was 6.65%. Since then the current coupon yield has increased 21 basis points, 14 basis points, and 40 basis points between reporting periods. A user of consensus forecasts would be using significantly faster prepayment assumptions if they valued the portfolio on the day prior to the survey reporting date. In fact, if the mortgage servicing valuation was adjusting the discount rates to reflect the higher yield environment, the values of the MSRs would decline from the beginning of the prepayment reporting period to the end. Once the next reporting period started, the MSRs would dramatically increase. This oscillating behavior would be nearly impossible to hedge effectively.

The adjustments to the consensus prepayments need to be made first because the forecasts are on different dates and second because the market has moved since the last round of forecasts was created.

Before one addresses how the prepayment forecasts change with the market changes, one is faced with the question of how does one measure the market conditions for the mortgage market. This is a difficult question because yield is the best measure of market conditions and, in order to compute yield for a mortgage asset, one needs a prepayment assumption. The solution to this problem is to use a mortgage yield benchmark tool called the current coupon yield.

Current Coupon Yields

Current coupon yield methodologies compute the current yield on the MBS whose price is very close to or at par or parity. The yield of an MBS is not effected by the prepayment assumptions, if the price is parity. There are several technically different methods for computing the current coupon yield, so we will describe the current coupon yield methodology utilized in the Mortgage Industry Medians.

The MBS pass-through sector is divided into 30-Yr and 15-Yr GNMAs, 30-Yr and 15-Yr Conventional FNMAs or FHLMCs, and 7-Yr and 5-Yr FNMA or FHLMC Balloons. For the Mortgage Industry Medians, we will use the GNMA 30-Yr and 15-Yr sectors, the FNMA 30-Yr, 15-Yr, and 7-Yr Balloon sectors, and the FHLMC 5-Yr Balloon sector. We will use a 3:00 PM Eastern Time closing price for 30-day forward settlement of pass-throughs whose coupons straddle the parity price. For example on May 28, 1999, GNMA 6.5% were priced at 97.55 (in decimal units) for 30-day forward settlement and GNMA 7.0% were priced at 100.01 for 30-day forward settlement. A GNMA 7.0% pass-through will have a parity price of 99.73 parity price. The parity price is the price such that the coupon on the pass-through is the same as the bond equivalent yield. If one linearly interpolates between the price of the 6.5% and the price of the 7.0% to the parity price and applies this to the 6.5% and 7.0% coupons, one has the mortgage yield current coupon yield. If one then converts this linearly interpolated coupon to a bond equivalent yield, as is the practice in the MBS market, you will get the Mortgage Industry Median current coupon yield.

Each sector's current coupon yield is derived without relying on a prepayment model assumption and can be used as a benchmark for MBS yields for each product sector.

Adjusting for Updates Provided on Different Dates

If one dealer updates on May 28th and another dealer updates on June 1st, but the market has moved significantly, the median forecasts need be to adjusted for the different market conditions. The Mortgage Industry Medians will adjust each dealer's forecast to reflect the market changes. The question is how are these adjustments made.

The Mortgage Industry Medians method will take the previous prepayment forecasts from each dealer and the corresponding current coupon yields on each date of each forecast to build an adjusted forecast on the most recent date. Using the most recent forecasts and the current coupon yield on the date of the forecast, the Mortgage Industry Medians will be able to estimate what the specific forecast for each dealer would likely be given the change in interest rates or mortgage yields. With each dealer's forecast estimated, one can then compute the product type and coupon's median.

For example, on May 14th the current coupon yield is 7.20%. Six of the eleven dealers provide prepayment forecasts. These are then used as the current forecasts for these six dealers. On May 17th, the next business day, the remaining five dealers provide their forecasts. The current coupon yield at the 3:00 PM EDT is now 7.25%. The six new forecasts are used and the previous five forecasts are adjusted to reflect the 5 basis point change in the mortgage market. With the new set of eleven forecasts, the medians are computed. These medians are the MIMs adjusted medians.

The Mortgage Industry Medians will provide both the medians as reported by the Bond Market Association and the adjusted medians to reflect the fact that forecasts were made on two separate days. Users can decide which medians would be more appropriate to use in their MSR valuations.

Adjusting for Changes between Reporting Dates

After the most recent forecast reporting date, the forecast of each dealer will be modified daily to reflect the changes in the current coupon yields. The trick is in determining how these forecasts are adjusted. The Mortgage Industry Medians will be computed by regressing the historical forecasts from each dealer on each product type against the corresponding current coupon yield. This will establish the anticipated forecast for small changes in interest rates for each dealer. With the set of each dealer's anticipated forecast, the Mortgage Industry Medians will be computed as the median of each product type's forecasts. Of course as actual forecasts are made, the median of the actual forecasts becomes the number used in the MIMs.

Not a Prepayment Model

One should not consider the Mortgage Industry Medians just another prepayment model. Prepayment models are not concerned with replicating a consensus of forecasts, but with replicating actual historical behavior. The MSR and CMO marketplaces are focused on replicating a market consensus of dealer prepayment forecasts. This is only possible on two days a month without MIMs. Prepayment models provide very useful opinions and more complete descriptions of the anticipated prepayment and cash flow behavior for specific interest rate environments and assets, but they do not replicate a market consensus.

In addition, MIMs is not a black box where the underlying coefficients are the intellectual property of the creator. MIMs is a model of anticipated consensus forecasts. Should an auditor or regulator want to more fully understand how the daily MIMs forecasts are created, this information will be provided by MIAC, the creator and owner of the MIMs product.

Where do I get the Mortgage Industry Medians?

The Mortgage Industry Medians are created by the Mortgage Industry Advisory Corporation ("MIAC") and are available at www.servicing.com. The daily MIMs forecasts are available for download in several formats including the leading mortgage valuation software products.

A Statistical Analysis

The purpose of MIMs is to estimate on a daily basis how dealer prepayment forecasts and the medians of similar dealer prepayment forecasts would change in reaction to changes in the mortgage market. MIMs are first forecasts of individual dealer forecasts and the median of the resulting forecasts is the MIMs number for that asset type. In order to see how well the MIMs model estimates the actual dealer prepayment forecasts, extensive statistical analysis was done to compare the forecasts from the MIMs model to the actual reported forecasts on the date that the dealers reported.

This analysis is measuring how effective each MIMs forecast model is at predicting the relationship between mortgage rates and individual dealer prepayment forecasts. Clearly, nearly all would agree that mortgage rate levels are the primary component to determining mortgage prepayment expectations. Each MIMs model is simply describing this behavior. Because of this inherent relationship between mortgage rates and prepayment forecasts, the statistical results are very conclusive.

Three different measurements were used to test the statistical accuracy of the forecasts estimated by the MIMs model versus the actual reported forecasts: the Wilcoxon signed rank test for medians; the Median Test which uses contingency tables; and a standard error measurement. The Wilcoxon test and the Median test are both hypothesis tests. We begin by forming a null hypothesis that we wish to test (e.g. the median of the sample equals a certain value), create a test statistic and then, based on the value of that statistic, either accept or reject the null hypothesis. These tests were chosen from the wide array of available tests since they are directly applicable to testing the medians of a sample and are non-parametric. This means they are powerful for small sample sizes, which we have in this case, and do not require any assumptions to be made regarding the distribution of the samples.

The theory, methodology, and an example calculation of each of these measurements are outlined below. Following these explanations are sample test results. As can be seen from these results, the MIMs model is statistically accurate for forecasting the actual reported forecasts.

1) Wilcoxon signed rank test for medians:

The Wilcoxon Test tests whether the median of a sample is equal to a hypothesized value by looking at the signs and magnitudes of the differences between each observation in the sample and that hypothesized median value. In this case the sample is the MIMs forecasts on report date and the hypothesized median value is the actual reported median. The theory behind this test comes from the definition of the median. Each observation in the sample has a probability of 0.5 of being above or below the median, by definition. If the median of the sample population is the same as the hypothesized median, the sums of the positive and negative ranks of the differences of each observation to the hypothesized median should be similar. If there is a large difference in these sums, there were more observations in the sample with differences above the median, or below the median, depending on the sign. This implies that there was not a .5 probability of being above or below the hypothesized median, which implies that the hypothesized median is not the median of the sample.

Methodology:

Before the test is run, the following hypotheses are set:

H0: The median equals m
H1: The median is not m

To run the test, calculate Di as the difference between each member of the sample, Xi, and the hypothesized median, m. Next rank the Di's by their absolute value and then sum those ranks for the positive and negative Di's. The smaller of those two sums is the T value.

In order to test this T value, compute the critical range using the following formulas:

Lower bound:

$$w_{\alpha/2} \cong \frac{n(n+1)}{4} + x_{\alpha/2}\sqrt{\frac{n(n+1)(2n+1)}{24}}$$

Upper bound:

$$w_{1-\alpha/2} \cong \frac{n(n+1)}{4} + x_{1-\alpha/2}\sqrt{\frac{n(n+1)(2n+1)}{24}}$$

where n is the number of observations in the sample, $x_{\alpha/2}$ is the standard normal variate such that the proportion $\alpha/2$ is to the left of $x_{\alpha/2}$, and $x_{1-\alpha/2}$ is the standard normal variate such that the proportion $1-\alpha/2$ is to the right of $x_{1-\alpha/2}$.

If the T value computed falls within this critical range, the null hypothesis can be accepted for the $1-\alpha$ confidence level.

This range is computed in such a way that there is only an α percent chance that the medians are shown to be the same only by some statistical anomaly, not because they are actually statistically the same.

For example:

For the sample below, a group of 11 MIM forecasts on report date for the Conventional 30 6.0 1998 product:

X = 119 120 118 142 132 139 132 146 97 128 116

To test if the median of this sample is statistically the same as the actual median reported of 130 with a confidence level of 0.95, first form the null and alternative hypotheses as follows:

H0: the median of X equals 130
H1: the median of X is not 130

Next, calculate the difference of each member of X from the hypothesized median:

Xi	Di	Abs(Di)	Rank
116	-14	14	9
119	-11	11	6
120	-10	10	5
118	-12	12	7.5
142	12	12	7.5
132	2	2	2
139	9	9	4
132	2	2	2
146	16	16	10
97	-33	33	11
128	-2	2	2

The ranks are assigned by the absolute value of the difference. In the case of a tie, the average of the ranks that would have been assigned is used. For example, there are two Di's equal to 12. Each of these is assigned a rank of 7.5 instead of 7 and 8 separately. In the case of a three-way tie, the average of the ranks is used as well. For example, there are three Di's equal to 2. Each of these are given a rank of 2 instead of 1,2 and 3 separately.

Once the ranks are assigned, find R+ and R- by summing the ranks of the positive and negative Di's.

$R^+ = 7.5+2+4+2+10 = 25.5$
$R^- = 9+6+5+7.5+11+2 = 40.5$

The smaller of R^+ and R^- is taken as our T value, in this case T = 25.5.

The next step is to compute the critical range. Setting $\alpha = .05$, we compute $w_{.025}$ and $w_{.975}$ as follows:

$$w_{.025} \cong \frac{11(12)}{4} + (-1.96)\sqrt{\frac{11(12)(23)}{24}} = 11$$

$$w_{.975} \cong \frac{11(12)}{4} + (1.96)\sqrt{\frac{11(12)(23)}{24}} = 55$$

Since T falls within this critical range of 11 to 55, the null hypothesis cannot be rejected and we conclude that the MIMs forecasted median does equal 130, the actual reported median.

2) The Median Test:

The Median Test tests whether two samples have the same median by comparing each observation in the samples to the grand median, the median of the two samples put together. In this case, the one sample is the actual reported forecasts and the other sample is the MIMs forecasts. The theory of this test is based on the binomial distribution. If the two samples have the same median, then each observation in both samples has the same probability of being above or below the grand median. For this test we build what is known as a contingency table based on the number of observations that are above and below the grand median in each sample and then examine the probability of having obtained that contingency table to determine if the two samples have the same median.

Methodology:

Before the test is run, the following hypotheses are set:

H0: The samples have the same median
H1: The samples have different medians

The first step of running the test is to find the median of the two samples together, the grand median. Next, build a contingency table as below based on whether each element of each sample is above or below the grand median.

Sample	1	2	Totals
> Median	O_{11}	O_{12}	a
≤ Median	O_{21}	O_{22}	b
totals	n_1	n_2	N

Then compute the test statistic, T, using the following formula:

$$T = \frac{N^2}{ab} \sum_{i=1}^{c} \frac{\left(O_{1i} - \frac{n_i a}{N}\right)^2}{n_i}$$

Finally, compare this T value to the critical value found in the Chi-squared table for confidence level 1-α with c-1 degrees of freedom. In the case of testing the MIMs forecasts against the actual reported forecasts, c will always equal 2, the number of samples being tested.

For example:

For the samples below, X, a group of 11 MIM forecasts on report date for the Conventional 30 6.0 1998 product and Y, the actual forecasts reported for the same product:

X = 119 120 118 142 132 139 132 146 97 128 116
Y = 116 121 120 137 132 131 144 149 99 130 113

Form the null and alternative hypotheses:

H0: X and Y have the same median
H1: X and Y have different medians

Calculate the grand median = 129 and build the contingency table:

Sample	X	Y	Totals
> 129	6	5	11
$\leq$ 129	5	6	11
totals	11	11	22

Compute T:

$$T = \frac{22^2}{11*11}\left(\frac{\left(6 - \frac{11*11}{22}\right)^2}{11} + \frac{\left(5 - \frac{11*11}{22}\right)^2}{11} \right) = 0.1818$$

The critical value from the Chi-squared table for the 95% confidence level with 1 degree of freedom is 3.841. Since the T value computed here is well below this critical value, we cannot reject the null hypothesis and so conclude that the medians of the two samples are statistically the same, i.e. the MIMs forecasted median is the same as the actual reported median.

3) Standard error:

This error measurement is the difference between the MIMs forecasted median and the actual reported median adjusted by the pooled variance of the two samples. The pooled variance is given by the following formula:

$$\frac{X_1 - X_2}{\sigma_{\Delta\chi}}$$

where X_1 = actual median, X_2 = MIMs forecast median, and $\sigma_{\Delta\chi}$ is defined as:

$$\hat{\sigma} \sqrt{\frac{n_1 + n_2}{n_1 n_2}}$$

where n_1 = number of dealer forecasts in actual median, n_2 = number of dealer forecasts in the MIMs median, and $\hat{\sigma}$ is defined as:

$$\sqrt{\frac{n_1 s_1^2 + n_2 s_2^2}{n_1 + n_2 - 2}}$$

where s_1 and s_2 are the standard deviations of the actual forecasts and MIMs forecasts respectively.

The $\sigma_{\Delta\chi}$ statistic is a measure of how great a difference can be expected between the median of the MIMs forecasts and the actual reported forecasts due to the variance of the two samples. When the actual difference between the medians is divided by this expected difference, the result is the standard error measure. At zero, there is no difference between the MIMs forecast and the actual. If it is above one, there is a greater difference than would be expected, and between zero and one, there is less difference than would be expected. As long as the standard error is between zero and one, the MIMs forecast can be considered statistically accurate.

Sample Test results:

The following pages show the results of these three tests run on all product types. The first set of results are out-of-sample tests for the MIMs forecasts estimated on report date versus the actual reported forecasts on November 1,1999. The second set are in-sample tests for the MIMs forecasts estimated on report date versus the actual reported forecasts on October 15, 1999. The issue years and coupons shown here are a sample of the total set. These are recent

issue years for each coupon, which represent a larger portion of the current market than the other issue years. The confidence level used in these tests was 95%. This means there was a 5% chance of a Type I error, when the null hypothesis, H0, is incorrectly accepted.

As these results show, the MIMs forecasts fall within the critical range for the Wilcoxon test, well below the critical value for the Median test, and have small error values, demonstrating that the MIMs model is statistically accurate for forecasting actual prepayment forecasts.

Tests of MIM forecast on report date versus the actual reported forecasts on 11/1/99

Out-of-sample test

NOTE: there were coupon changes made by BMA on 11/1/99.
Where appropriate, the history from other coupons was used for new coupons, e.g. 6.0 1998 used for 6.0 1999

GNMA 30

Coupon	Issue	MIM Median	Actual Median	Wilcoxon Signed rank test	Critical range 9 D of F 95%	Median test (Chi-squared)	Critical value 1 D of F 95%	Standard Error
6.0	1999	102	100	19	8-47	0.8	3.841	0.1263
6.5	1999	115	113	22	8-47	0	3.841	0.1410
7.0	1996	138	139	21	8-47	0	3.841	0.0656
7.5	1997	155	153	12	8-47	0	3.841	0.1052
8.0	1997	186	187	24	8-47	0	3.841	0.0414
8.5	1996	226	231	21	8-47	0.20	3.841	0.0816
9.0	1995	277	274	24	8-47	0	3.841	0.0413
9.5	1995	312	314	23	8-47	0	3.841	0.0223

CONVENTONAL 30

Coupon	Issue	MIM Median	Actual Median	Wilcoxon Signed rank test	Critical range 9 D of F 95%	Median test (Chi-squared)	Critical value 1 D of F 95%	Standard Error
6	1993	142	142	22	8-47	0	3.841	0.0000
6	1999	124	122	20	8-47	0	3.841	0.3272
6.5	1996	145	145	23	8-47	0	3.841	0.0000
7	1996	156	156	25	8-47	0	3.841	0.0000
7.5	1997	173	179	16	8-47	0	3.841	0.9052
8	1992	203	205	26	8-47	0	3.841	0.1905
8.5	1991	246	248	24	8-47	0	3.841	0.1130
9	1995	306	308	25	8-47	0	3.841	0.0812
9.5	1995	333	336	21	8-47	0	3.841	0.1080

GNMA 15

Coupon	Issue	MIM Median	Actual Median	Wilcoxon Signed rank test	Critical range 9 D of F 95%	Median test (Chi-squared)	Critical value 1 D of F 95%	Standard Error
5.5	1999	121	120	25	8-47	0	3.841	0.0482
6.0	1999	133	134	24	8-47	0	3.841	0.0518
6.5	1999	145	145	23	8-47	0.8	3.841	0.0000
7.0	1997	165	163	19	8-47	0	3.841	0.1125
7.5	1997	191	187	19	8-47	0	3.841	0.1714
8.0	1996	218	216	23	8-47	0	3.841	0.0714

CONVENTONAL 15

Coupon	Issue	MIM Median	Actual Median	Wilcoxon Signed rank test	Critical range 9 D of F 95%	Median test (Chi-squared)	Critical value 1 D of F 95%	Standard Error
5.5	1999	135	132	25	8-47	0	3.841	0.1981
6.0	1999	142	141	24	8-47	0.20	3.841	0.0870
6.5	1996	154	153	24	8-47	0.8	3.841	0.0481
7.0	1997	164	164	23	8-47	0	3.841	0.0000
7.5	1997	184	187	23	8-47	0.8	3.841	0.1534
8.0	1996	225	227	23	8-47	0.8	3.841	0.0508

7YR BALLOONS

Coupon	Issue	MIM Median	Actual Median	Wilcoxon Signed rank test	Critical range 6 D of F 95%	Median test (Chi-squared)	Critical value 1 D of F 95%	Standard Error
6.0	1996	263	271	13	2-26	0.286	3.841	0.0112
6.5	1996	288	280	12	2-26	0.286	3.841	0.0107
7.0	1996	322	320	14	2-26	0.286	3.841	0.0025
7.5	1996	342	353	13	2-26	0.286	3.841	0.0150

Tests of MIM forecast on report date versus the actual reported forecasts on 10/15/99

In sample test

GNMA 30

Coupon	Issue	MIM Median	Actual Median	Wilcoxon Signed rank test	Critical range 10 D of F 95%	Median test (Chi-squared)	Critical value 1 D of F 95%	Standard Error
6.0	1996	109	109	21	11-55	0.2	3.841	0.0000
6.5	1998	114	114	28	11-55	0.2	3.841	0.0000
7.0	1998	133	130	23	11-55	0.2	3.841	0.1943
7.5	1997	153	152	21	11-55	0.2	3.841	0.0492
8.0	1992	180	178	17	11-55	0.2	3.841	0.0678
8.5	1996	220	220	27	11-55	0.2	3.841	0.0000

CONVENTONAL 30

Coupon	Issue	MIM Median	Actual Median	Wilcoxon Signed rank test	Critical range 10 D of F 95%	Median test (Chi-squared)	Critical value 1 D of F 95%	Standard Error
6	1996	144	144	24	11-55	0.2	3.841	0.0000
6.5	1998	139	135	30	11-55	0.2	3.841	0.5490
7	1996	161	155	25	11-55	0.2	3.841	0.7580
7.5	1993	168	168	15	11-55	0.2	3.841	0.0000
8	1992	203	207	27	11-55	0.2	3.841	0.3000
8.5	1996	245	245	22	11-55	0.2	3.841	0.0000

GNMA 15

Coupon	Issue	MIM Median	Actual Median	Wilcoxon Signed rank test	Critical range 10 D of F 95%	Median test (Chi-squared)	Critical value 1 D of F 95%	Standard Error
5.5	1998	120	120	27	11-55	0.2	3.841	0.0000
6.0	1998	131	132	30	11-55	0.2	3.841	0.0523
6.5	1998	145	144	32	11-55	0.7	3.841	0.0559
7.0	1992	186	180	26	11-55	0.2	3.841	0.2035
7.5	1997	188	184	13	11-55	0.2	3.841	0.1606

CONVENTONAL 15

Coupon	Issue	MIM Median	Actual Median	Wilcoxon Signed rank test	Critical range 10 D of F 95%	Median test (Chi-squared)	Critical value 1 D of F 95%	Standard Error
5.5	1998	136	135	24	11-55	1.7	3.841	0.0620
6.0	1998	143	144	20	11-55	0.2	3.841	0.0730
6.5	1998	149	148	24	11-55	0.2	3.841	0.0700
7.0	1997	164	161	17	11-55	0.2	3.841	0.1080
7.5	1992	185	182	18	11-55	0.2	3.841	0.0590

7YR BALLOONS

Coupon	Issue	MIM Median	Actual Median	Wilcoxon Signed rank test	Critical range 7 D of F 95%	Median test (Chi-squared)	Critical value 1 D of F 95%	Standard Error
5.5	1996	278	279	16	8-46	0.000	3.841	0.0017
6.0	1996	269	276	14	8-46	0.000	3.841	0.0119
6.5	1996	289	282	12	8-46	1.000	3.841	0.0114
7.0	1996	340	316	13	8-46	0.000	3.841	0.0371
7.5	1996	373	358	12	8-46	0.000	3.841	0.0236

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