A Fixed-Income Market View of Mortgage REIT Valuations

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Real-estate investment trusts (REITs) are a particular type of corporation and benefit from favorable tax treatment under certain conditions. They are exempt from income tax as long as they meet a series of constraints, the most relevant of which is that they be invested in real estate, through securities or direct holding, and that they pay essentially all their income as dividends. By extension, mortgages or mortgage-backed securities (MBS), as loans backing real estate, are considered qualifying REIT assets. A substantial proportion of the mortgages or MBS held by a REIT must be in whole-loan or pass-through form, which limits a REIT's holdings of CMOs or non-agency MBS.

The mortgage REIT business model, tapping the equity market in order to finance the leveraged acquisition of mortgage assets, has been around for many years, but it has recently evolved toward more liquid assets. Before 2007, most mortgage REITs were buying whole loans and using securitization as term financing. With the crisis and the liquidity dry-up for the more credit-exposed paper, the mortgage REIT industry initially refocused on agency MBS, which were less impacted than other mortgage assets. Since then, several REITs have also added exposure to non-agency legacy assets (called hybrid mortgage REITs), but the share of agency-focused mortgage REITs remains substantial, with more than $30 billion in equity market capitalization and more than $300 billion in mortgage assets. (See George, Rahmani and O'Steen [2013] for an overview.)

These agency mortgage REITs typically finance themselves through repurchase agreements and enter a series of hedges (swaps, swaptions, caps, and other instruments) to manage the price risk of their MBS holdings.

Agency mortgage REITs are a particularly interesting asset class because their assets and liabilities are very liquid and can be valued fairly accurately. This is in contrast with REITs holding brick-and-mortar assets, and to some extent with hybrid mortgage REITs' non-agency holdings as well. However, a large share of the agency mortgage REITs investor base is retail and generally unable to continuously arbitrage away large discrepancies in market prices versus book value.

There have been extensive research and publications on traditional REIT valuations and analysis, mainly focused on the commercial real-estate market. However apart from broker/dealer research publications, there has essentially been no academic research looking at the valuation of mortgage REITs, and in particular agency mortgage REITs.

This article discusses the findings from analyzing agency mortgage REITs as what they are at the core: a levered MBS and derivatives portfolio. In the first part, we address certain key aspects in capturing

these REITs' holdings to form a representative portfolio. Then we discuss the book value projections that can be derived from the detailed analysis of the REITs' assets. We show that these projections generally come very close to the actual numbers. We found that, across seven agency mortgage REITs, and across the past six quarters, the standard deviation of book value projection errors from one quarter to the next is 2.4%, to be compared with a total standard deviation of book value changes of 8.6%. Addressing some directionality in projection errors, the residual error can be reduced to 1.8%.

Next, we discuss the fixed-income-specific risk measures that can be calculated on these agency mortgage REITs, such as durations and convexities. We also compute simple market-implied scenarios, capturing the discount or premium of actual prices relative to projected book values. Of late, the market has considered that most mortgage REITs' valuations were driven by interest rates. We show that is indeed justified to some extent.

Finally, we address performance attribution. One could wonder whether mortgage REITs' performance is driven by their underlying positions option-adjusted spread (OAS). Also, it is natural to wonder why mortgage REITs can generate yields in the teens, trading a presumably well-arbitraged market. With our tools, we show that OAS levels are not a significant driver of performance, but OAS changes are, and that mortgage REITs' large yields can be mostly attributed to the implied versus realized volatility spread, beyond pure duration bets.

We have anonymized the few REITs we used as examples as REIT A, B, C, and so on. *The Journal of Fixed Income's* editor and the author have the actual list, and it can be communicated on request. Exhibit 1 shows the list of REITs we used as our sample, along with some information on their ownership.

EXHIBIT 1
Sample Mortgage REITs and Ownership Information

Ticker	Name	% Retail	% Institutional
AGNC	American Capital Agency	54%	46%
ARR	Armour Residential REIT	68%	32%
CMO	Capstead Mortgage	41%	59%
CYS	CYS Investment	37%	63%
HTS	Hatteras Financial	34%	66%
NLY	Annaly Capital Management	54%	46%
WMC	Western Asset Mortgage Capital	67%	33%

Source: Nasdaq, as of 9/1/2013.

REPRESENTATION OF AN AGENCY MORTGAGE REIT's ASSETS AND LIABILITIES

Agency mortgage REITs trade the full range of agency MBS, including TBAs, as well as generic pools, specified pools, and newly issued or more seasoned adjustable-rate mortgages (ARMs) and hybrid ARMs. All kinds of specified pools can be found on mortgage REITs' books, from strongly call-protected low loan balances (LLBs) to more negatively convex conforming jumbo pools, and including all shades of high loan-to-value (LTV) HARP (Home Affordable Refinance Pools) refinancing program pools.

Mortgage REITs typically provide information on their portfolios of assets and derivatives as of the end of each quarter, in their 10-Q or 10-K Securities & Exchange Commission (SEC) reports. They do not give a detailed list of assets (such as Cusips or pool IDs) but rather aggregate characteristics, sometimes bucketed along some basic pool category. The information provided is not designed so that one could easily reconstruct the full detail of their positions.

Our approach in building a portfolio representative of a REIT's assets has not been to look for a particular bond or class of bonds for each line item provided in the REIT's reports. Instead, we have focused on finding a distribution of weights among a set of representative "atomic" positions, so that the aggregate characteristics of the representative portfolio were as close as possible to the reported aggregate characteristics. There are essentially three steps in this approach:

1. Create the representative atomic positions. We use about 300 of them, covering the whole spectrum from TBAs to particular specifieds.
2. Formulate all the available information in terms of constraints on these representative positions. This is a rather manual task, parsing a 10-Q or 10-K into a mathematically usable input.
3. Determine the set of weights across the atomic positions so that the constraints are verified to the maximum extent possible. This is resolved by brute force computing power.

We had to define a value function, that is the trade-off between being a little closer for some aggregate, versus being a little closer for another aggregate. For example, a 1% difference in aggregate conditional

prepayment rate (CPR) could be equivalent to a 0.5 point difference in aggregate price. Finding the optimal representative portfolio boils down to minimizing the value function.

For our optimization logic to work optimally, there is an implicit assumption that the possible atomic positions used to capture any given REIT's portfolio really cover the entire MBS universe. We achieve that by resorting to OAS-based pricing on certain pool types or mortgage types on which we do not have marks.

We used a Heath-Jarrow-Morton two-factor model as the core interest rate dynamics for derivatives and MBS valuations. (See Acar and Natcheva-Acar [2008] for a description of these interest rate processes.) The dynamics are calibrated to Libor and swap rates, as well as at-the-money swaption prices.

ACCURATE REPRESENTATION OF DERIVATIVES

One of the most significant factors that influence returns on mortgage REITs is the use of derivatives. There is substantial variability among mortgage REITs in terms of derivative hedge maturity distributions, as well as in terms of product choices. Notwithstanding the nature of their assets on the long side, some tend to enter short-dated swaps, while some use much longer-dated swaps, or swaptions. As a result, it is critical to fully capture the range of maturities they are exposed to, rather than simply concentrate all these positions into a single aggregate. The importance of using information on hedges in their full detail is clear once we look at the average error in book value projections. Factoring in the full detail of hedges, as mentioned earlier, it is 2.4%; when factoring in only aggregate derivatives positions, it comes out above 5%.

Accurate Asset Representation

Systematically accessing detailed pricing information on all the possible specified pools can be difficult, and some mortgage REIT investors use to-be-announced mortgage pools (TBAs) instead, which are more readily available. However, the differences in duration and in risk characteristics between TBA, generic pools, and the more extreme specified pools can be quite significant. Exhibit 2 shows as an example, for a given coupon and product, the characteristics of a few typical MBS as of the end of March 2013.

Exhibit 2 clearly illustrates the enormous range of durations and characteristics, all for the same product and coupon. The dollar prices in this example (a cuspy coupon at that time) are quite concentrated, falling within a point of each other for the most part. The extreme differences in prepayment behavior (both actual and anticipated) lead to a five-year range in durations, according to our models. Therefore, it is reasonable to expect that using TBAs instead of the appropriate specifieds to represent a REIT portfolio can lead to entirely misleading conclusions.

Exhibit 3 shows the details of how an example REIT's MBS holdings are represented. The number of

EXHIBIT 2
Comparison of Specifieds Characteristics on Fannie 30-Year 3.5s

Type	WAC	WALA	LTV	ALS	OMS	Fact	OAS	Price	ZV OAS	OC	Dur.	Yld	3m CPR
TBA	4.03	15	71	237	0.01	84%	–14	105.6	51	65	3.3	2.72	16.1
2-yr WALA	4.04	19	69	242	–0.09	78%	–15	105.6	51	66	3.1	2.70	22.4
3-yr WALA	4.02	47	69	229	–0.93	73%	–8	105.6	50	58	3.3	2.63	26.8
LLB	3.99	9	67	67	0.27	97%	6	106.8	43	37	6.6	2.65	4.0
MLB	3.99	10	70	98	0.15	97%	2	106.5	45	43	6.0	2.69	4.0
HLB	3.99	10	72	130	0.17	97%	–3	106.3	46	49	5.4	2.72	4.8
Low FICO	4.03	16	68	219	–0.03	90%	–15	106.0	47	62	3.6	2.68	17.8
Investor	4.11	8	66	283	0.43	96%	–16	105.8	48	64	3.8	2.70	10.9
HARP/80	4.04	8	85	252	0.34	96%	7	105.9	51	44	6.1	2.78	7.1
HARP/90	4.00	8	95	232	0.31	98%	5	106.3	47	42	6.5	2.78	3.1
HARP/100	4.02	8	103	227	0.33	99%	2	106.6	43	41	6.7	2.76	1.3
Jumbo	4.05	10	69	538	0.20	82%	–24	104.3	53	77	1.7	2.67	35.1

Source: Amerigo Capital Analytics models. Data as of end of Q1 2013. ALS: average loan size. OMS: Off-market spread, the difference between initial WAC and the prevailing mortgage rate at the time of origination. ZV OAS: zero-volatility OAS. OC: option cost.

EXHIBIT 3
Modeled and Reported Characteristics on an Example REIT

Product Type	Wgt	Nb. Items	Cpn	WAC	WALA	ALS	MTR	OAS	Price	Duration	Cvx.	Yld
15-yr specifieds	27%	18	3.07	3.53	11	146	–	21	105.39	4.1	–0.3	1.87
15-yr WALA	19%	18	2.97	3.51	20	186	–	1	104.87	2.8	–0.7	1.63
20-yr TBA	6%	6	3.16	3.73	10	198	–	–6	104.99	3.6	–1.0	2.18
30-yr specifieds	25%	40	3.43	4.00	10	174	–	4	105.34	6.7	–0.4	2.66
30-yr WALA	6%	22	3.92	4.53	33	221	–	–2	105.94	3.0	–1.1	2.43
New Hybrid	14%	21	2.65	3.20	10	285	89	21	104.39	3.0	–0.4	1.93
Short ARM	3%	2	2.58	3.08	12	220	0	8	106.52	0.7	0.0	1.56
Model aggregate	**100%**	–	**3.13**	**3.66**	**14**	**190**	–	**10**	**105.18**	**4.2**	**–0.5**	**2.07**
Reported aggregate	–	–	**3.11**	–	–	–	–	–	**105.18**	–	–	**2.04**

Source: Company reports, Amerigo Capital Analytics models, as of Q1 2013 end. Aggregate yields and OASs are simple averages, not duration-weighted.

items is the number of separate atomic positions used in each bucket. We show only some of the portfolio-level reported aggregates, but in this particular case there were a variety of marginal aggregates provided in the company report, such as weighted-average coupon (WAC), average coupon and average price, for several particular product types. In this case, for example, the average price reported on 15-year MBS leads our optimization process to allocate a sizable exposure to specified pools trading at a pay-up versus TBAs.

Accurate Asset or Liabilities Cash Flows

Notwithstanding changes in asset prices over time, the cash flows they generate must be properly factored in. A particular pool type could print very high (or low) CPRs over a few months, but these speeds might not lead to any significant change in pricing. The speeds would however matter very much in terms of the total return from holding the bonds.

Our approach is to use the representative item's cohort-level speed to derive the cash flows. So, for example, we would use aggregate Fannie Moe 3.5% LLB speeds to project the cash flows on such a representative. When projecting within a quarter (before the actual speeds are known), we use projections from our prepayment models.

BOOK VALUE PROJECTIONS

The single most important number for a mortgage REIT is likely its book value per share. This is simply how much its net assets are worth, per common share outstanding.

The equity market looks closely at these numbers, and share prices are generally compared with the last reported book value per share, in order to derive a market premium or discount over book value (see George et al. [2013]).

Changes in book value per share (either positive or negative) that differ from consensus generally lead to a rapid price correction in the equity market. Such surprises would include, for example, AGNC's Q1 2013 book value drop by 8% released May 2, 2013, while the consensus was about flat, and HTS's Q2 2013 book value drop over 20%, released July 23, 2013, versus a consensus around –10%.

These examples do stress the importance of forming an accurate view of a mortgage REIT's book value in order to avoid such surprises.

Starting from a detailed representation of each REIT's assets and liabilities, as discussed above, and at various points in time (quarter ends), we compute a projected change in book value. To keep the analysis simple, we made a fairly strong assumption: the REITs do not actively trade their positions, do not rehedge, and reinvest all asset cash flows into the same type of product. Looking at mortgage REIT quarterly reports showing their allocation on various product types over time, there is no doubt that the no-trading assumption is wrong. However, while these REITs definitely change their portfolios, it is not clear they do so before significant market moves. As a matter of fact, our results would tend to indicate the contrary. If indeed these REITs will trade after the main market events have taken place, then the impact of that trading on the overall performance is bound to be limited.

An alternative to consider, which we are not developing here, is to model a range of possible strategies (such as up-in-coupon, hedge rebalancing, progressive convexity hedging) and look at the impact they have on the end result, compared with the default no-trading strategy. The resulting range of quarter-end book value projections provides useful brackets around the default projection.

Some other simplifying assumptions were made for this exercise, in particular the small non-agency holdings of some of the example REITs were neglected, and management and operations expenses were all assumed to be 1.5% of equity on an annualized basis. We do not think that a more precise modeling on these points would materially change the results.

How accurate, then, are book value projections derived from a detailed representation of agency mortgage REITs' holdings? Exhibit 4 provides a graphical answer to that question. We can see that projected and actual changes in book value per share are strongly correlated, and that this is true across REITs.

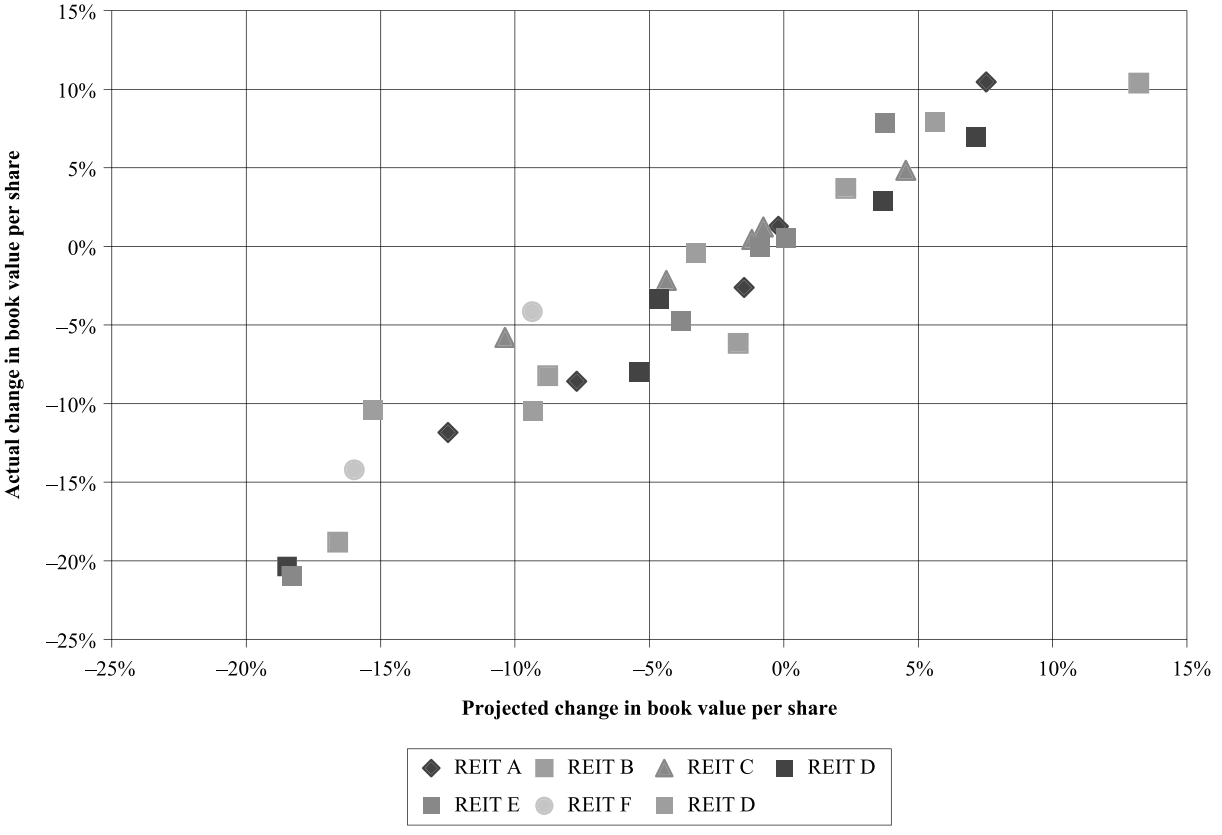
As mentioned earlier, the standard deviation of actual changes in book value on this sample was 8.6%, while the standard deviation of the projection error was 2.4%. Our straight constructive approach, therefore, explains roughly three quarters of book value changes.

There are a few outliers, with errors in book value changes around 4%. These outliers are not particularly concentrated at any specific time period, or on any particular REIT.

Book Value Projection Error Model

Looking closely at projected and actual changes in book value, there appears to be a degree of directionality, however. On the down side, the actual changes

EXHIBIT 4
Actual and Projected Changes in Book Value Per Share



Source: Amerigo Capital Analytics, company reports. Reporting periods covered: Q2 2012, Q3 2012, Q4 2012, Q1 2013, Q2 2013.

EXHIBIT 5

Regression for Actual Book Value Changes vs. Projections

Variable	Coefficient	Std. Error	Pr(>|t|)
Projected change in BV if >0	1.01	0.15	0%
Projected change in BV if <0	1.06	0.07	0%
REIT A	0.009	0.011	42%
REIT B	–0.021	0.014	14%
REIT C	0.015	0.014	29%
REIT D	–0.013	0.014	33%
REIT E	–0.002	0.013	87%
REIT F	0.034	0.019	8%
REIT G	0.018	0.014	23%

Source: Amerigo Capital Analytics.

seem to be a little more negative than the projections. We can confirm this by running a simple regression:

[actual change in BV] =
a [projected change in BV if positive]
+ b [projected change in BV if negative]
+ [REIT-dependent constant] + residual

with so few data points, some of the coefficients are not likely to be significant, but including a REIT-specific term also allows us to capture any potential systematic out/under performance, at least according to our models.

The regression results are shown in Exhibit 5. The standard deviation of residuals for this regression is 1.8%. For positive projections, the slope is 1.01, and this indicates the projections are unbiased. On the down side, however, as hinted earlier the slope is stronger at 1.06. A plausible explanation could be that this is related to the REIT's efforts to maintain leverage. When the markets are moving down over a quarter, the minimum values will typically be worse than the end point. At that minimum value intra quarter, a REIT aiming to maintain its leverage could have had to liquidate some positions. Then, as the market bounced back somewhat, they would not have benefited as much from the partial recovery.

The magnitude of the REIT-specific coefficients standard errors are such that it is a stretch to infer any conclusions on their respective managements quality.

RISK MEASURES

Using OAS models on agency MBS and pricing models for fixed-income derivatives, we can compute the impact of changes in underlying market conditions or in mortgage-specific factors. Some of the more relevant scenarios we can look at are:

- Stresses on the interest rate curve: parallel moves, changes in curve shape, changes in implied volatilities. These stresses typically affect both assets and liabilities in a REIT.
- Stresses on implied volatility: changes in implied volatility, all else being equal, which affects both MBS and interest-rate derivatives with an optional component such as swaptions, caps, and floors.
- Stresses on the mortgage market: changes in OAS, changes in certain mortgage rates. These scenarios normally affect only assets and have no impact on typical swaps or swaptions.
- Stresses on borrower behavior: changes in prepayment patterns such as refinancing ability, access to various government programs, changes in the competitive environment between lenders.

Note that mortgage-market-specific or borrower-specific stresses can have a second-order effect on straight interest rate derivatives, for example, because of altered hedging needs for the entire mortgage market, but we chose not to reflect these effects to keep the analysis simpler at this stage.

REIT-Level Risk Metrics

Rolling up the impact of various stresses on all REIT assets and liabilities, we obtain the book value level impact. Then, using standard formulas, we can derive the book value duration and convexity (based on 50 bps parallel moves in rates). Using 50 bps curve steepening and flattening stresses, we also derive curve slope durations. Also, with a 50 bps OAS widening stress and correlated mortgage rate increase, we get an OAS duration or mortgage basis duration. Finally, using a parallel shift of the volatility curve (both long- and short-end volatilities moving by the same amount proportionately), we compute a volatility duration, akin to a vega. The results are shown in Exhibit 6.

As Exhibit 6 illustrates, the durations are fairly diverse among REITs, with a few running significant rate exposures. In addition, these durations have trended shorter in the last quarter. This is interesting, because the underlying assets have generally extended. The shorter

EXHIBIT 6
Fixed-Income Risk Metrics Across Mortgage REITs

REIT	Period	Duration	Convexity	Basis Duration	Slope Duration	Volatility Duration
REIT A	2012-Q2	6.0	–2.7	32.8	–3.7	18.5
	2012-Q3	3.4	–4.3	35.3	–3.3	21.7
	2012-Q4	8.3	–4.2	37.0	–3.4	23.1
	2013-Q1	8.3	–4.5	42.7	–2.4	27.4
	2013-Q2	9.2	0.0	48.3	0.0	30.3
	2013-Q3	3.3	–1.2	49.8	0.4	25.4
REIT B	2012-Q2	4.3	–4.8	30.3	–7.7	16.5
	2012-Q3	0.5	–7.9	35.0	–14.2	24.2
	2012-Q4	11.9	–6.3	38.4	–7.9	26.6
	2013-Q1	15.1	–7.4	42.1	–7.4	31
	2013-Q2	19.4	–2.9	54.7	–1.8	33.8
	2013-Q3	16.7	–2.9	55.7	1.7	28.9
REIT C	2012-Q2	2.2	–0.6	29.0	–3.1	2.2
	2012-Q3	8.3	–1.5	30.5	–6.8	4.8
	2012-Q4	4.0	–1.0	31.1	–3.6	4.1
	2013-Q1	5.2	–1.1	33.1	–3.8	4.5
	2013-Q2	7.4	–1.1	33.9	–3.3	8.7
	2013-Q3	6.0	–1.2	34.0	–2.4	8.2
REIT D	2012-Q2	11.6	–2.1	27.4	–8.4	8.4
	2012-Q3	10.7	–3.1	26.3	–8.9	11.2
	2012-Q4	15.6	–4.3	33.3	–10.0	18.4
	2013-Q1	17.3	–4.6	35.7	–7.8	19.3
	2013-Q2	29.2	–1.5	43.5	–6.0	21.2
	2013-Q3	27.5	–1.2	52.0	–1.1	22.8
REIT E	2012-Q2	2.5	–1.2	17.5	–4.2	2.9
	2012-Q3	3.9	–2.2	22.5	–6.0	5.0
	2012-Q4	6.8	–2.5	24.7	–6.1	6.7
	2013-Q1	7.4	–2.4	24.7	–6.1	7.5
	2013-Q2	13.3	–2.1	29.9	–4.6	11.7
	2013-Q3	21.3	–2.7	41.0	–5.5	13.3
REIT F	2013-Q1	10.9	–6.9	32.0	–9.2	30.5
	2013-Q2	15.3	–3.9	34.9	–7.0	32.2
	2013-Q3	16.1	–3.7	40.0	–2.9	27.3
REIT G	2012-Q3	–3.6	–7.8	34.7	–14.1	33.4
	2012-Q4	12.3	–8.4	57.1	–13.6	35.2
	2013-Q1	6.6	–5.5	53.3	–13.0	40.1
	2013-Q2	5.6	0.9	53.0	–11.2	36.8
	2013-Q3	15.6	–2.3	57.7	–10.0	32.3

Source: Amerigo Capital Analytics. Slope duration is the duration to a 100bps shift in the spot forward curve slope. Volatility duration is relative to a 100bps move in implied volatility. Q3 2013 numbers are as of 8/15/13.

durations are a consequence of the REITs' strategy to reduce rate exposure as they integrated the tapering environment of early/mid 2013. The order of magnitude of the average duration shown in Exhibit 6 makes it comparable to a low-coupon pass-through, or to a long sequential, that is, a particularly long MBS.

Exhibit 7 shows the same risk measures as in Exhibit 6, but aggregated across all these REITs using book value as weight.

According to Exhibits 6 and 7, convexity on these mortgage REITs is rather concentrated, between –1 and –3. It is mostly affected by the REITs' hedging strategy (using swaptions in addition to swaps, or not), as well as by the nature of their assets (essentially hybrids versus fixed-rate mortgages (FRMs)). The magnitude of that negative convexity is generally not much worse than that of a straight current coupon MBS pass-through. Over time, convexity has trended down, mainly due to a trend toward more swaption-based hedging among REITs, as well as the back up in rates.

The slope exposure we measured on this selection of agency mortgage REITs has moved significantly

EXHIBIT 7
Aggregate Risk Measures

Period	Duration	Convexity	Basis Duration	Slope Duration	Volatility Duration
2013-Q1	10.2	−5.4	36.0	−6.5	26.2
2013-Q2	13.9	−2.1	41.0	−4.0	28.6
2013-Q3	12.5	−2.5	45.1	−1.6	24.8

Source: Amerigo Capital Analytics. Weighted by book value at beginning of period.

over time, recently trending lower, probably as the curve steepened and REITs learned to be wary of curve exposure. The book value curve exposure we measured is generally around six to eight years, which is fairly substantial, and more intense than what one would observe on any standard MBS.

By far the most significant exposure is basis risk. This is natural since it is essentially unhedgeable with swaps and swaptions. The overall risk profile of an agency mortgage REIT is, therefore, very unusual and cannot be mapped to any standard mortgage product: fairly long duration, moderate negative convexity, and heavily concentrated basis risk. If one had to pick an MBS that resembles such a combination of exposures, a principal-only (PO) would work to some extent: levered basis exposure, long duration.

The degree of exposure to OAS can also be seen with a regression of quarterly book value changes over changes in portfolio aggregate OAS: The R-square is 0.41, with a slope of 4% per 10 bps tightening.

Another very significant risk exposure is relative to volatility. Because of the leverage in these mortgage REITs, and in spite of a few swaptions being used as hedges, residual exposure to the implied volatility curve is a multiple (about eight times) of that of a typical MBS. The differences among REITs in exposure to implied volatility are more widespread than for the mortgage basis exposure. This is most likely due to the fact that some of these mortgage REITs hold ARMs, which are less sensitive to volatility than FRMs.

One interesting consequence of the typical REIT's profile is that it could be hedged with interest-only (IOs), to the expense of some additional negative convexity and volatility exposure. For example, a current coupon IO will have a negative duration, and substantial negative basis exposure. In addition, the positive slope duration that a typical IO would bring could potentially help smooth out the REIT's strongly negative curve exposure.

Companies that specialize in holding excess servicing rights, being long a lot of IOs, could hence theoretically act as hedges for the typical mortgage REIT. There are, however, two caveats to this notion: first, the equity market does not necessarily trade these servicing rights companies like one would trade IOs, and their empirical behavior might not match what one would expect; second, these companies have an evolving book of business and do not own a static pool; their future growth needs to be priced in.

Market-Implied Scenarios

Agency mortgage REIT stock prices are usually not close to the REIT's book values per share. This can be surprising given the liquid nature of these REITs' holdings. The discount or premium embedded in stock prices reflects a particular trust or distrust in management, as well as some anticipation of changes in market conditions. However, MBS and interest rate derivatives market already embed participants' expectations. Hence, one way of understanding the equity market premium or discount for REITs could be by recognizing they reflect different expectations from the fixed-income markets. Using the scenario analysis discussed earlier, we can quantify these expectations by computing the weight distribution, so that at a point in time the weighted average book value per share across scenarios matches the market price.

Exhibit 8 shows the weights across simple stress scenarios so that the weighted-average discounts to book value are as close to 1 as possible, for various observation periods. The implied scenarios we obtain do seem to capture the fears that were generally discussed in the market at these times: Some exposure to a rally in mid-2012 (which did take place toward the end of the year), and a progressive shift toward the impact of the Fed's taper, eventually including its effect on mortgage relative value. One could even read in this analysis a degree of prescience in the equity market, the broad issues being somewhat anticipated before they fully took place.

EXHIBIT 8

Market-Implied Probability Weights from Book Value Discounts

Period	Base-Case	Parallel Move Down 50bps	Steepener 50bps	OAS Wider 50bps
2012-Q2/2012-Q3	0.33	0.28	0.39	0.00
2012-Q4/2013-Q1	0.67	0.00	0.29	0.04
2013-Q2/2013-Q3	0.00	0.00	0.81	0.19

Source: Amerigo Capital Analytics.

PERFORMANCE ATTRIBUTION

Agency mortgage REIT stocks generally offer dividend yields relative to book value in the high single digits to low teens. With Libor essentially at zero, and 10-year Treasuries under 3%, such high yields should sound strange. The assets and liabilities of these REITs are among the most liquid products in the world, and as we have seen so far, the actual returns on equity of these REITs are largely predictable using a static portfolio, without any trading but some rebalancing on a quarterly basis.

The extra return generated by mortgage REITs is necessarily some form of compensation for particular risks being assumed. What are these individual risks? Based on the results discussed in the previous section, where we measured various risks taken on by mortgage REITs, we can establish the following list:

- Duration and curve exposure, which should lead to some compensation since agency mortgage REITs generally run a non-negligible amount of duration;
- Mortgage basis exposure, which brings OAS as an extra return;
- Negative convexity, or short-term realized volatility exposure;
- Vega, or implied-volatility exposure as well as implied versus long-term realized volatility exposure.

Duration and Curve Exposure

As was shown in Exhibit 7, the current aggregate curve shape exposure of the REITs we were looking at was fairly small (under two years in absolute value), but the overall duration exposure is substantial enough, around 12 years. Twelve years of duration in the swap market (or fairly equivalently in the agency bullet market) currently yields about 3%, so that should be the return contribution of that risk. Or, alternatively, it would cost about 3% in return to cancel out the risk brought by this exposure.

Mortgage Basis Exposure

Here we address the pure MBS exposure, net of optionality effects, which is properly captured by OAS. As discussed earlier, mortgage REITs run a massive amount of mortgage basis duration. How much extra return does that risk bring?

First, it helps to look at the average assets OAS observed on these REITs portfolios. Over the past three quarters, we find averages of 2, 5, and 14 bps (weighted by OAS duration). This does not sound like much, even though it has been widening. In terms of carry or return contribution, however, weighting by duration is not appropriate. We are not interested here in how much values would change if OAS changed, but rather in how much extra return there is over a period of time due to the fact that OASs are not zero. Hence, we calculated, for each core position, the OAS return contribution as the amount of OAS, times market value, relative to the total book value. We termed this the OAS contribution, and it factors in the amount of leverage inherent in the REITs' positions. For example, this captures the fact that the more levered REITs might also own the higher OAS bonds.

In aggregate, and over the past three quarters, we found a total OAS contribution of 0.65%, 0.67%, and 1.74%. The order of magnitude of the mortgage basis exposure contribution to REIT performance is therefore around 1%.

Convexity Exposure

Mortgage REITs carry a reasonable amount of negative convexity, at −2.5, but it is not that large factoring the leverage they have, or relative to the duration exposure. The implied volatility on 6m × 10y swaptions has averaged around 80 bps over the past two years (it has ramped up, now around 100 bps). One way to price

the extra return of negative convexity is to estimate what it costs to buy it back. Over a quarter, the short-term swaption implied volatility is approximately 40 bps. The contribution of a convexity C to a price change, for a yield change of y expressed in percentage, is (C y^2), so in our case we obtain 0.4%, over a quarter. Annualized, it amounts to 1.6%.

This return represents compensation for very near term rate volatility exposure.

Vega Exposure

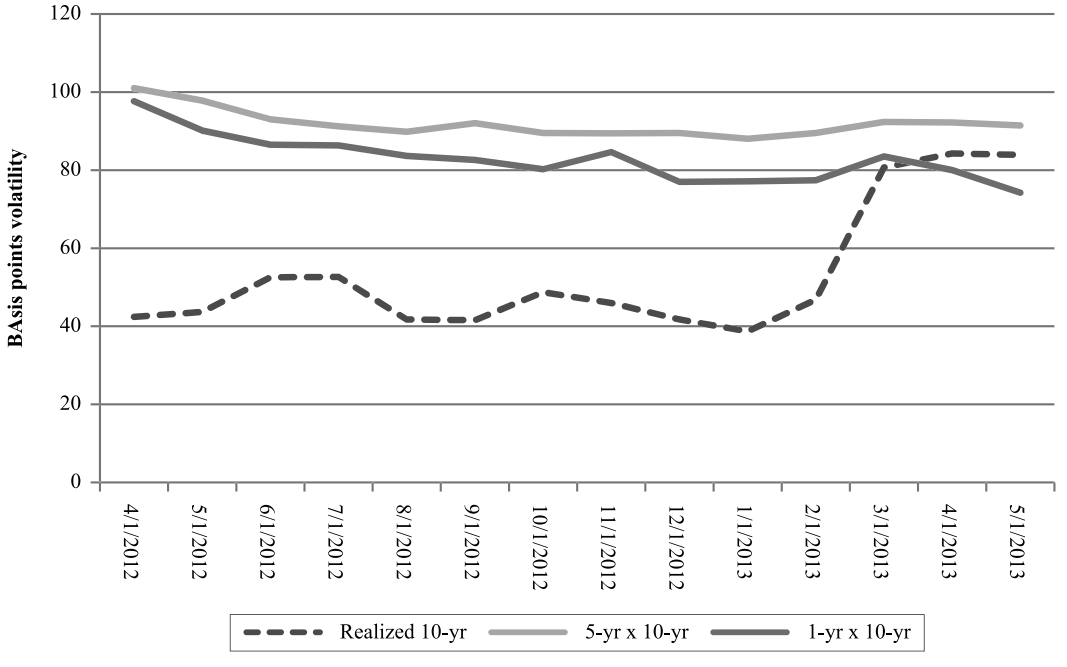
Because of the sizable amount of embedded options that an MBS is short, a levered position in MBS naturally carries a large implied volatility exposure.

It is important to note that while vega and gamma exposure are related, they are not necessarily perfectly linked. One can have a substantial implied volatility exposure without being directly exposed to changes in the rate levels (make or lose money depending on implied volatility changes, for example with a delta-neutral position long/short at-the-money swaption straddles with different maturities). Or one can have substantial convexity (or gamma) exposure, with a very low implied volatility exposure (for example, with short-term swaptions with minimal implied volatility exposure).

The volatility exposure embedded in a REIT is effectively a play on how much one makes selling longer-term options, versus how much they actually cost over time through realized volatility. There has been a fair amount of research on the volatility risk premium. See, for example, Rennison and Pedersen [2012] for an overview across all global markets, and Fornari [2008] for a study specific to the swaption market. In summary, the research shows that one generally gets paid by the market to sell options, or alternatively that implied volatilities are chronically higher than realized volatilities, as well as future volatility predictions that would come from the statistical study of past returns.

Exhibit 9 shows the recent evolution of the realized volatility on 10-year swaps, for a 7-month time

EXHIBIT 9
Historical Realized and Implied Volatility on 10-Year Swap Rates



Source: FRED, Amerigo Capital Analytics.

EXHIBIT 10
Summary of REIT Return Contributors

Sector of Exposure	Book Value Risk Metric	Current Leverage	Typical Contribution Range	Approx. Recent Contribution
Yield curve	Duration	12	2–5%	3.0%
Mortgage basis	OAS Duration	45	0.5–2%	1.0%
Near-term realized volatility	Convexity	–2.5	1–3%	1.5%
Implied volatility vs. long-term realized volatility	Vega/Implied-volatility duration	30	0–4%	3.0%
Total	–	–	3.5–14%	8.5%

Note: The typical contribution range reflects reasonable levels for the risk factor but assumes the leverage to these risk factors would remain the same.

frame straddling the observation time, compared with long-term implied volatilities. We can see how realized volatility ramped up, while it had remained quite lower than implied for some time.

Over 2012 and part of 2013, implied volatility on 10-year swap rates was twice realized volatility, with a spread between the two in the 40–60 bps range. For a strategy that relies on selling options, this is quite significant. How can we estimate the extra return that REITs were able to get thanks to their volatility exposure? We do this in two steps:

1. Take the implied volatility duration we have calculated for each REIT, at each point in time, times the assumed implied/realized spread, for example 60 bps if we want to capture the return contribution at a time when that spread was attractive. The result is the overall contribution one would have over the entire life of the REIT's asset/liability portfolio.
2. To convert the overall contribution into an annualized one, we divide it by the assets' OAS duration. This way we capture the time span over which the cash flows are distributed.

We calculated this extra return at the aggregate level across our sample REITs, and obtained an annualized return contribution around 3%, for a 60-bps implied/realized volatility spread. We find total contributions of 3.2%, 3.4%, and 2.4%, respectively, for the first three quarters of 2013. There are substantial variations among REITs in terms of volatility exposure, which translates into large variations in volatility-derived returns.

Overall Attribution

Exhibit 10 summarizes our analysis of REITs' performance. We listed the various types of exposure we have identified on agency mortgage REITs, the risk metric they correspond to, the current amount of gearing they have to these exposures, the typical range of contribution from these factors, and recent approximate contribution from these factors on the REITs we have tracked.

From Exhibit 10, we can infer some stylized facts regarding the REITs' large returns:

- Agency mortgage REITs are not a play on the shape of the curve. While equity research often tends to characterize mortgage REITs as a play on steepened curve (lend high, borrow low), this is generally not the case.
- The residual duration taken on by REITs brings a sizable share of overall returns. However, there is substantial diversity among REITs in terms of duration exposure.
- Negative convexity risk on aggregate is not a large contributor to performance. REITs are not largely exposed to the usually large volatility risk premium embedded in very short-term swaptions.
- The volatility risk premium is a major contributor to mortgage REITs' returns. As such, the economics of mortgage REITs are very dependent on implied and realized volatility.
- The fact that the REITs' holdings are mortgages, as opposed to being long bonds and short vega/gamma, does not matter very much relative to the other risks taken on by the REITs. Gamma or vega-related returns are one order of magnitude

more important than basis-related returns. Naturally, a corporation trading only swaptions would not qualify as a REIT and could not tap the equity market as directly as a properly set up mortgage REIT can.

We can draw some inferences regarding the resilience of REITs' large returns. If they keep approximately the same type of exposure, then a reversion of the implied/realized volatility spread should take away an important part of the REITs' returns. With a higher interest rate environment, on the other hand, returns could benefit, but that would likely not be a sufficient compensation.

CONCLUSION

In this study, we discussed our valuation and analysis approach for agency mortgage REITs, which is deeply grounded in fixed-income modeling. We showed how certain techniques specific to bonds and derivatives markets could be applied to mortgage REITs, in particular for risk analysis. This allowed us to shed some light on the sources of agency mortgage REIT performance.

Future research on this subject could address a more precise modeling of mortgage REIT equity issuance and buy-back strategy and its effect on performance. Another important area for further study is the inclusion of non-agency assets, potentially applying credit OAS models on these products, following the logic discussed in Levin and Davidson [2008].

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