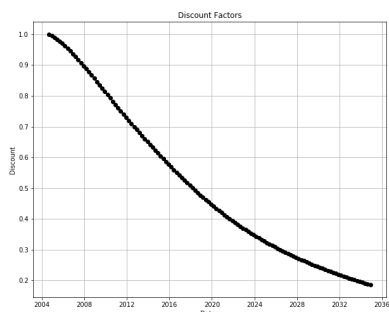
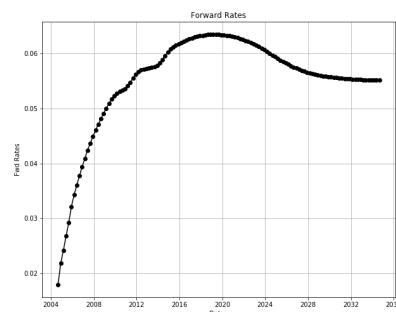


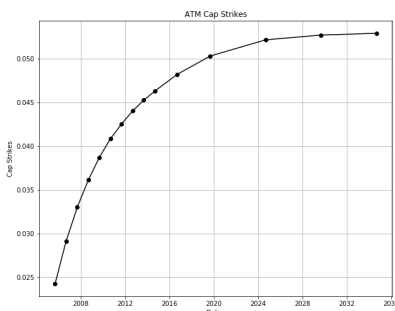
1 Hull-White (HW) Model



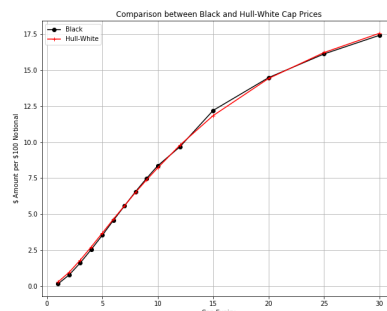
(a) Discount Factors



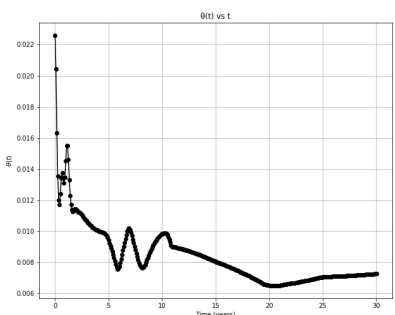
(b) Forward Rates



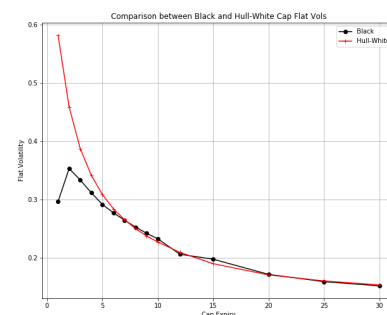
(c) ATM Cap Strikes



(d) Comparison of Models



(e) $\theta(t)$



(f) Flat Vol implied by HW

We have provided a few of the values of $\theta(t)$ in the table below. For the entire table, please refer to theta.csv submitted. Since we've ignored leap years, the time in years jumps after every 4th year.

Time (years)	$\theta(t)$	Time (years)	$\theta(t)$	Time (years)	$\theta(t)$
1	0.01454	6.00274	0.00774	12.00822	0.00883
2	0.01139	7.00274	0.01011	15.00822	0.00805
3	0.01062	8.00548	0.00774	20.0137	0.00653
4.00274	0.01004	9.00548	0.00888	25.01644	0.00706
5.00274	0.00943	10.00548	0.00983	30.01918	0.00727

The flat volatility implied by the Hull-White model differs from the Black model considerably at the start because

we have minimized the sum of squared errors while calibrating. Since the cap prices for lower maturities are lower, the error in relative terms becomes very high which drives the deviation in volatility (which is a normalized measure). Since the σ parameter in hull-white model is not time-varying, we do not have the flexibility to fit option prices and vols exactly.

2 Pricing REMIC Bonds

- (a) The prices of nine bonds(including residual), standard errors, effective durations, convexities and implied OAS are showed as below.

Bond	Prices (\$)	STE (\$)	Effective Duration	Convexity	OAS
CG	78,018,498	1170	2.15	0.07	0.0179
VE	5,404,639	54	1.85	0.04	0.0193
CM	14,743,807	911	3.79	0.40	0.0115
GZ	23,076,574	3417	5.07	1.49	0.0071
TC	20,719,881	4311	5.10	1.79	0.0051
CZ	23,473,424	15738	7.78	5.26	-0.0015
CA	34,007,175	1794	3.02	0.47	0.0121
CY	14,072,902	5430	5.89	3.14	0.0011
R	420,232	224	-9.26	-5.44	

- (b) It's interesting to note that OAS seems to be inversely related to duration. In particular, the CZ bond has a negative OAS. This is because the current forward rates increase with maturity, rising above the 5% coupon. Hence, bonds with back loaded cash flows (longer Macaulay Duration) will have lower OAS.
- (c) The OAS is typically interpreted as compensation for uncertain cash flows. For example: The OAS of a callable corporate bond should remove the value of the short call option from the Z-spread. A positive value would be compensation for credit, liquidity, and idiosyncratic risk. However, for our FRMC REMIC, there is no credit risk. We also do not remove the option value (prepayment). Hence, we should interpret the OAS value largely to represent compensation for prepayment risk, with perhaps a little bit of liquidity and idiosyncratic risk.