Playing the Mortgage Game Like a Professional

www.kalotay.com/calculators

January 24, 2007
The Size of the Mortgage Market

Home mortgages
- $10 trillion outstanding
- $2.5 trillion originated in 2006

Mortgage-backed Securities (MBS)
- $6 trillion total outstanding
- Of which $4 trillion are Fannie, Freddie and Ginnie

($4.5 trillion US Treasury securities outstanding)
Engaged to value MBS
  MBS are collateralized by mortgage pools
  Need a prepayment model

Current “econometric” prepayment models are based on history
  They lack “borrower intelligence” and intuition
  Unending flow of “new and improved” models

Proposed alternative: a true option-based model
  Based on “optimal refinancing”
  “Optimal” provides a benchmark for sub-optimal behavior (“leapers” and “laggards”)
Conventional Mortgages

Offered in standardized structures

We’ll focus on 30-year fixed rate mortgages
Borrower can reduce rate by paying points
Or accept a higher rate and not pay transaction costs

Prepayable at any time
Rate reflects an implicit charge for this option
Refinancing entails transaction costs

Personal income taxes are important
Interest payments and discount points are deductible
Closing costs are not
Decisions Faced by Borrowers

Which mortgage to choose?

  From menu of similar structures with different interest rates and upfront points

Refinance or wait?

  Refinancing incurs transaction costs
  Waiting involves paying above-market rates

Fixed? ARMs? Hybrid ARMs? Interest only?

  Or a combination under a single contract!

Is it better to pay down mortgage or invest?

  Say in tax-exempt bonds
Which mortgage to choose?

The one with the lowest Annual Percentage Rate (the IRR of the cashflows) over the borrowing horizon

*But if rates decline, mortgage may be refinanced*

Refinance or wait?

Refinance if current rate is at least 50 bps below outstanding rate

*But transaction costs of repeated refinancings add up*
Mortgages are in the domain of housing economics

Economists tend to focus on the big picture

But the required analytical tools are in fixed income

Option Adjusted Spread technology has been around since 1986

OAS is a surrogate credit spread

Essential for valuing bonds with options
Modeling of Mortgage

Treat as a callable amortizing bond

Assume principal balance is paid off at horizon

Represent call prices as remaining principal plus anticipated transaction cost

  e.g. 1% of remaining principal

Ensure that tax treatment conforms to IRS regulations
Choose a benchmark yield curve

- Such as Treasuries or swap curve
- Use a volatility consistent with swaption vols

Find (horizon-adjusted) OAS of new mortgage relative to benchmark curve

- To a borrower with a short horizon, a 30-year FRM seems expensive relative to hybrid ARMs
## New 30-Year Mortgages

### 30-year Horizon

<table>
<thead>
<tr>
<th>Rate (%)</th>
<th>Points (%)</th>
<th>APR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.00</td>
<td>0.0</td>
<td>6.00</td>
</tr>
<tr>
<td>5.75</td>
<td>0.5</td>
<td>5.80</td>
</tr>
<tr>
<td>5.50</td>
<td>2.0</td>
<td>5.68</td>
</tr>
</tbody>
</table>
Mortgage Selection: Calibration
30 year horizon, 1% refinancing cost

Benchmark Curve as of August 14, 2005
Interest Rate Volatility 15%

<table>
<thead>
<tr>
<th>30-Yr Fixed Rate (%)</th>
<th>Points (%)</th>
<th>OAS (bps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.00</td>
<td>0.0</td>
<td>102.8</td>
</tr>
<tr>
<td>5.75</td>
<td>0.5</td>
<td>89.8</td>
</tr>
<tr>
<td>5.50</td>
<td>2.0</td>
<td>96.7</td>
</tr>
</tbody>
</table>
# Mortgage Selection: Option-Adjusted APR

<table>
<thead>
<tr>
<th>30-Yr Rate and Points (%)</th>
<th>Option Value (% par)*</th>
<th>Proceeds + Option Value (% par)</th>
<th>Option-adjusted APR*</th>
<th>Conventional APR</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.00 (0.0)</td>
<td>9.106</td>
<td>109.106</td>
<td>5.206</td>
<td>6.000</td>
</tr>
<tr>
<td>5.75 (0.5)</td>
<td>7.231</td>
<td>106.731</td>
<td>5.162</td>
<td>5.800</td>
</tr>
<tr>
<td>5.50 (2.0)</td>
<td>5.631</td>
<td>103.631</td>
<td>5.180</td>
<td>5.680</td>
</tr>
</tbody>
</table>

*Based on OAS of mortgage with par proceeds (102.8 bps)
## Mortgage Selection: Taxable Equivalent Option-Adjusted APR

<table>
<thead>
<tr>
<th>30-Yr Rate and Points (%)</th>
<th>Option Value (% par)*</th>
<th>Proceeds* + Option Value* (% par)</th>
<th>Taxable Equivalent Option-Adjusted APR</th>
<th>Conventional APR</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.00 (0.0)</td>
<td>7.864</td>
<td>107.864</td>
<td>5.150</td>
<td>6.000</td>
</tr>
<tr>
<td>5.75 (0.5)</td>
<td>6.420</td>
<td>106.095</td>
<td>5.095</td>
<td>5.800</td>
</tr>
<tr>
<td>5.50 (2.0)</td>
<td>5.170</td>
<td>103.870</td>
<td>5.100</td>
<td>5.680</td>
</tr>
</tbody>
</table>

*After-tax values; tax rate 35%
Optimum Refinancing

Yardstick: refinancing efficiency

Act only if value received is “adequate”

Value consists of:

Cashflow savings

Refinancing option of new mortgage
The Right Tool Is
Generalized Refunding Efficiency

\[ \text{Efficiency}_{gen} = \frac{PV \text{ Savings}}{\Delta \text{Option Value}} \]
**Refinance or Wait?**

**Should I Refinance?**

<table>
<thead>
<tr>
<th>CURRENT MORTGAGE</th>
<th>NEW MORTGAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years left:</td>
<td>26</td>
</tr>
<tr>
<td>Interest rate (%):</td>
<td>6.000</td>
</tr>
<tr>
<td>Remaining principal ($):</td>
<td>100,000</td>
</tr>
<tr>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Interest rate (%):</td>
<td>5.600</td>
</tr>
<tr>
<td>Discount points (%):</td>
<td>1.000</td>
</tr>
<tr>
<td>Upfront costs (legal fees, etc.) ($):</td>
<td>1,500</td>
</tr>
<tr>
<td>New principal ($):</td>
<td>102,525</td>
</tr>
</tbody>
</table>

**And The Answer Is...**

<table>
<thead>
<tr>
<th>CASH FLOWS</th>
<th>RECOMMENDATION</th>
</tr>
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<tbody>
<tr>
<td>Current monthly payment ($):</td>
<td>634</td>
</tr>
<tr>
<td>New monthly payment ($):</td>
<td>588</td>
</tr>
<tr>
<td>Savings per month ($):</td>
<td>46</td>
</tr>
<tr>
<td>Principal remaining after 26 years ($):</td>
<td>25,259</td>
</tr>
<tr>
<td>Loss of option value (in today's $):</td>
<td>2,029</td>
</tr>
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</table>

Analysis as of 09/07/2005 11:02:14 10-Yr Treasury at 4.131%

**Kalotay Refi Score**
100% best. Refinancing not recommended below 90%.

**Not Yet!**

See www.kalotay.com/calculators
## What's Under the Hood?

### Should I Refinance?

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### Refinance Now?

**U.S. Treasury Rates**

- Analysis Date: 09/07/2005
- Short-rate Vol.: 16.0
- Mean Rev.: 0.0

<table>
<thead>
<tr>
<th>Rate</th>
<th>3-mth</th>
<th>6-mth</th>
<th>1-yr</th>
<th>2-yr</th>
<th>3-yr</th>
<th>4-yr</th>
<th>5-yr</th>
<th>7-yr</th>
<th>10-yr</th>
<th>15-yr</th>
<th>20-yr</th>
<th>30-yr</th>
</tr>
</thead>
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### And The Answer Is...

**CASH FLOWS**

- Current monthly payment ($): 634
- New monthly payment ($): 570
- Savings per month ($): 64
- Principal remaining after 26 years ($): 24,577

**RECOMMENDATION**

- Total savings (in today’s $): 4,865
- Loss of option value (in today’s $): 4,849
- Kalotay Refi Score: 99.7%

**Analysis as of 09/07/2005 11:02:14 10-Yr Treasury at 4.131%**

**Go For It!**
Transaction Costs Reduce Efficiency

![Graph showing the relationship between Old Rate - Refi Rate (bps) and Refinancing Efficiency (%). The graph includes lines for 1% Cost, 2% Cost, and 95% Efficiency. The x-axis represents the Old Rate - Refi Rate in Basis Points (bps), ranging from 70 to 20, while the y-axis represents Refinancing Efficiency (%) from 105 to 65.]
Efficiency Declines As Interest Rate Volatility Increases

Refinancing Efficiency (%)

- 6% 30-year Outstanding Mortgage

Old Rate - Refi Rate (bps)

- 10%
- 16%
- 30%
- 95% Efficiency Threshold
Approach Applicable to Modeling MBS Prepayments

Classify refinancing tendency of mortgagors

Define leapers and laggards (relative to “financial engineers”)

Assign distribution across “leaper-laggard” spectrum

Approach provides insights lacking in conventional models, and with fewer knobs

E.g., transaction cost impedes refinancing and thereby increases MBS value
How Is MBS Value Affected by Mortgage Refinancing Costs?

![Graph showing the difference in MBS value (% par) vs. MBS coupon with different transaction cost scenarios.]

- **Base Case:** Transaction Cost: 1% of Principal
- **Transaction Cost 2%**
- **Transaction Cost 0%**

The graph illustrates the impact of different transaction costs on the MBS value. The x-axis represents the MBS coupon rate, while the y-axis shows the difference in value (% par). The graph has two lines: one for Transaction Cost 2% and another for Transaction Cost 0%. The base case is marked as 1% of Principal.
Summary

OAS technology can help the masses to manage their mortgages like fixed income professionals

Applicable to all types of mortgages, including ARMs

Can incorporate borrower-specific considerations

Horizon

Personal income taxes

Transaction costs

Approach applicable to MBS modeling

As in AKA’s CLEAN™*

*Coupled Lattice Efficiency ANalysis
“Optimum Bond Calling and Refunding”, W. M. Boyce and Andrew J. Kalotay, Interfaces (November 1979)


“Optimum Refinancing: Bringing Professional Discipline to Household Finance”, Andrew Kalotay, Deane Yang, and Frank Fabozzi, working paper

“A Pointer on Points,” Andrew Kalotay and Jinghua Qian, forthcoming in OR/MS Today

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