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Exposing MBS Model Risk: Look *Outside* the Black Box



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Toronto

Heard It Through The Grapevine

"The actual sensitivity of MSR's to implied volatility is complex and somewhat controversial"

Ben Golub in "Mark-to-Market Methodology, Mortgage Servicing Rights, and Hedging Effectiveness"

"The model we use doesn't even get the sign right for volatility hedging of MSR's"

A/L management advisor

"The price response to skew adjustment seems exaggerated"

Hedge fund manager

Why do intuition and model disagree when it comes to volatility?

Uses of Fixed Income Analytics

Pricing: determine fair value given prevailing environment

Yield curve, interest rate volatility, etc.

Market risk: determine change in value given change in environment

Shift yield curve, increase volatility

Are models consistent across asset classes?

Valuation of Fixed Income Securities

1. Generate probabilistic yield curve scenarios

Based on a standard process, such as BDT, HJM, Black-Karasinski, Hull and White

Represented as a lattice

2. Determine cashflows for each scenario

May entail option exercise (call or put)

Focus of this talk

3. Calculate present value of cashflows for each scenario

Discount at the scenario-dependent rates

4. Obtain price/value by averaging over scenarios

How to Quantify Market Risk Given Price

1. Calculate security's OAS (option-adjusted spread) under current environment
2. Freeze OAS
3. Determine ΔP for specified change of the environment

***Risk Managers Must Be Aware of
Sensitivity of ΔP to Choice of Model***

Option Exercise Rules Are Standard for Callable Bonds and Cancelable Swaps

Call bond when exercise price is less than cost of
leaving the bond outstanding

Compare savings to loss of option value

Greater option value \Rightarrow willing to wait longer

Results from different systems should agree

Demonstrated below

But this is not the case for MBS!

Different systems use different prepayment models

So cashflows and value also vary

How to tell a good model from a bad one?

Today's Topics

When analytics are standardized, model risk is insignificant

The computer protects you even if your intuition fails
Demonstrated for callable bonds

Mortgages are callable bonds

So they can be 'managed' accordingly
But not everybody is a "financial engineer"

MBS prepayment models

Credibility test: Sensible response to interest rate volatility

How Does the Expected Life of a Callable Bond Change When Rates Rise?

Lengthens

Because bond is less likely to be called

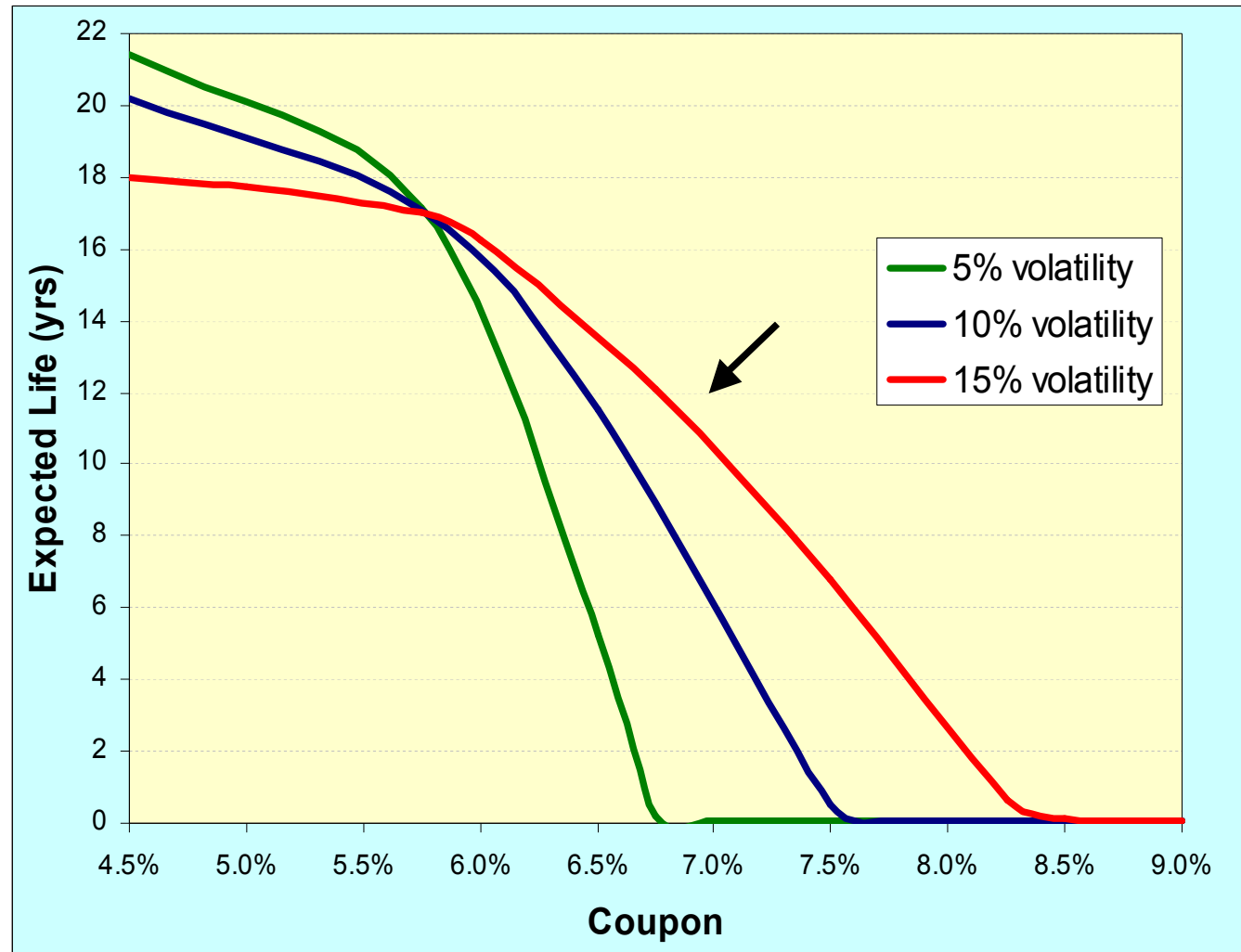
How Does the Expected Life of a Callable Bond Change When Volatility Increases?

Depends on the coupon

Low coupon: more opportunities to refund economically shortens expected life

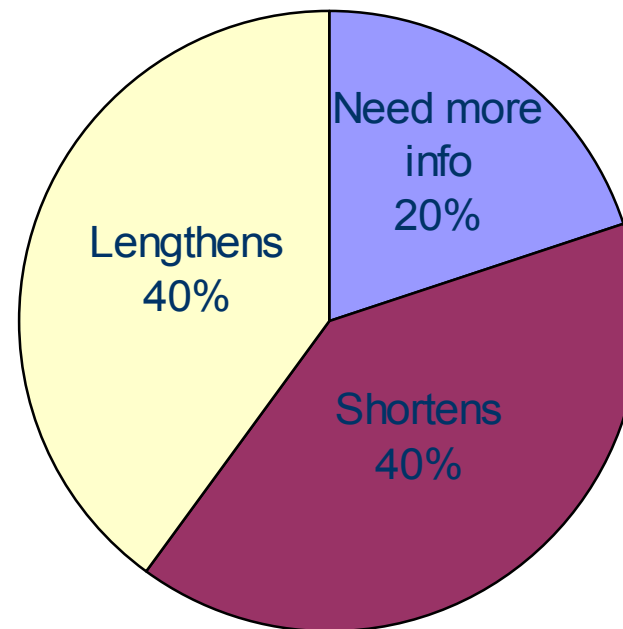
High coupon: greater time value of option reduces incentive to refund and therefore lengthens life!

Volatility Extends Expected Life of High Coupon 30-Year Callable Bonds



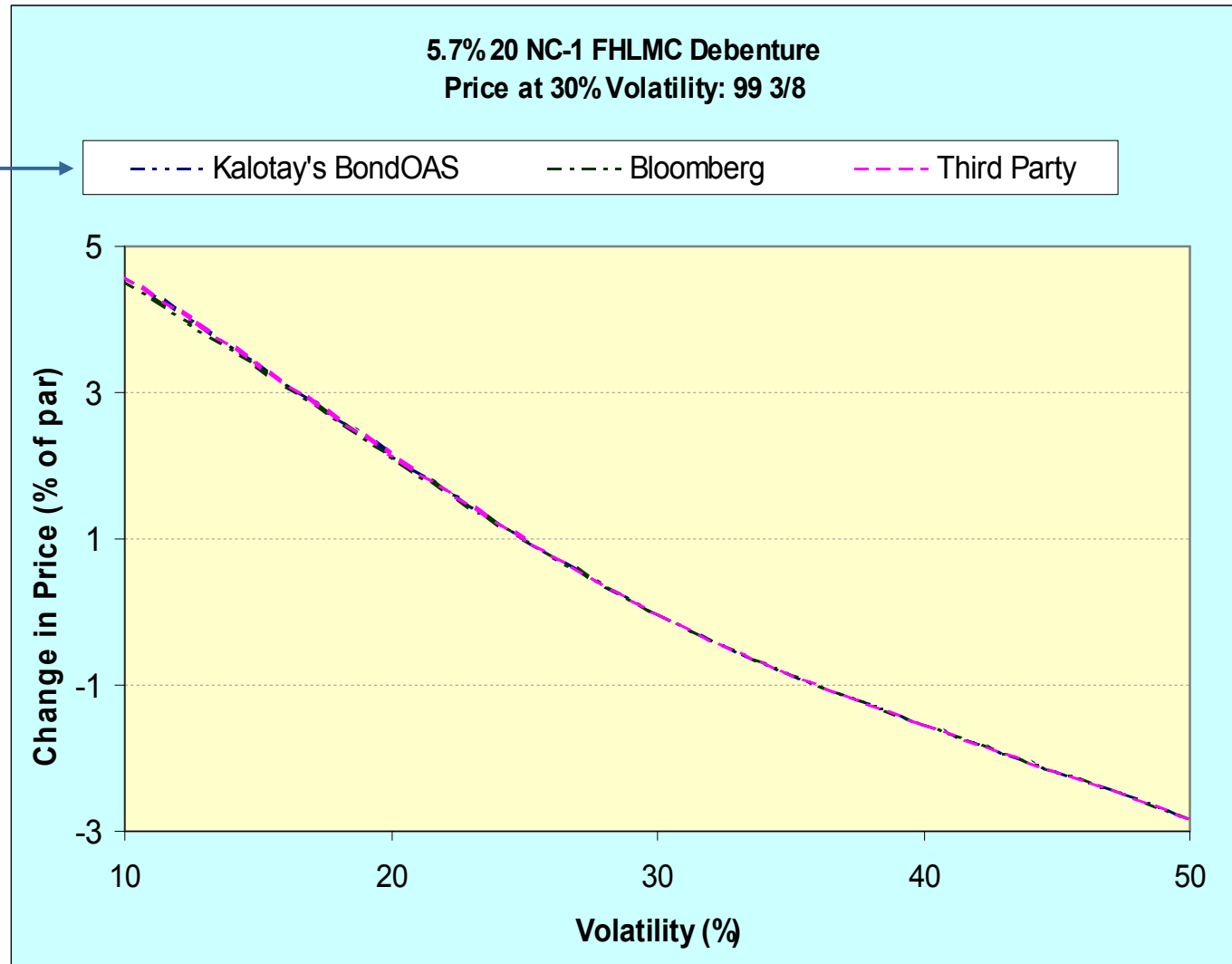
Even Bond Experts Are Confused *Survey Results*

“How does increasing volatility affect the expected life of high-coupon callable bonds?”



But For Callable Bonds Every Model Gives the Same ΔP

*All using
lognormal interest
rate process; zero
mean reversion



Fixed Coupon Agency MBS

Issued by Fannie Mae or Freddie Mac

The vast majority

Collateral consists of conforming prime fixed coupon mortgages

30-year and 15-year maturities

Excludes jumbos

Default risk is moderate

Dominant risk is refinancing

Recommendation For Prepayment Modeling: Use Bottom-Up Approach

*Understand Mortgages;
MBS Valuation Will Follow Naturally*

Observations on Prepayment Modeling

The goal is an effective *valuation* model

Modeling prepayments is only a means to an end

Need to understand refinancing dynamics

For an effective dynamic hedging strategy

A mortgage is a callable amortizing bond

Mortgage prepayment model should be consistent with bond refunding model

Bonds are called when 'efficiency' reaches 100%

$$\text{Efficiency} = \frac{PV \text{ Savings}}{\text{Option Value}}$$

When Should a Mortgage be Refinanced?

New rate should be lower than old one

But how much lower?

Current rule of thumb: when you save 50 bps

Does this make sense?

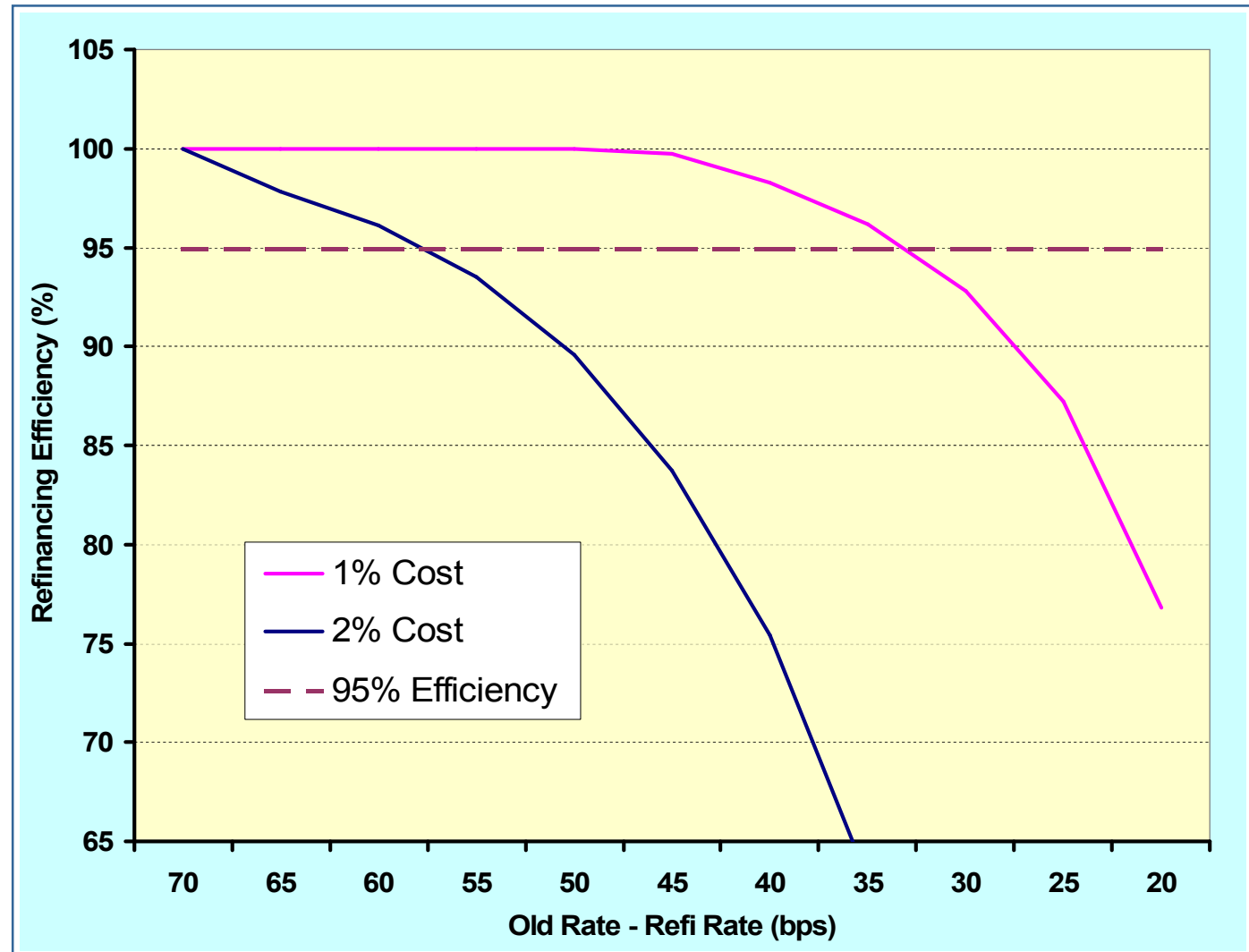
A Financial Analysis of Consumer Mortgage Decisions

Andrew J. Kalotay and Qi Fu



Patented option-based Mortgage Refinancing Calculator
at www.kalotay.com/calculators

Call Efficiency Applied to Mortgages: Refi If You Can Save 40 to 70 bps



Call Efficiency Implemented in CLEAN™ Prepayment Model

Use a deterministic assumption for turnover rate

As in other models

Mortgagors should refinance like ‘financial engineers’

When efficiency reaches 100%

But most mortgagors are not FEs!

Assign ‘laggard’ factors to those who wait too long

Roughly 10 buckets

Mortgagors refi in inverse order of laggardness

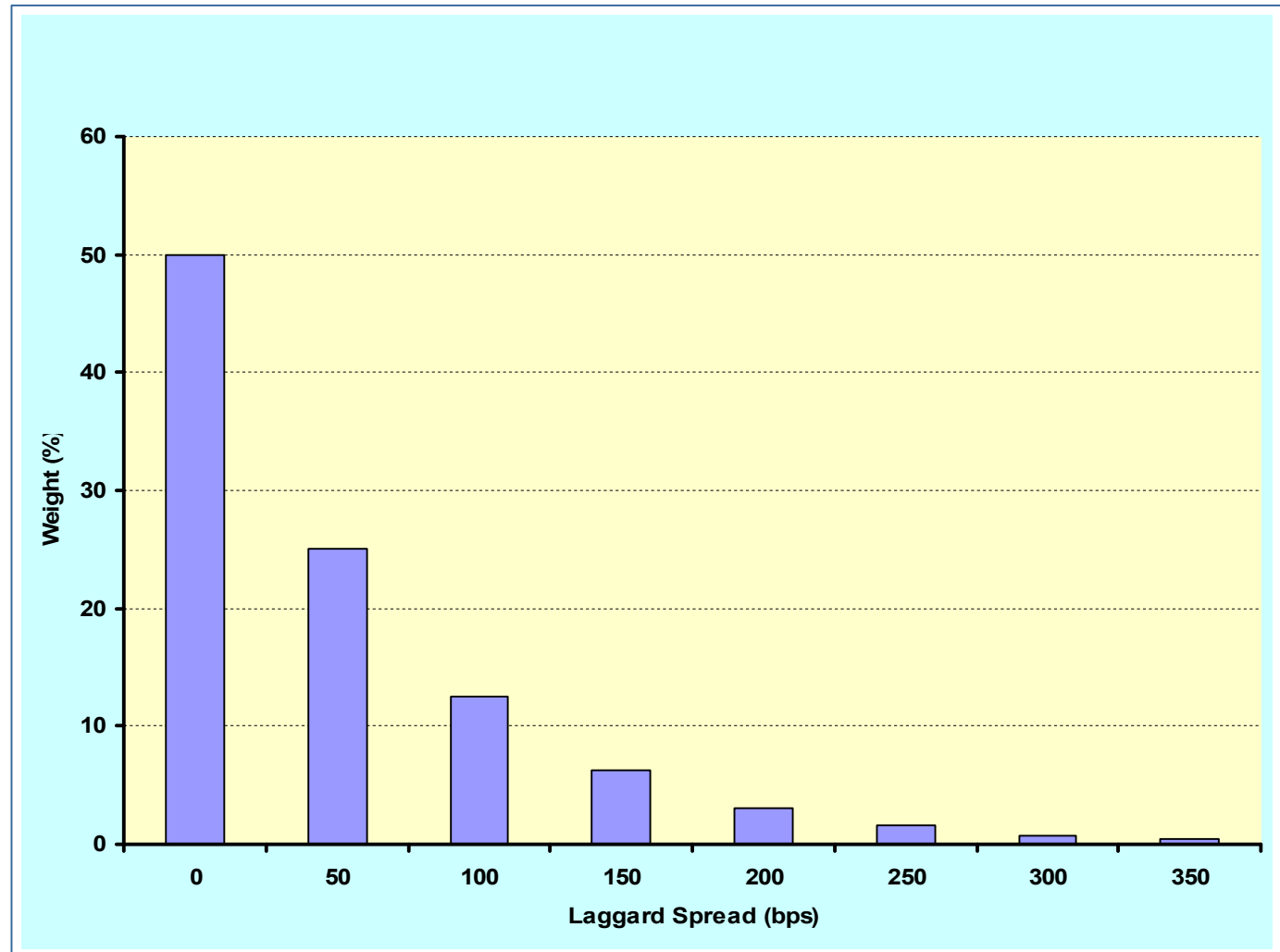
Automatically accounts for ‘burnout’

Assign weights to the laggardness buckets

Calibrate to market prices

Generic Laggard Distribution

A 100 bps laggard refs when a “financial engineer” refs a mortgage with a 100 bps lower coupon



MBS Valuation Using CLEAN™

Mortgage rates and MBS rates are modeled as a coupled lattice

Each lattice has its own option-adjusted spread relative to LIBOR swap curve

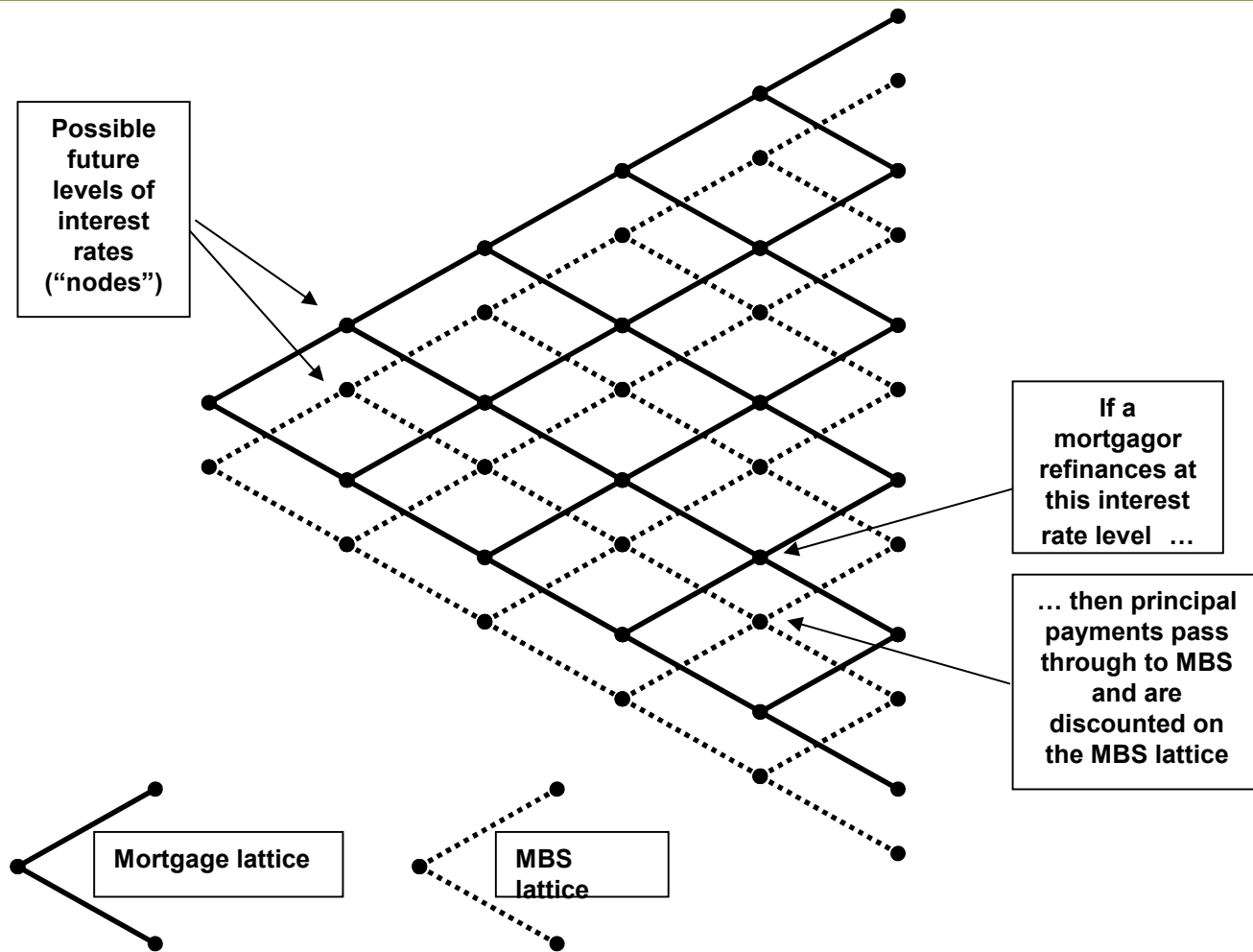
For risk management MBS OAS is backed out of initial price

Mortgage rates determine refis

Using notion of refunding efficiency

MBS cashflows (coupon and principal) discounted on MBS lattice

Mortgage-MBS Coupled Lattice



JPMorgan Report (2003): “It’s All About Economics”

...prepayment models have strayed away from economics and have increasingly relied on the fitting of data with complicated *ad hoc* parameterizations...

...prepayment behavior of large pools can be explained ... through ***economic incentive*** ...

How to Increase Refinancing Speed Via Economic Incentives

Reduce mortgagor's OAS

Lowers current borrowing rate

Say from 125 bps to 90 bps

Reduce transaction cost

Lowers all-in borrowing cost

Reduce laggard spacing

Increases refinancing efficiency

Case Study

New 4.5% MBS, Priced at 101 2/32

Interest rate environment as of 2/2/2010

Swap rates: 10-year 3.756%, 30-year 4.445%

Volatility: 30%

Mortgagors' credit

96 bps OAS to swap curve

Expected turnover rate

6% per year

Refinancing risk

Standard laggard distribution

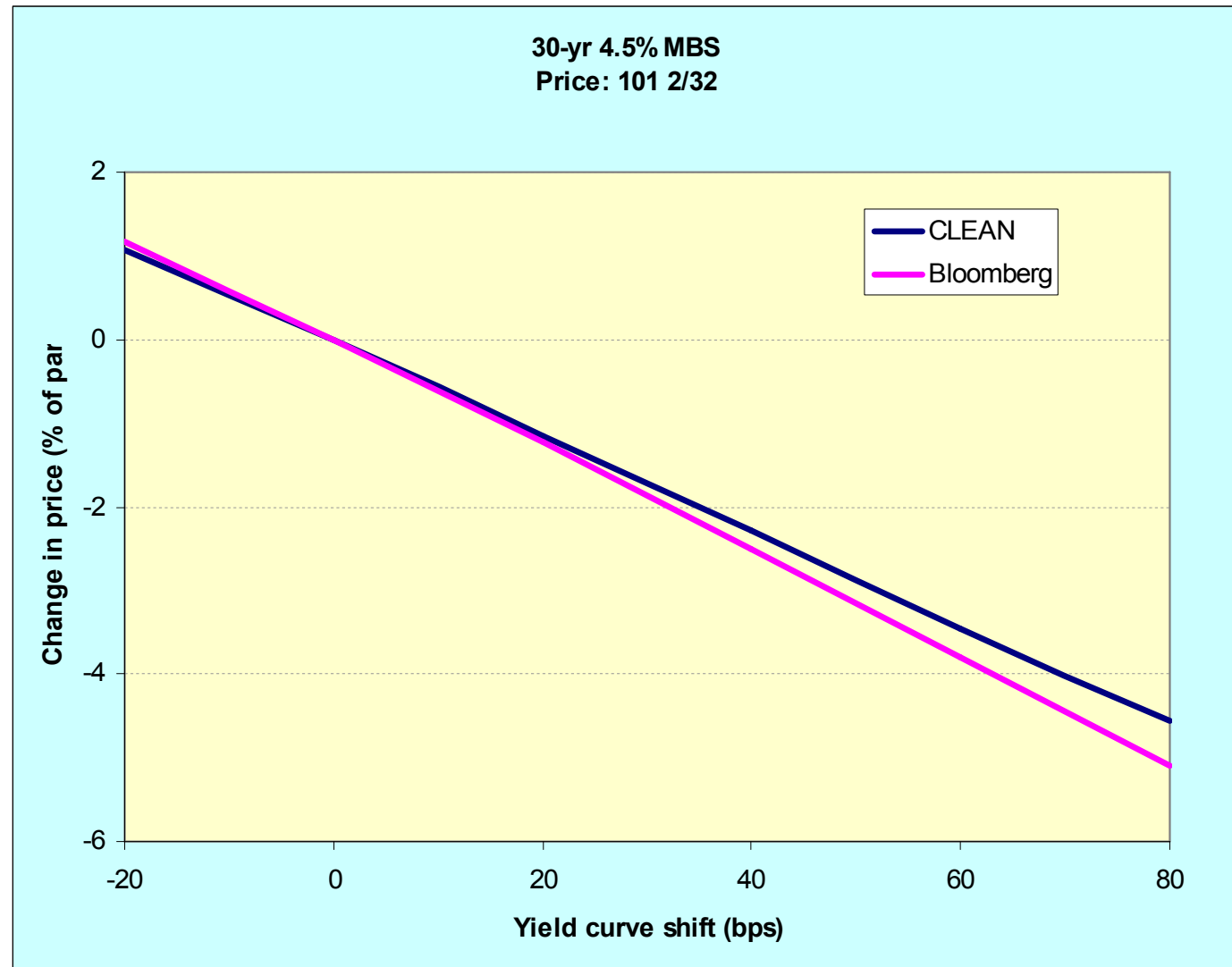
Transaction cost

1% of principal

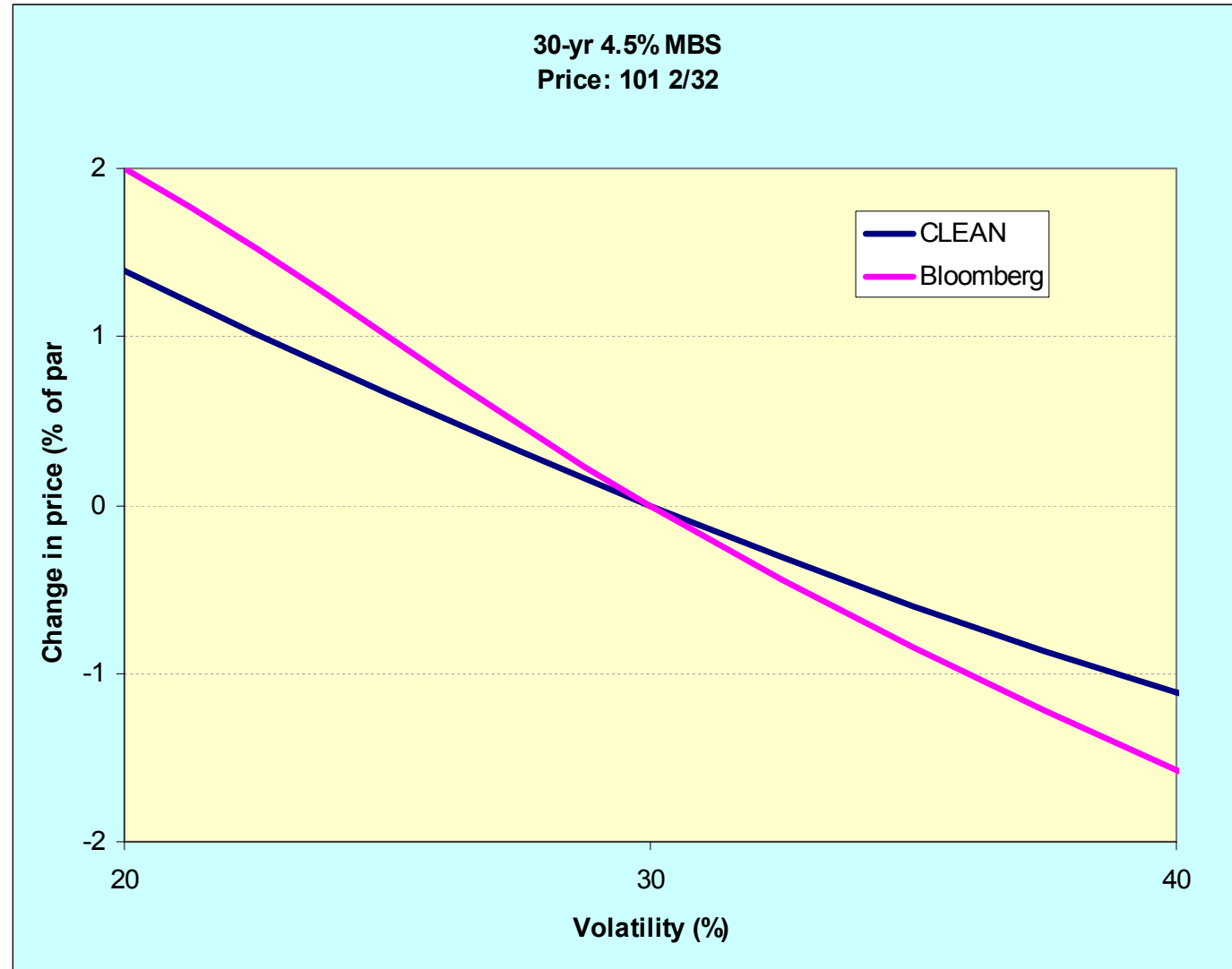
MBS OAS solves to 8 bps

Freeze this OAS for 'what-ifs'

Sensitivity of ΔP to Shift in Yield Curve Varies Little Across Models



Traditional Prepayment Model Exaggerates Sensitivity of ΔP to Change in Volatility



Why Traditional Prepayment Models Cannot Cope With Interest Rate Volatility

Refinancing speed depends on current mtg. rate

Lower current rate → More refis

Current rate is a function of benchmark yield curve
and a *spread that includes a charge for refi option*

Higher volatility → Wider spread

Mortgage rate specified by TPM's depend on
benchmark curve, but not on volatility

TPM's underestimate the effect of higher volatility on
future mortgage rates

→ 'Near-the-money' mortgages refinance too soon

→ Duration *shortens*, instead of lengthening!

Traditional Prepayment Models: What Went Wrong?

Rickety foundation

Refi was an afterthought

Never-ending patches

Also known as 'enhancements'

Including attempts to incorporate volatility

In response to demand for sensible answers

Lack of transparency

Parameters not based on economic incentives

... and a fundamental inconsistency between MBS and the rest of fixed income

Rigorous option-based prepayment model is the only
reasonable alternative

Benefits of an Option-Based Approach

Sensible results with fewer knobs to turn

- Realistic response to 'risk-management' scenarios
- Model dampens effect of volatility

Calibration is straightforward and intuitive

- Parameters correspond to economic incentives

Amenable to recursive valuation

- 14,000 securities per minute
- Orders of magnitude faster than Monte Carlo

Private Label MBS and Whole Loans

Need to specify default rates and recovery value

Analytically straightforward

Effect of potential defaults becomes the dominant consideration in valuation and risk analysis

Model Selection for MBS Analysis

Understand theoretical underpinnings and limitations of models

Are refis truly option based?
If not, why not?

Strive for consistency with well-established valuation of bonds and swaps

Demand transparency and hands-on control

Make an informed choice!

References (available at www.kalotay.com)

- “Mortgage servicing rights and interest rate volatility,” Andrew Kalotay & Qi Fu, *Mortgage Risk* (May 2008)
- “Optimum refinancing: bringing professional discipline to household finance,” Andrew Kalotay, Deane Yang, & Frank Fabozzi, *Applied Financial Economics Letters* (Vol. 1, 2008).
- “Refunding efficiency: a generalized approach,” Andrew Kalotay, Deane Yang, & Frank Fabozzi, *Applied Financial Economics Letters* (Vol. 3, 2007)
- “An option-theoretic prepayment model for mortgages and mortgage-backed securities,” Andrew Kalotay, Deane Yang, & Frank Fabozzi, *International Journal of Theoretical and Applied Finance* (December 2004)

Questions re: CLEAN™ implementation of option-based refi model?
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