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

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Toronto

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Heard It Through The Grapevine

"The actual sensitivity of MSRs 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 MSRs"

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?

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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?

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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-dependen rates
4. Obtain price/value by averaging over scenarios

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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

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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 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?

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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

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

Lengthens

Because bond is less likely to be called

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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!

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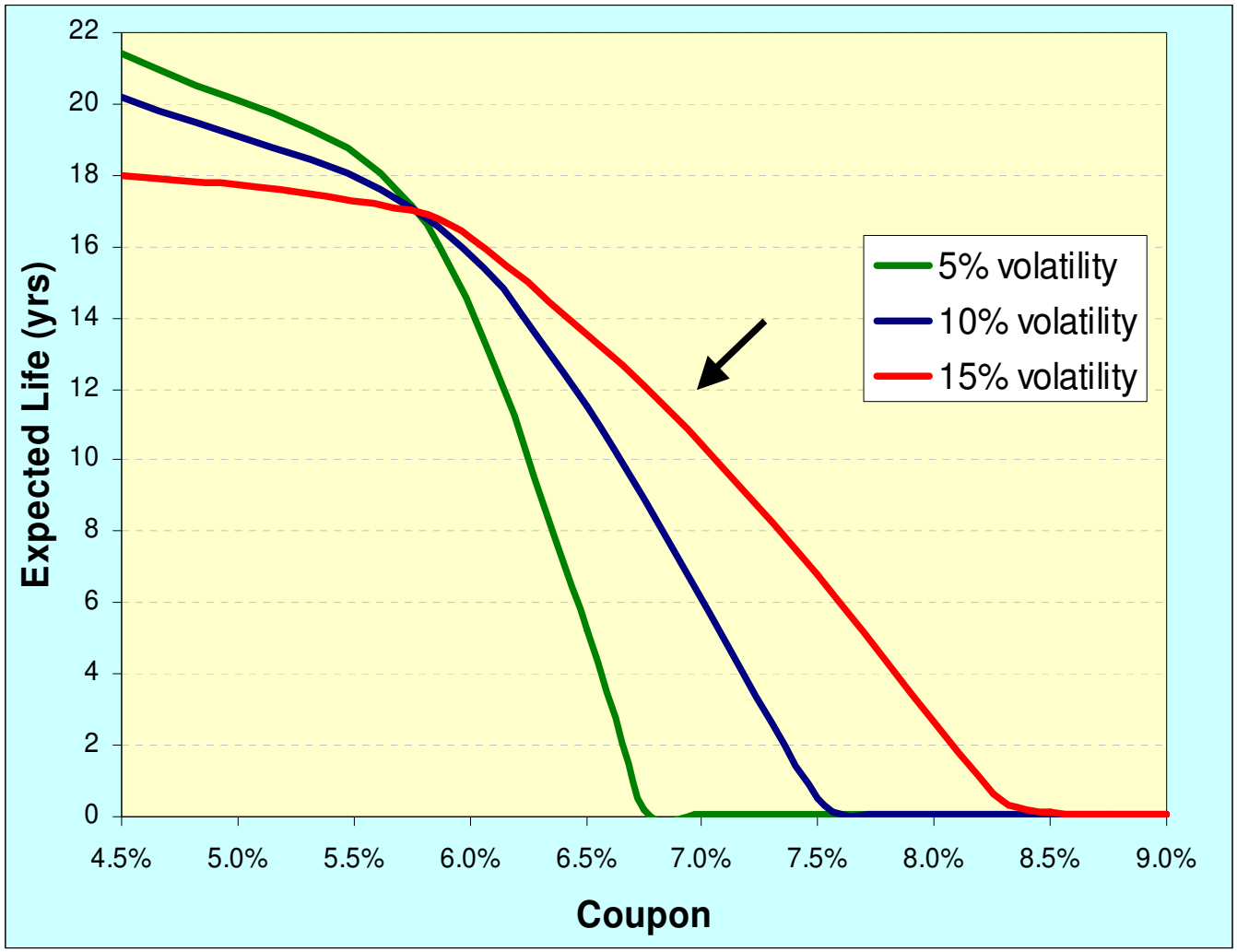
Volatility Extends Expected Life of High Coupon 30-Year Callable Bonds



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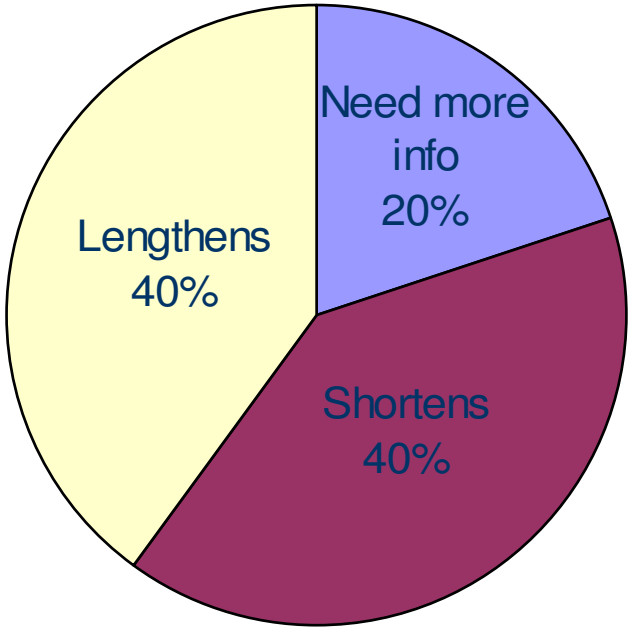
Even Bond Experts Are Confused
Survey Results

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



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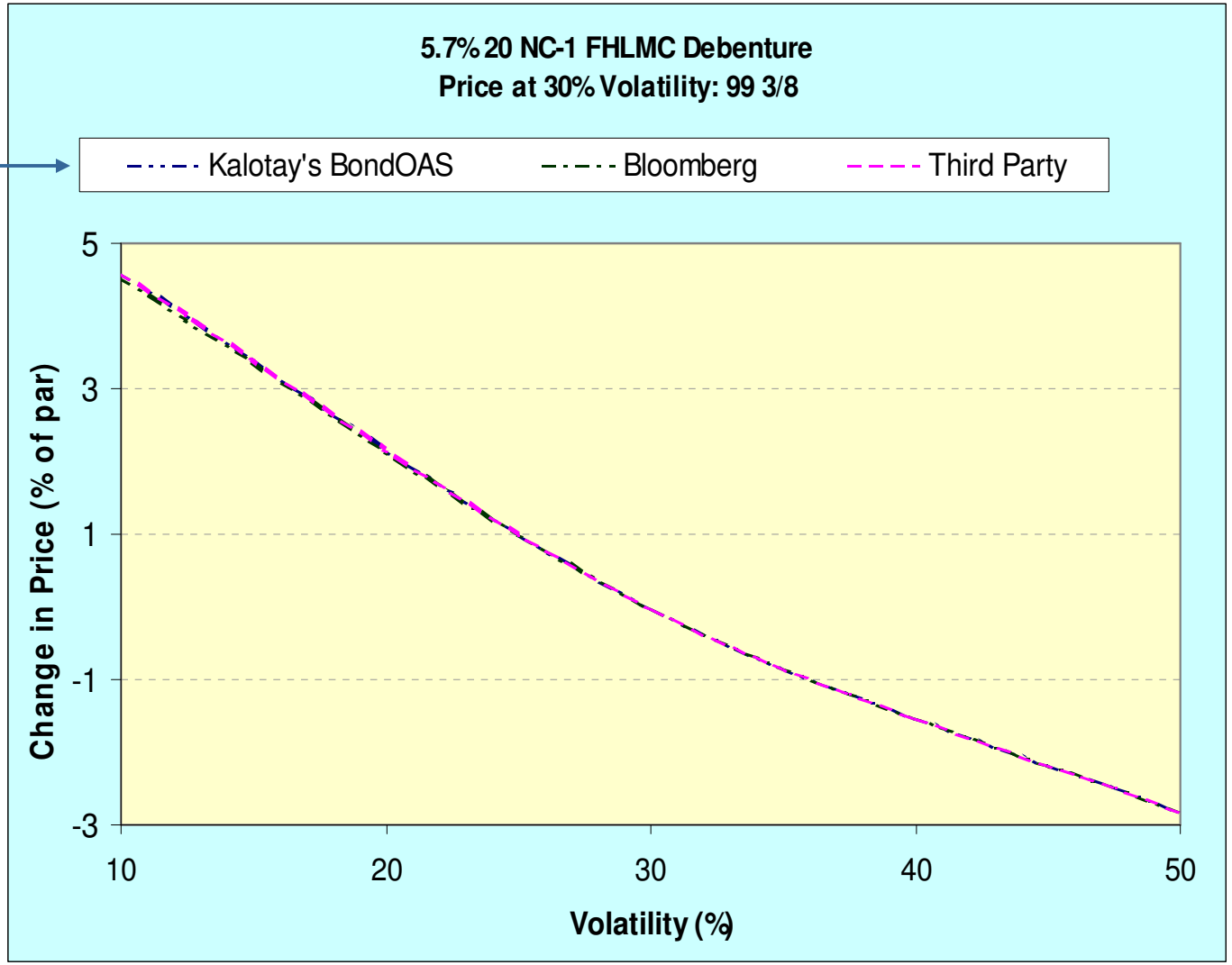
But For Callable Bonds Every Model Gives the Same ΔP

*All using lognormal interest rate process; zero mean reversion



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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

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Recommendation For Prepayment Modeling: Use Bottom-Up Approach

Understand Mortgages;
MBS Valuation Will Follow Naturally

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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%

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

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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?

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Option-Based Refinancing For Homeowners

A Financial Analysis of

Consumer Mortgage Decisions

Andrew J. Kalotay and Qi Fu

RESEARCH INSTITUTE for HOUSING AMERICA

MORTGAGE BANKERS ASSOCIATION®
Investing in communities

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

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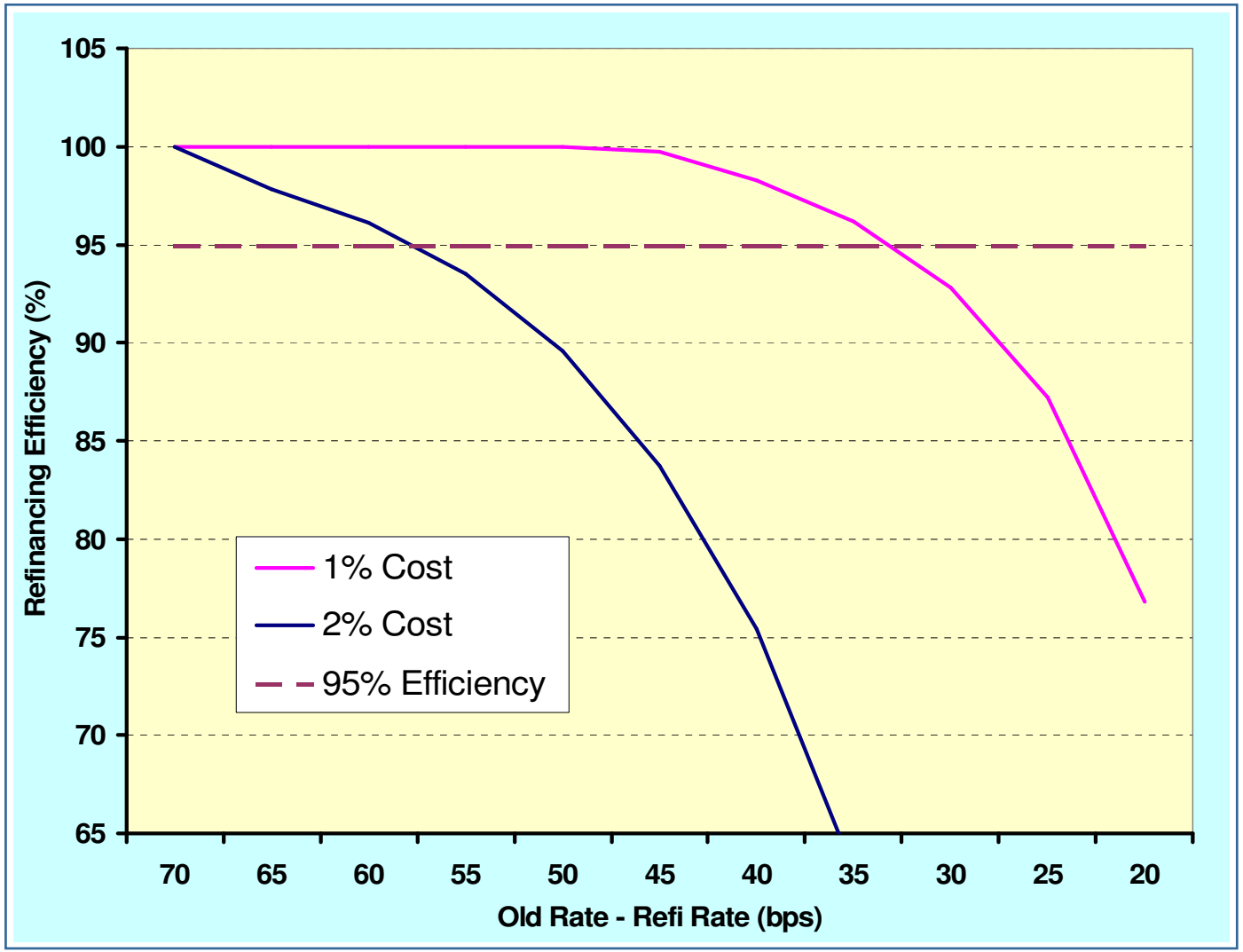
Call Efficiency Applied to Mortgages: Refi If You Can Save 40 to 70 bps



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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

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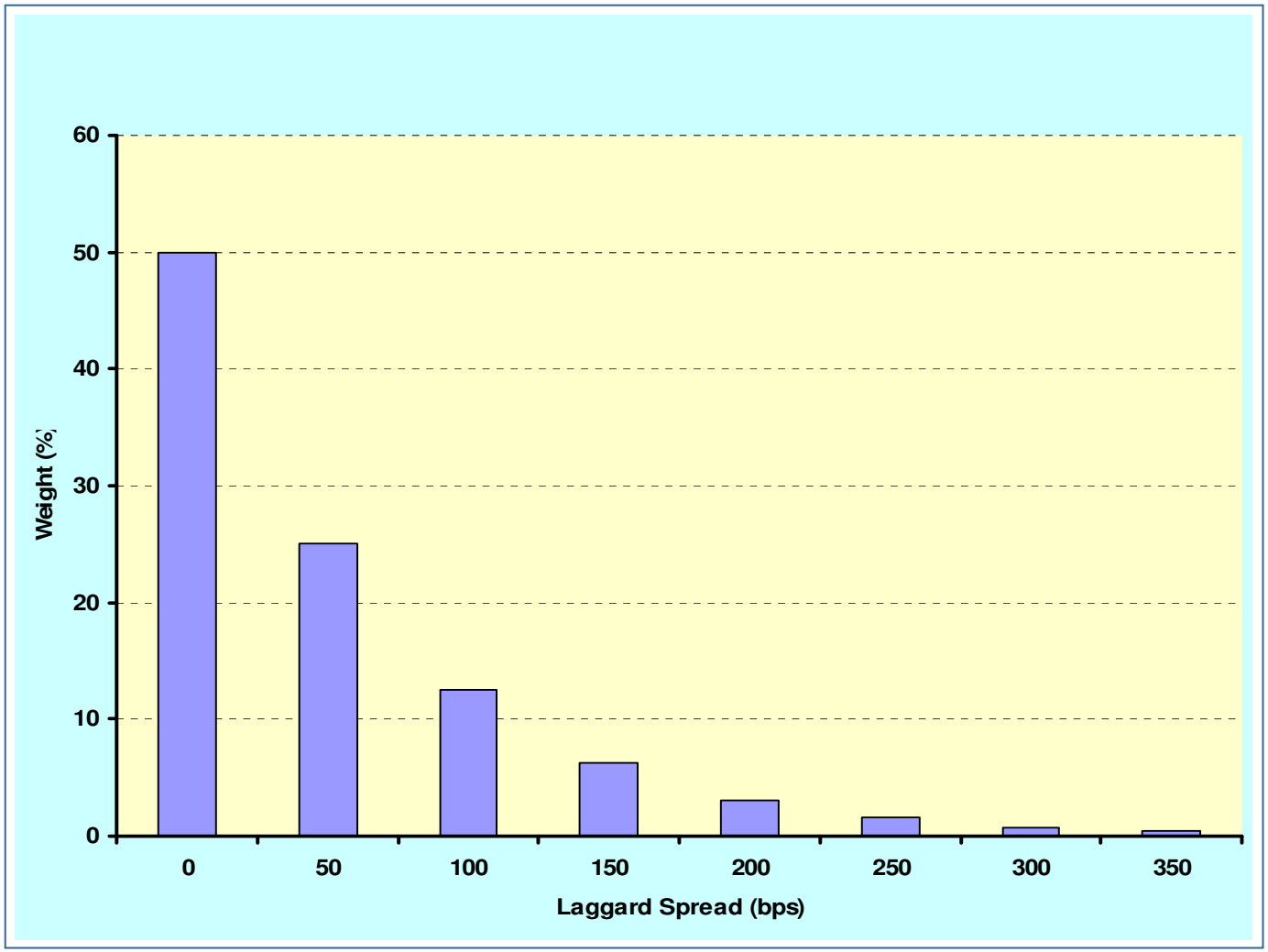
Generic Laggard Distribution

A 100 bps laggard refis when a "financial engineer" refis a mortgage with a 100 bps lower coupon



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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

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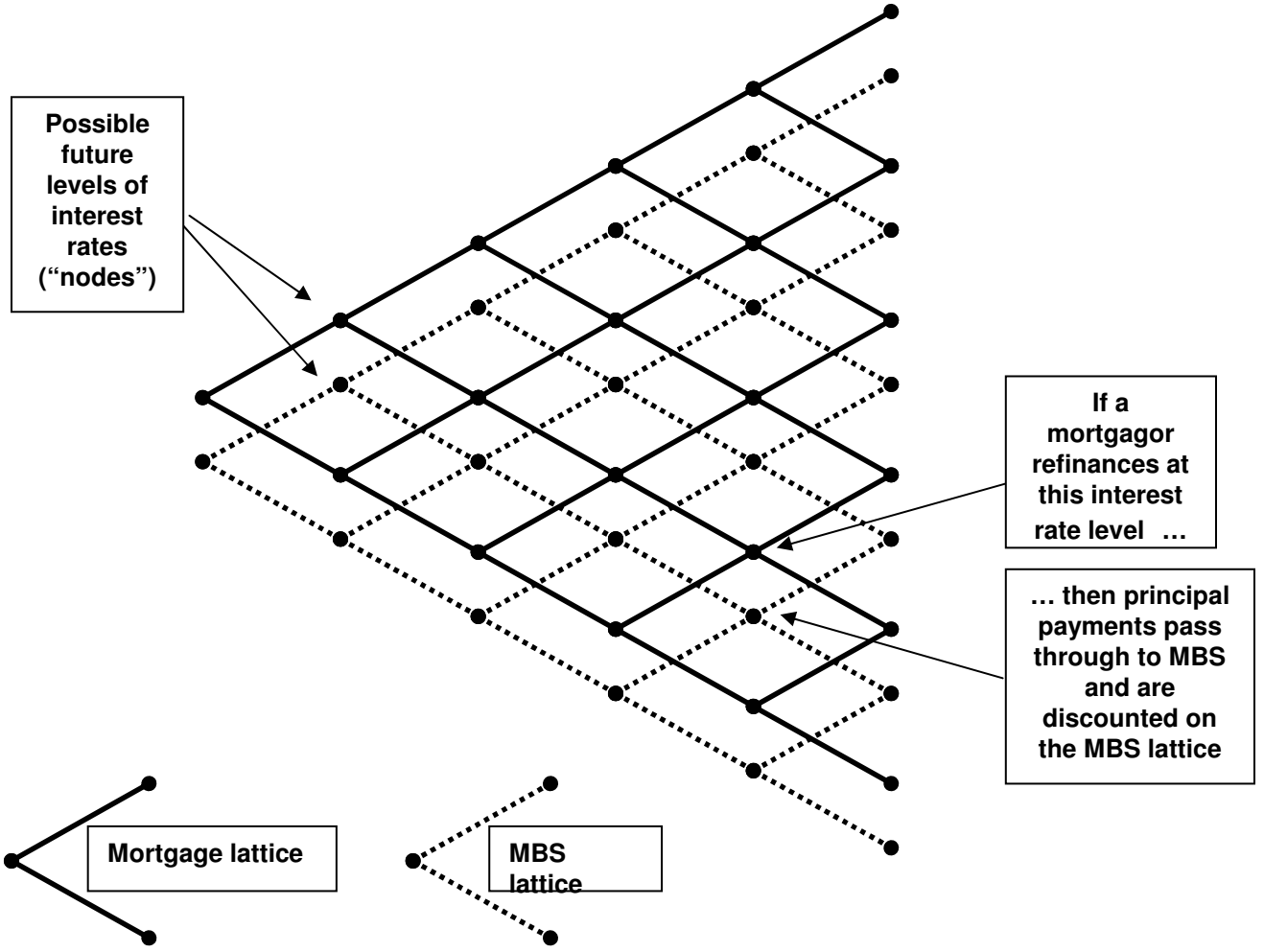
Mortgage-MBS Coupled Lattice



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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*** …

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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

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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'

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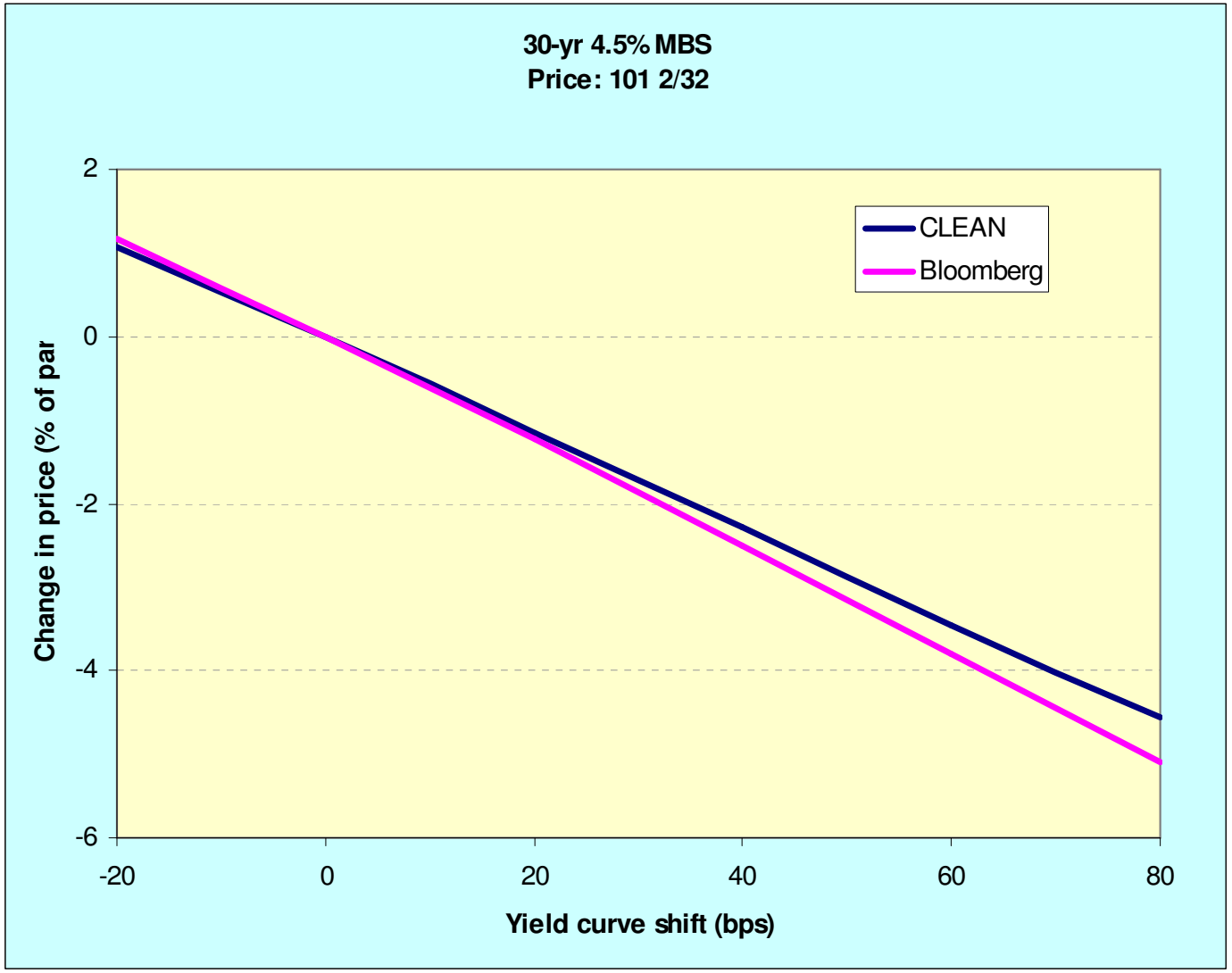
Sensitivity of ΔP to Shift in Yield Curve Varies Little Across Models



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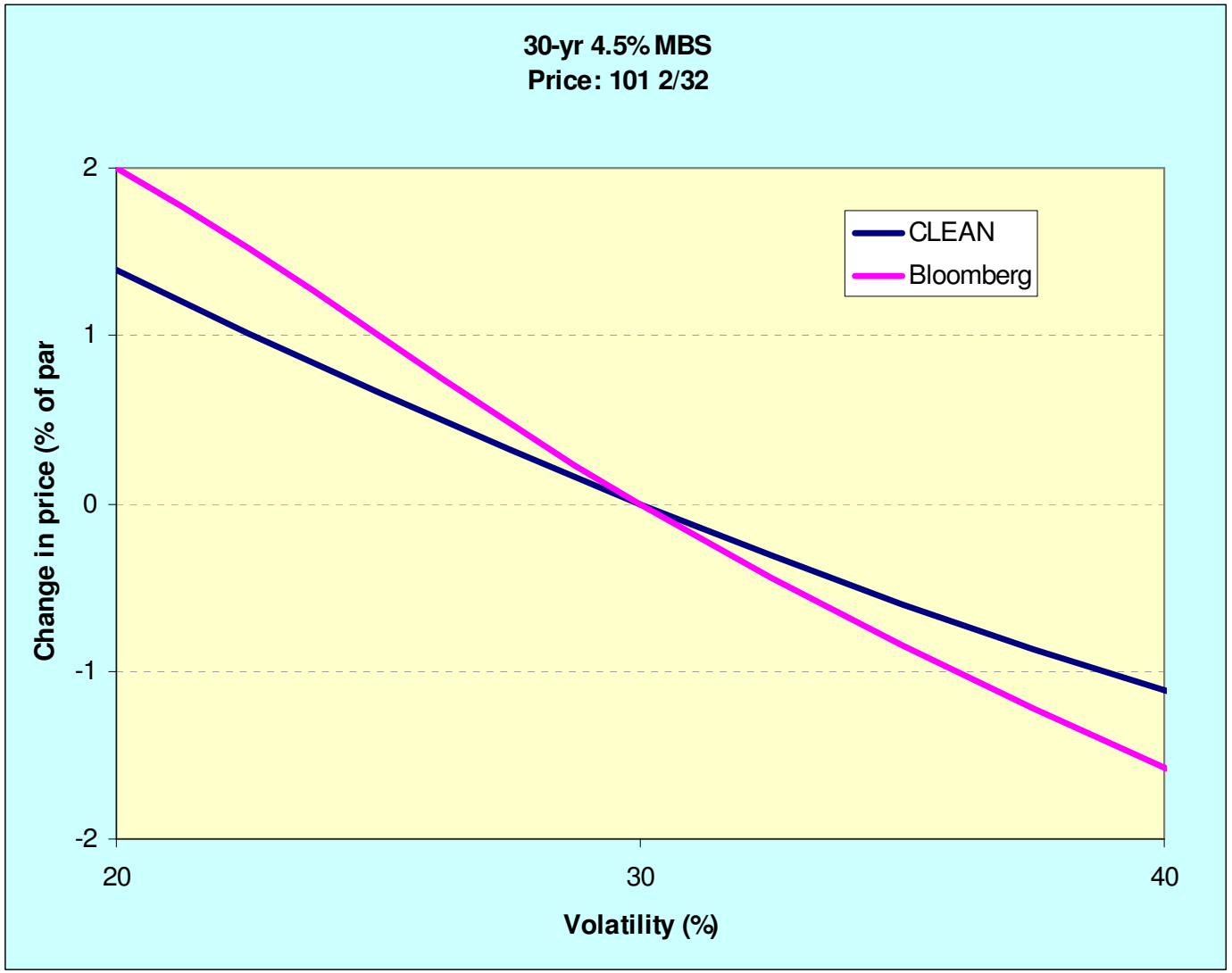
Traditional Prepayment Model Exaggerates Sensitivity of ΔP to Change in Volatility



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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!

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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

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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

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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

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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!

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