Quantitative finance

Lecture 14

Statement of the Problem:

Need for a New Approach to ERM

- What is Enterprise Risk Management?
  - Aggregating balance sheet risk?
  - Aggregating VaR and EaR of the enterprise?
  - Assigning economic capital to business units?
- An enterprise is a portfolio of businesses, not just assets and liabilities
  - How do you manage the risk of a portfolio of businesses?
  - Macro Risk Management

Contributions of the Presentation

- Describes a very comprehensive approach for aggregating the risks for the enterprise – a new approach known as macro risk management
  - Valuation – new modeling results
  - Simulation – credit and market risks
  - Aggregating business risks
- A Case Study: a quantitative risk study by Office of Thrift Supervision (OTS)
  - Highlight: business risk concentration
  - Implications for managing the risks of the business processes of an enterprise
- *My presentation does not represent the views of OTS*

Outline of the Presentation

- A Case Study (work in progress): Office of Thrift Supervision
  - Data and reports: institutional framework
  - Valuation models
    - Interest rate model
    - Mortgage prepayment model
    - Credit risk model
  - Simulation (“stochastic on stochastic” models)
  - Analysis of simulation results
- Implications of Macro Risk Management for ERM
  - Approaches to aggregating business risks

Office of Thrift Supervision

- Federal regulator of over 800 savings institutions or thrifts
- Monitors the risks on the balance sheet and the businesses
- Role of OTS examiners
- Ensure safety and soundness of the thrift industry
- Similar to the risk management of an enterprise with multiple businesses

Net Portfolio Value (NPV) Model

- A supervisory tool that identifies thrifts with excessive interest rate risk
  - A starting point for assessing the quality of interest rate risk management practices at individual thrifts
  - Identify outlier thrifts that need more supervisory attention
  - Identify systemic interest rate risk trends within the thrift industry
  - Designed to spot storm clouds on the horizon
- Fair valuation of all balance sheet items in disaggregated level using the CMR schedules
- Determine the market value of equity for each thrift

Schedule CMR and IRR Report

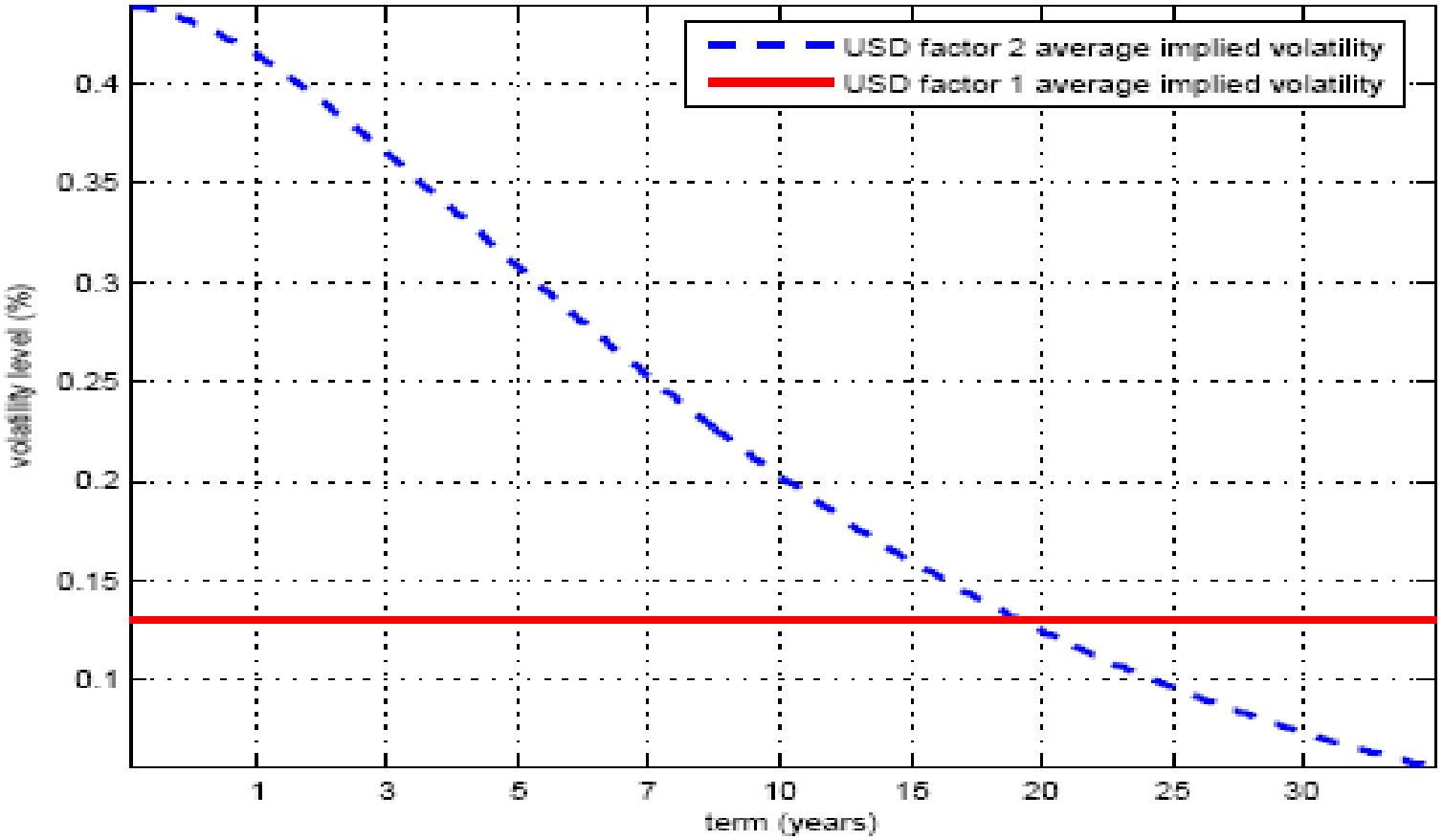
- CMR Filing Statistics (June 30, 2005)
  - 821 OTS-regulated thrifts filed Schedule CMR
  - 58.5% of reports were from voluntary filers
  - 90.7% of institutions that are not required to file Schedule CMR do so voluntarily
- Interest Rate Risk (IRR) Report
  - Over 15 years of historical data

Interest Rate Model

- Generalized Ho-Lee model: n factor implied principal yield curve movements
  - Arbitrage-free calibrated to the Treasury curve
  - Implied mixed lognormal/normal model
  - Implied rate correlations
- Calibrated to the entire swaption surface
- Contrast with BGM (LIBOR, Market), String, Unspanned volatility models.

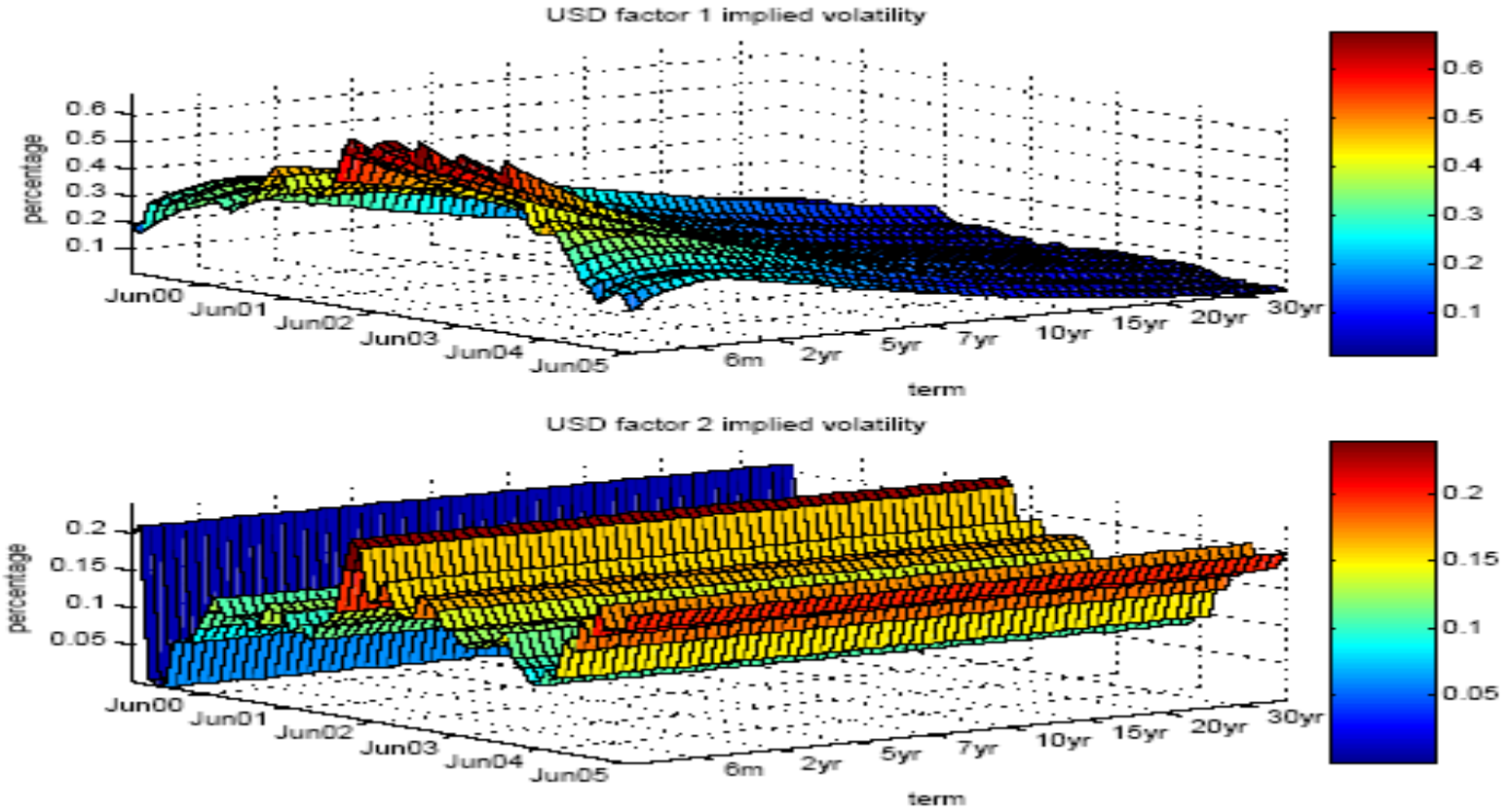
Estimated Implied Volatility Function:

Principal movements of the yield curve



Stochastic Movements of the Implied Volatility Functions:

Importance of implied correlations and distributions



Valuation Errors of the Generalized Ho-Lee Model:

Accuracy and stability of the model (Ho-Mudavanhu (2006))

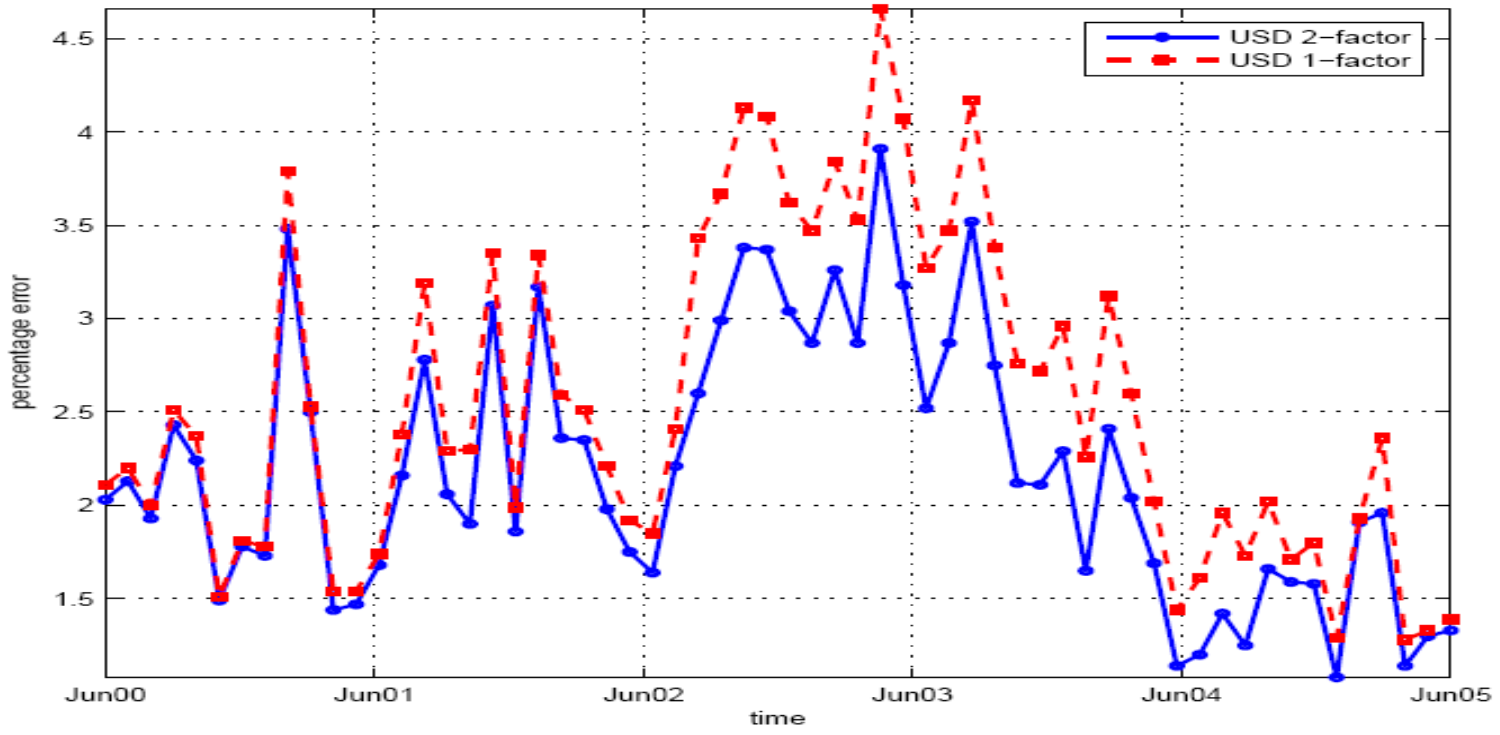


Fig. 10 Comparison of the percentage absolute errors of the one factor and two factor models.

Research on Prepayment and Default Claim Model

- Multinomial logit model
- FICO score
  - Impact on prepayments
  - Impact on the option adjusted spreads
- Multiple prepayment models
- Extension to loan valuation

Multinomial Prepayment/Default Model:

Specification of the correlation of prepayment and default risks

- $CPR_{i,t} = \exp(x(i,t)' \beta_p) / A$
  and
- $CDR_{i,t} = \exp(x(i,t)' \beta_d) / A$
- where $A = 1 + \exp(x(i,t)' \beta_p) + \exp(x(i,t)' \beta_d)$
- x(i,t) independent variables: age, seasonality, refi function, FICO score

Prepayment/Default Model Results:
Preliminary results on fixed rate mortgages

- Refi and burnout effect
  - The model confirms the S curve behavior of refi.
  - The burnout effect is significant
- Slope of the yield curve
  - Higher the slope, greater is prepayment (positive)
- Seasoning effects
  - The results confirm the PSA model
  - The results show that the default rate peaks in 5 years
- FICO effect
  - For prepayment, the higher the FICO score, the more likely that the mortgagor prepays
  - In the default model, FICO score is significant
- Size: hot and cold money
  - Larger the origination size, hotter is the money
  - Larger the origination size, the higher is the default risk

Default Risk Modeling: Correlation

- Survival rate: derived from historical cumulative default experience for each rating cohort group
- Recovery rate: by seniority (historical)
- Correlation: by industry (historical)
- Standard deviation: concentration in each industry
- Default event: maturity structure

Default Correlation

- Gaussian and t-dependence copula model
- Input data:
  - Face value/portfolio
    - Fixed rate mortgages
    - ARMs
    - Loans: construction, consumer, commercial
  - Proportion in
    - Industry group
    - Maturities
    - Ratings

Business Models of Thrifts

Principal Components Analysis (preliminary)

	PC1	PC2	PC3
mortgage/EC	0.75	-0.64	0.13
Nonmort/EC	0.02	0.23	0.97
Deposits/EC	0.65	0.72	-0.19

- proportion of variations explained

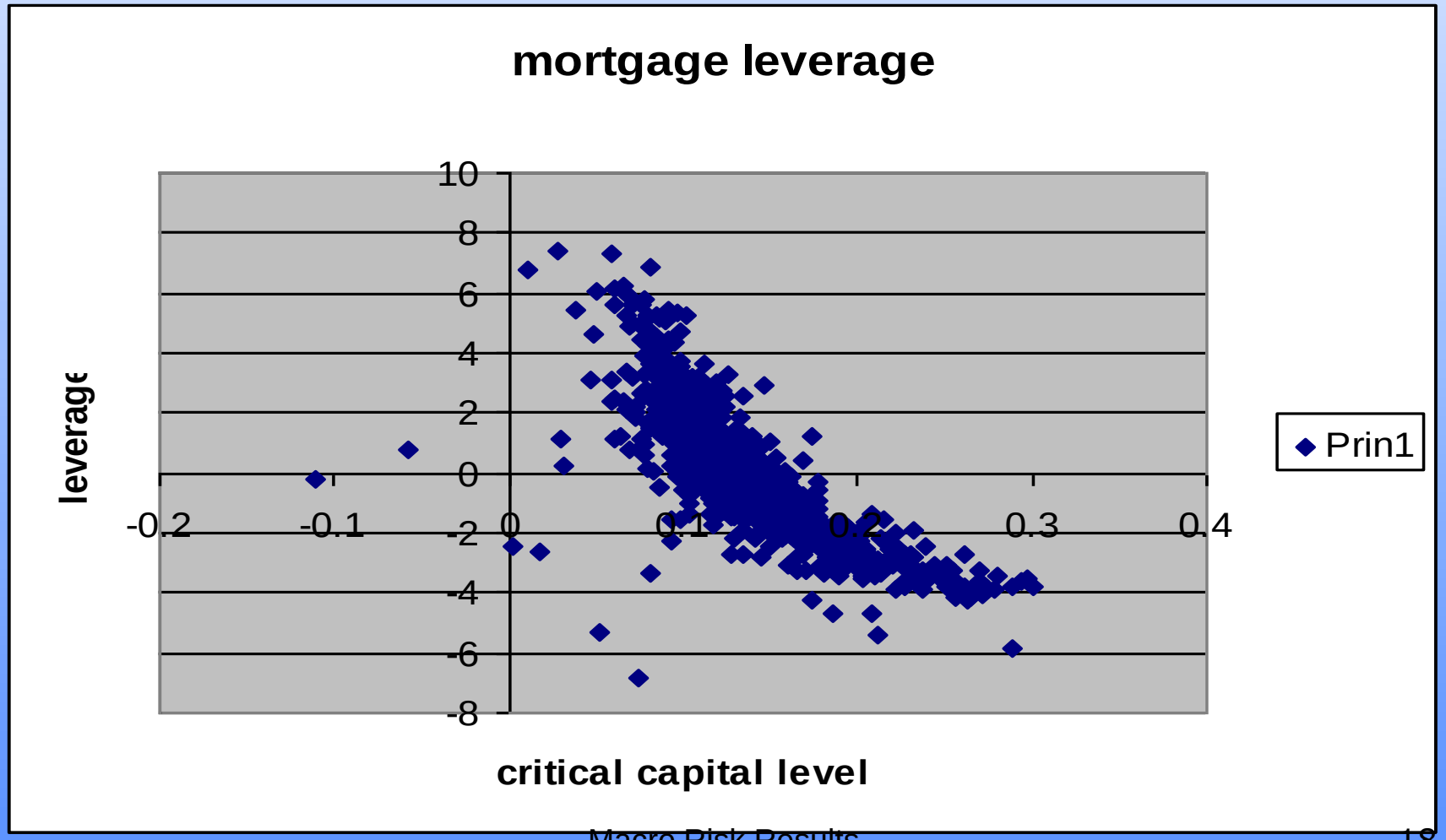
78% (PC1), 17% (PC2), 5% (PC3)

- EC =economic capital

Relating the Risk Profiles to the Business Models:

Variations along PC1 vs Critical Capital

preliminary results



Implications of the Case Study for ERM

- An enterprise is a portfolio of businesses, defined in terms of business processes, not only as corporate entities
- ERM should not only aggregate the balance sheet risks
- ERM should consider the correlation of business risks of the business processes