# Discussion of "The Allocation of Interest Rate Risk and the Financial Sector"

Chris Sleet

Tepper School of Business
Carnegie Mellon University

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# Content

## Methodology

- Initiated in Doepke-Schneider (06), Piazzesi-Schneider (10).
- New target: financial institutions.
- Extension: Interest rate derivatives.

## Initial Result: Maturity Mismatch

- Bank liabilities short term, bank assets long term.
- Interest rate swaps sometimes enhance effective mismatch.

# Basic Method

- Value of payoff stream:

$$\pi_t(y) = \exp\{\alpha_t^y + \beta_t^y f_t\}$$

- Factors evolve as:

$$f_{t+1} = \mu + \phi f_t + \sigma \varepsilon_{t+1}, \qquad \varepsilon_{t+1} \sim N(0, I_N).$$

- So that:

$$\pi_{t+1}(y) - \pi_t(y) \approx a_t^y + b_t^y \sigma \varepsilon_{t+1}.$$

# Basic Method

- Value of payoff stream: Validity of factor model?

$$\pi_t(y) = \exp\{\alpha_t^y + \beta_t^y f_t\}$$

- Factors evolve as:

$$f_{t+1} = \mu + \phi f_t + \sigma \varepsilon_{t+1}, \qquad \varepsilon_{t+1} \sim N(0, I_N).$$

- So that: Quality of approximation?

$$\pi_{t+1}(y) - \pi_t(y) \approx a_t^y + b_t^y \sigma \varepsilon_{t+1}.$$

# Basic Method

- $1 + N$ spanning securities; first one period riskless bond.
- Replicate asset:

$$\pi_{t+1}(y) - \pi_t(y) = \begin{pmatrix} a_t^y & b_t^y \end{pmatrix} \begin{pmatrix} 1 \\ \sigma\varepsilon_{t+1} \end{pmatrix}$$

$$= \begin{pmatrix} \theta_t^1 & \theta_t^T \end{pmatrix} \begin{pmatrix} i_t & 0 \\ a_t & b_t \end{pmatrix} \begin{pmatrix} 1 \\ \sigma\varepsilon_{t+1} \end{pmatrix}.$$

- Change in $N$ spanning bond prices: $a_t + b_t\sigma\varepsilon_{t+1}$

# Basic Method

- Recover spanning portfolio:

$$\begin{pmatrix} \theta_t^1 & \theta_t^T \end{pmatrix} = \begin{pmatrix} i_t & 0 \\ a_t & b_t \end{pmatrix}^{-1} \begin{pmatrix} a_t^y & b_t^y \end{pmatrix}$$

- Apply to assets/liabilities in banks portfolio.
- Hence, replicate the bank.
- For components of bank portfolio, recover:
  - $\pi_t(y) = \exp\{\alpha_t^y + \beta_t^y f_t\}$.
  - Hence, $(a_t^y \; b_t^y)$ and $(\theta_t^1 \; \theta_t^T)$.

# Bond Pricing

## Affine Model

- SDF:

$$M_{t+1} = \exp\left(-i_t - \frac{1}{2}\lambda_t^T \lambda_t - \lambda_t^T \varepsilon_{t+1}\right) \qquad \lambda_t \quad = l_0 + l_1 f_t.$$

## Zero Coupon Bond Prices

- Riskless Bond price:

$$P_t^{(n)} = \exp(A_n + B_n^T f_t)$$

- Risky Bond Price:

$$\widetilde{P}_t^{(n)} = \exp(\widetilde{A}_n + \widetilde{B}_n^T f_t).$$

# Replicating the Bank

- Treat assets as bundles of riskless or risky bonds.
- Approach applied to:
  - Assets that reprice $\frac{1}{4}$-ly treated as S.T. private, public bonds.
  - Long term securities treated as portfolios of zero coupons.
  - Loans harder as “fair values” for portfolio not available.

# Replicating the Bank

- Approach applied to derivatives.
- All derivatives treated as swaps (most are, but...).
- Swap replicated by portfolio of short and long run debt.
- Difficulty cannot observe which side of the swap bank is on.
- Clever procedure for estimating this from the data. Details

# Questions

## Do factors adequately span risk?

- 2 year swap rate used to capture interest and credit risk.
- Does it adequately capture risk on bank loans?

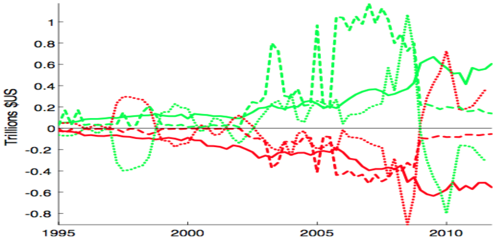
## Is risk associated with off balance sheet activity captured?

- Banks engaged in regulatory arbitrage.
- Offering liquidity, credit enhancements to conduits, SIVs.
- Conduits borrowed short term in CP market.
- Purchased LT securities. Banks pledged liquidity support.

# JP Morgan Chase


Figure 4: Replication portfolios for JP Morgan Chase. The portfolios are holdings of cash (in red) and a 5-year riskless zero coupon bond (in green). Solid lines are replicating porfolios for the traditional fixed income position, while dotted lines are for derivatives and dashed lines are for bonds held for trading.

# JP Morgan Chase: Interpretation

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- Mainly, ST liabilities, LT assets.
- Run up to/during Crisis:
  - ST FI position more negative, LT position more positive.
  - Broadly consistent with He-Krishnamurthy (10). Details

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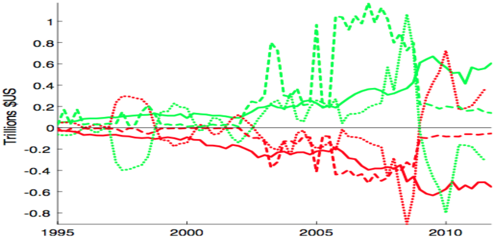


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- 2007/8 JPMC takes large net position in pay float swaps.
- Borrow short term (pay float) and lend long term (receive fix).
- Exposes JPMC to a significant interest rate risk.
- A bet that rates will fall/stay low. Bet paid off.

# Who are the counterparties?


Figure: Chief financial officer of the Bay Area Toll Authority Brian Mayhew said, “It was brilliant, and it all blew up on me.”

# Counterparties

*"For more than a decade, banks and insurance companies convinced governments and nonprofits that financial engineering would lower interest rates on bonds sold for public projects such as roads, bridges and schools. That failed promise has cost more than $4 billion, according to data compiled by Bloomberg, as hundreds of borrowers from the Bay Area Toll Authority in Oakland, California, to Cornell University in Ithaca, New York, quietly paid Wall Street to end agreements since 2008."*

(Bloomberg, Nov. 2010).

# Who are the counterparties?

- Local governments. Non-profits.
  - Jefferson County. Bay Area Toll Authority. Harvard University.
  - Interest on outstanding debt did not match floating rate in swap.
- Non-financials.
- Shadow Banks.
  - Shadow Bank interest rate risk onto balance sheet via swaps?
  - And, hence, on to tax payers?

# Next Steps

- Quantify risk which "maturity mismatch" exposes banks to.
- Connect factors explicitly to macro risks and macro policies.
- Use results to inform models of bank portfolio choice.

# Maturity Mismatch: Risks

- Interest Rate Risk.
    - Lustig-Sleet-Yeltekin (2008): Government issues long term nominal debt to hedge fiscal shocks.
    - Tilts yield curve upwards after such shocks.
    - Berndt-Lustig-Yeltekin (2012), Berndt-Yeltekin (2012) empirical investigation of fiscal risk factors.
- Credit/Refinancing Risk.
    - Banks must rollover short term debt.

# Maturity Mismatch: Risks and Portfolio Choice

- Farhi-Tirole (2012) intertwine these risks.
    - Interest rate policy insures banks against refinancing risk.
    - Encourages banks to increase short term leverage.

# Maturity Mismatch: Policy and Portfolio Choice

- In crises, LT projects need fresh infusions of liquidity.
- But bank committed to repay ST debt.
- If bank is highly leveraged, this problem is more severe.
- In crises, Govt can help banks by suppressing returns to savers.
- Enables bank to finance liquidity infusion.
- Not a time consistent policy.

# Bank Portfolio Choice

- Renewed interest in models of bank portfolio choice.
- Leverage constrained models:
  - Geanakoplos-Fostel (2008), Adrian-Shin (2010), Brunnermeier-Pederson (2009).
  - Can explain why hedge funds delevered in crisis.
- Equity-constrained models:
  - Xiong (2001), He-Krishnamurthy (2008, 2009), Brunnermeier-Sannikov (2010).
  - HK can explain why commercial banks increased leverage in crisis.

# Conclusion

- Interesting, novel and ambitious paper.
- Remains to quantify explicitly the implied risks.
- Paper can inform theories of bank portfolio choice.
- Hence, macro-models of crises.

# Recovering Fair Value of Bank: Swaps

- Fair value of pay fix swap:

$$FV_t^{\text{fix}} = N_t - (sC_t^{(m)} + P_t^{(m)})N_t = F_t(s,m)N_t.$$

- Value of net position in swaps.

$$FV_t = \sum_m N_t^m \omega_t^m F_t(s_t^m, m), \qquad \omega_t = \frac{N_t^{m+} - N_t^{m-}}{N_t^m}$$

- Problem: do not observe $\omega_t$ in call reports.

- Clever procedure for identifying and estimating $\omega_t$

Return

# Balance Sheet Changes, 2007 Q4-2009 Q1

## Assets

- Commercial Banks increase holdings of securitized assets by about $550 billion.

## Liabilities

- Govt backed debt issued by the commercial banks, inc. FDIC insured deposits and guaranteed bonds, increases by about $1.3 trillion.

- Book leverage of commercial banks increases from 10 to between 20 and 32.

◂ Return