A Multi-Agent Model of Financial Stability and Credit Risk Transfers of Banks

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MOTIVATION

- Systemic risk from securitization (MBS, ABS)
- CCFEA research started 5 years ago recognized that ABS & MBS will have systemic risk implications
- Anticipated crisis of subprime defaults
- Multi-agent model needed for: fine grained data base for agents with spatial and dynamic features; non-linear feedbacks; multi period modelling

Origins of Crisis and Why We Are Mired in it ?

- **'Weapons of mass destruction'(Warren Buffet): Residential Mortgage Backed Securities (RMBS) on Sub Prime Mortgages, Collateralized Mortgage/Debt Obligations (CM/DOs) and Credit Default Swaps (CDS)**
- **Little or no regulatory scrutiny**
- **Multiples of debt/leverage ('shadow' banking sector est. at $62 tn vs. deposit based banking at $39 tn and M0 at $ 3.9 tn Source: Guardian 29Feb 09) with little contribution to returns from investment in the real economy (Global GDP $55 tn). Systemic Ponzi scheme collapsed, (Aug 07Bear Sterns – Northern Rock – Sept 08 Lehman etc) , then Freddie Mac and Fanny Mae in Sept 08, severe mark downs on the market value of retail banks**
- **Interbank and short term markets for liquidity seized up resulting in the credit crunch.**
- **'Liquidity trap' even at low interest rates of 1% or under, a loss of investor and consumer confidence**
- **Little traction in interest rate policy, reflation by printing money, euphemistically called 'quantitative easing'.**
- **Limited success to date of tax payer bail-out of the banking system :Why ?**
- **Radical options:A 'toxic'/ Recovery bank or full nationalization of banks**
- **Massive public sector spending on capital projects to prevent a slide into another 'Great Depression'**

Financial Contagion

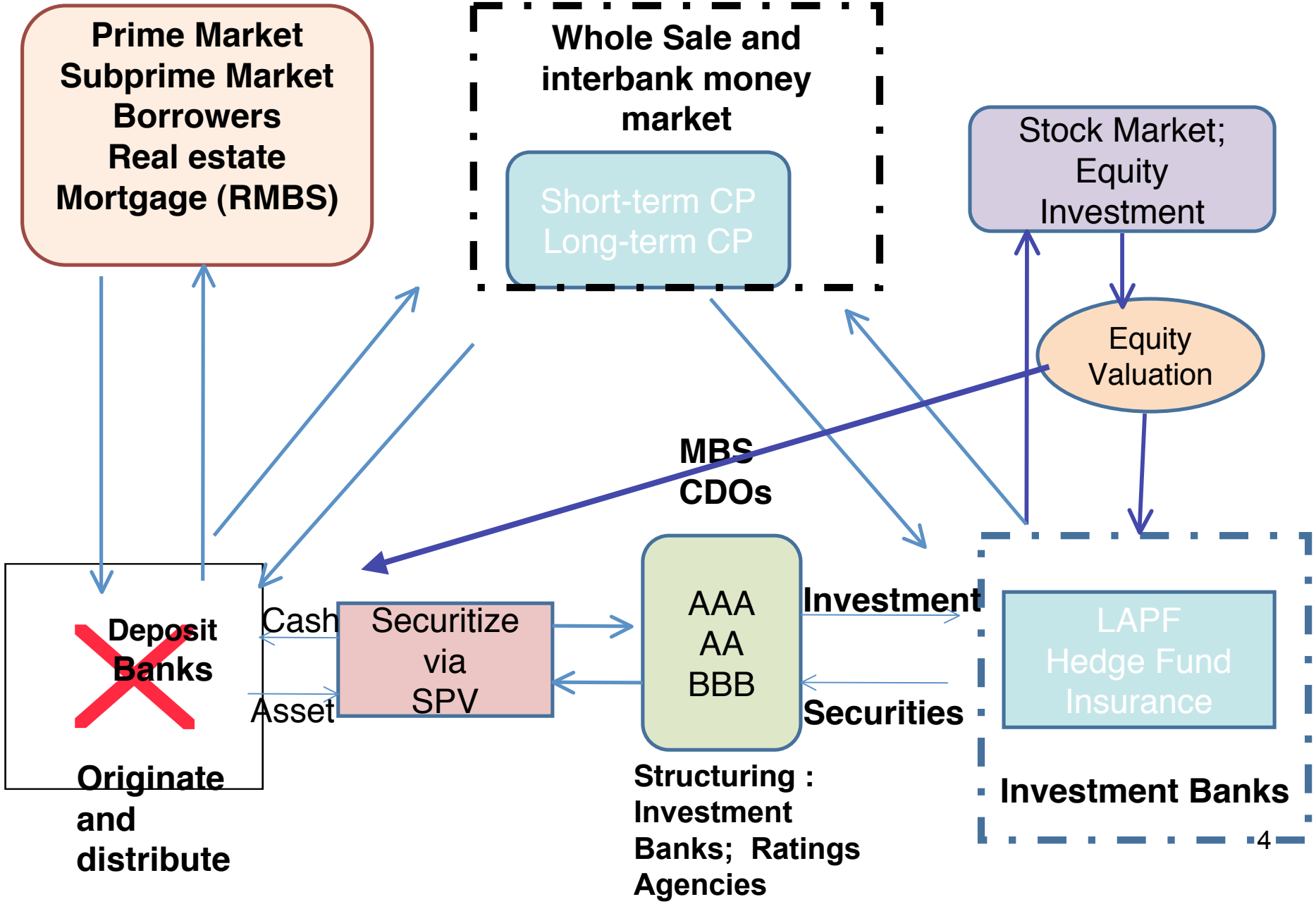
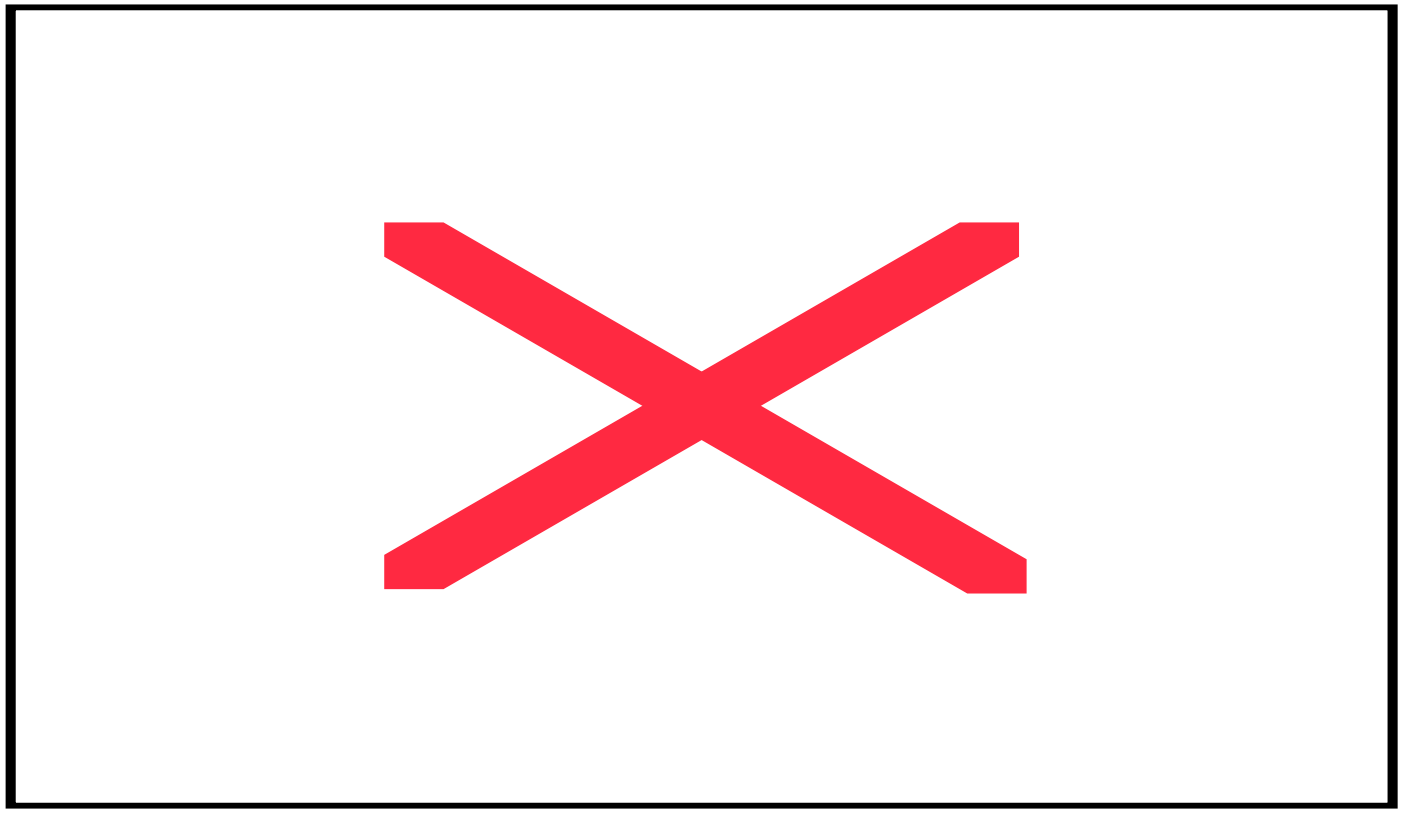


Figure 1.5: Increase in Subprime Delinquency 2005 to 2006 Map



Source: First American LoanPerformance; Census Bureau , and Wall Street Journal Online

Two Sector ABM for Credit Risk Transfer

- **A dynamic multi-period model of securitization with a A/L framework was missing (Simon Wolfe ABS model (2000) : lucid but static)**
- **Banks profit maximisation should be constrained by insolvency risk**
- **Regulations are set to mitigate the systemic risk implications: capital adequacy requirement**
- **What banks did? Securitization and credit risk transfer play a key role in enabling them to reduce their regulatory capital amount and increasing loan portfolio growth**

Where it Began : Securitization of Bank Loans

Regulatory Arbitrage

- Basel I required 8% of equity capital against bank assets ie. the loan side of the balance sheet
- Consider 1 bn Mortage Loans
- Equity Capital needed 80 million
- If .5 bn securitized and moved off balance sheet ie.50% of securitization
- Bank now needs only 40 million of Equity Capital ; further 40 million can be lent out ; securitize again and again ….. MONEY PUMP

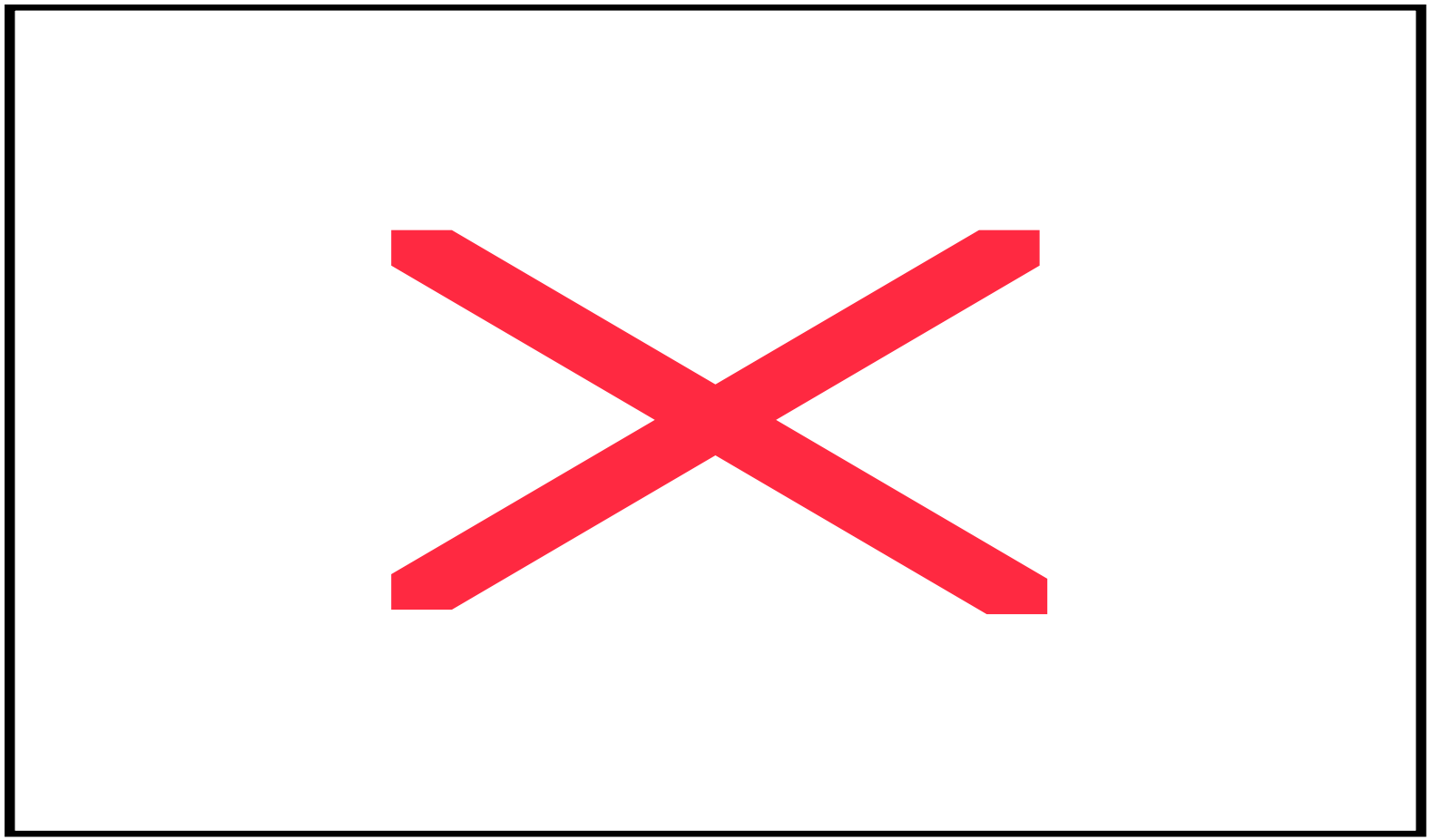
Sub-prime Market
MBS on Loan on Real Estate:Source FDIC

°°	WASHINGTON Mutual	NEW CENTURY
2001.3	0.497971656	0.255255547
2001.6	0.427332242	0.236253407
2001.9	0.393723897	0.205321179
2001.12	0.302951192	0.180109436
2002.3	0.232911549	0.17544783
2002.6	0.198129305	0.218473105
2002.9	0.170938075	0.192971619
2002.12	0.155603184	0.157524953
2003.3	0.110635337	0.130638446
2003.6	0.071946644	0.109395568
2003.9	0.076294759	0.126652608
2003.12	0.052989651	0.122883974
2004.3	0.037408302	0.112385321
2004.6	0.038606	0.127830593
2004.9	0.035673732	0.134108553

Was there excessive securitization ?

The question is how were banks able to willy nilly pass on the subprime loans ? In other words what needs explaining is how so much bad stuff got passed on. The 'popular' answer: Default risk on these loans and hence costs to the bank for securitization in coupon payments and credit enhancement **were under estimated** .

Ratings companies helped pass off sub prime with high ratings. **Basel II in 2004 requiring equity against MBS came too late**



With linear costs note that as a higher and higher % of assets are securitized, a bank can keep improving its capital accumulation :
The Money Pump model of Securitization

Collateralized Debt Obligation,CDO
Weapon of mass destruction (Warren Buffet)

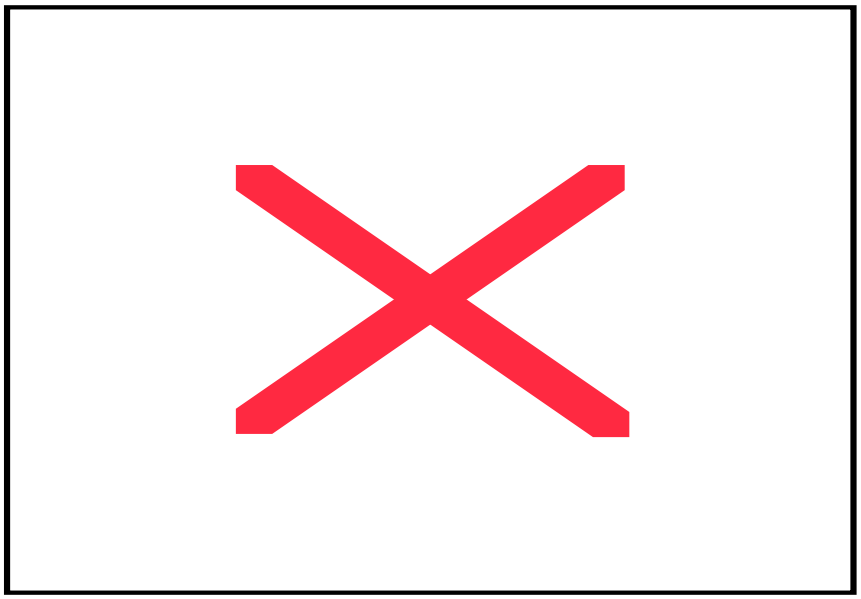
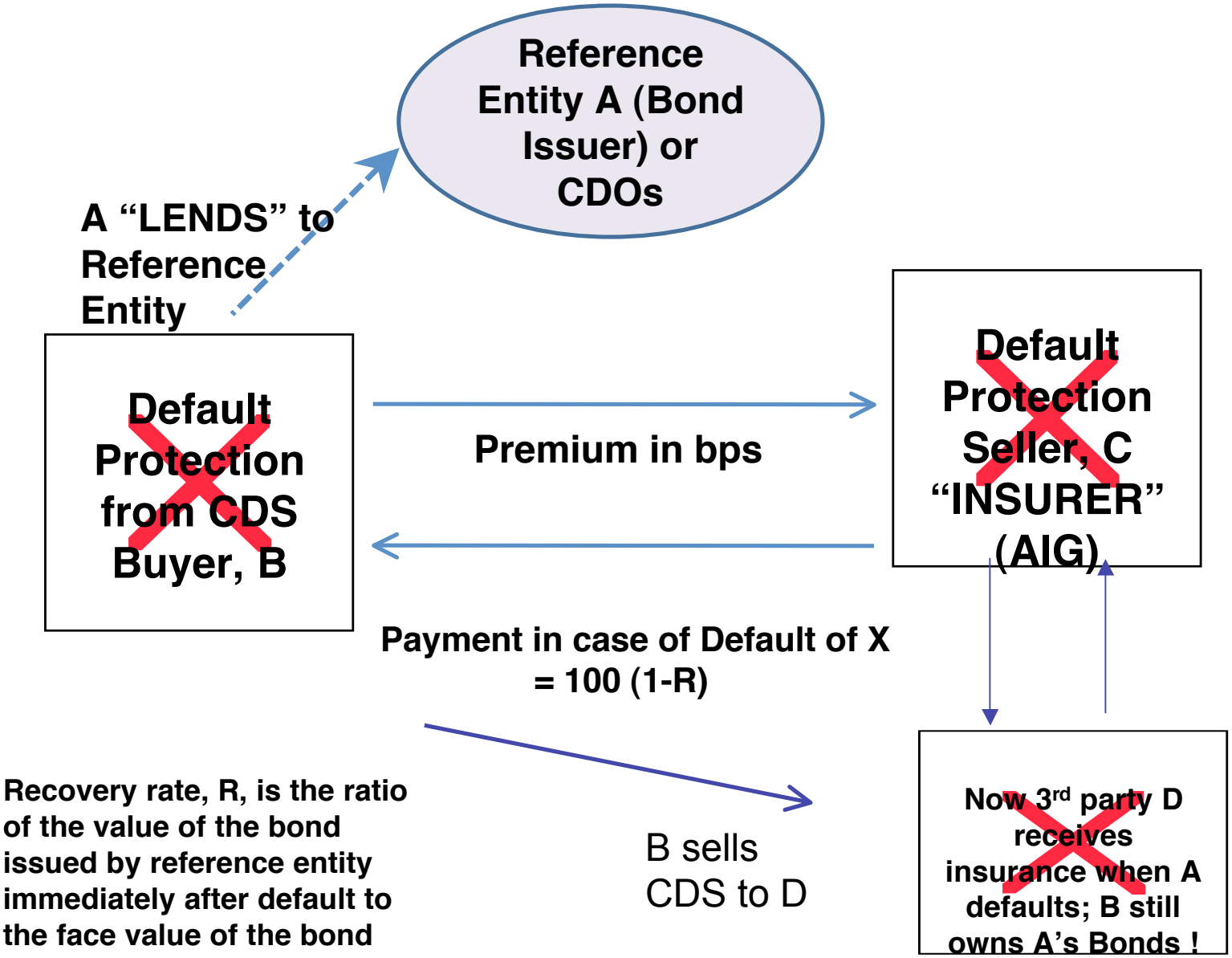


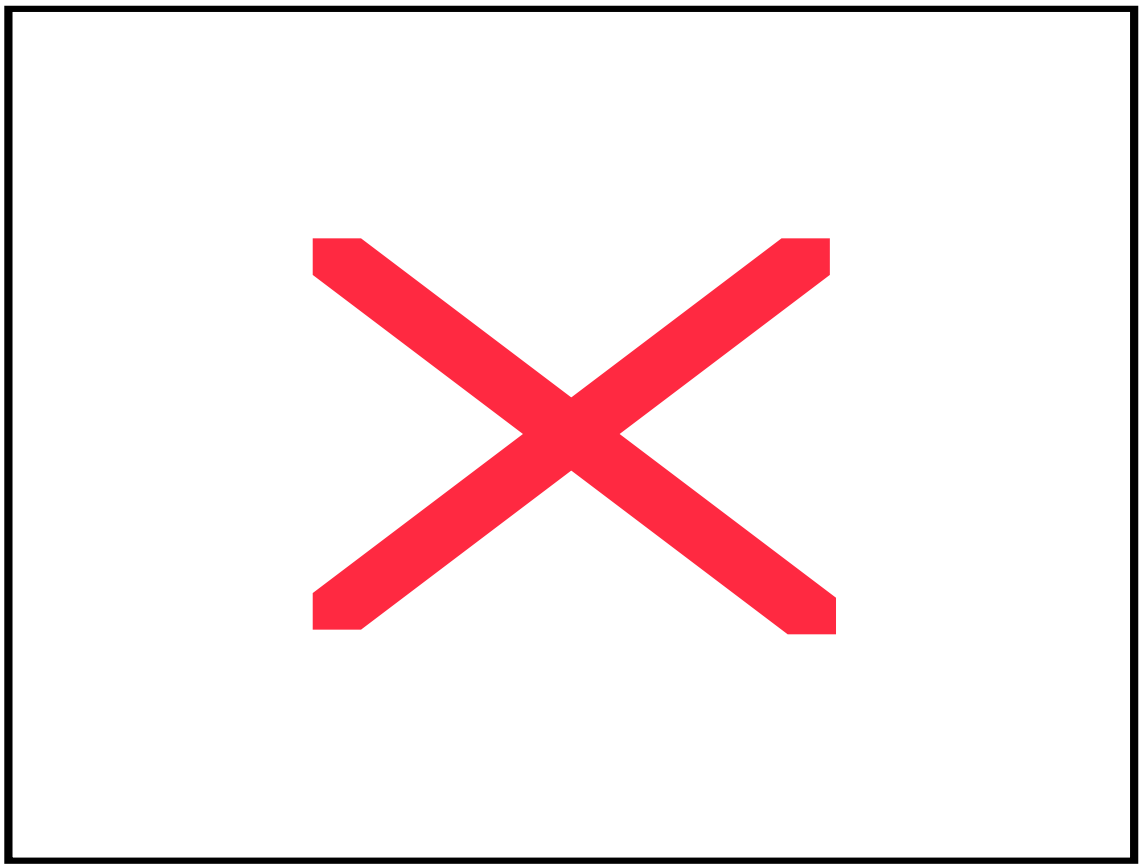
Fig. 1. Tranche structure at time t_0; at time t_1, pool's losses (shaded in black) absorbed by Equity tranche; Mezzanine Jr., Mezzanine, Senior and Super-Senior tranches are not yet affected by pool losses.

Credit Default Swap Structure(CDS) and Bear Raids

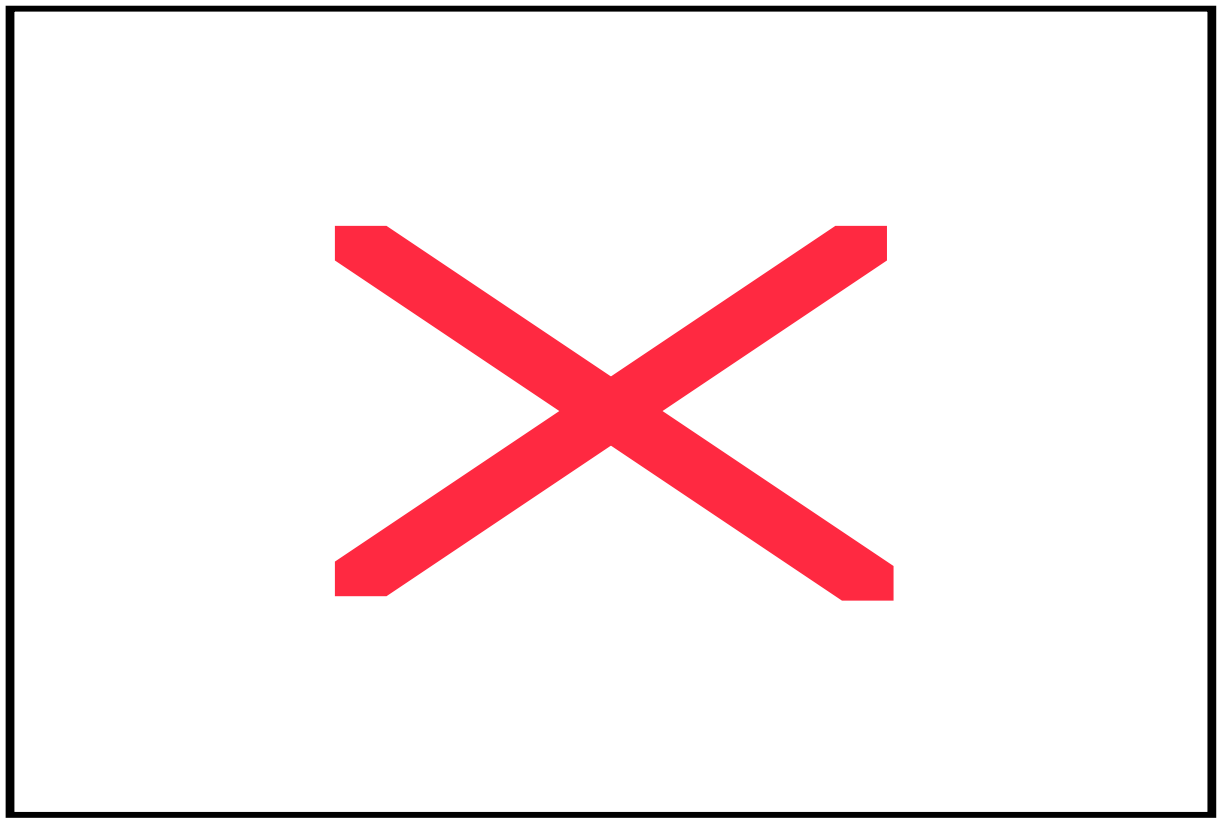


Recovery rate, R, is the ratio of the value of the bond issued by reference entity immediately after default to the face value of the bond

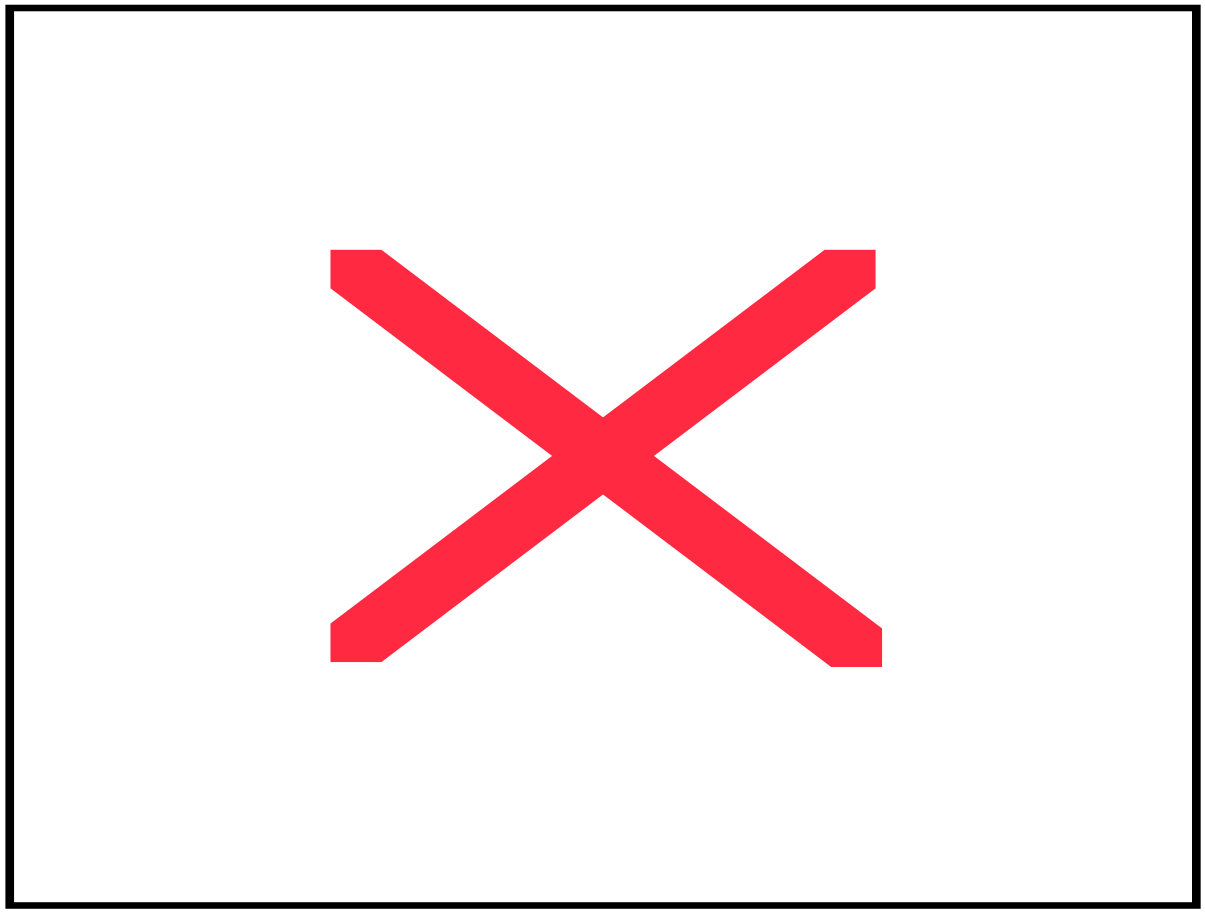
Credit Crunch Mainly From ZERO Growth in ABS vs Troubled Assets Relief Program (TARP)



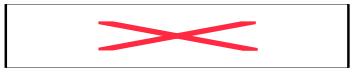
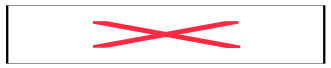
2008 Value of SubPrime



ABX: Mark to Market Value of SubPrime Losses $1.6 as ABX implies 20 cents to Dollar
First American Loan Performance estimated a default rate of 15%, this would translate to $300 billion of non-collectable principal and interest.

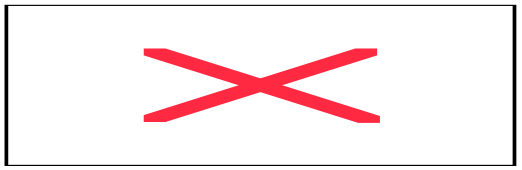


Section 1: Multi-period: Dynamic Model for Securitization in Banks

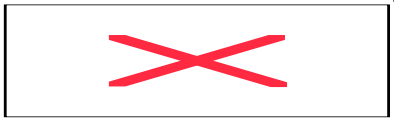
- **Definitions**
  - N banks with initial liabilities given by  , where r^L is the interest rate on liabilities
  - Banks have a basic asset accumulation process such that   is the survival rate on assets and r^A is the return on assets
  - Bank equity capital is given by 
  -  is the minimum capital required to be held on the balance sheet in the capital account, where  denotes the capital adequacy requirement ratio which is 8%

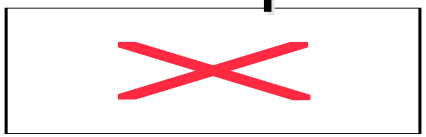
Insolvency analysis

Bank is solvent

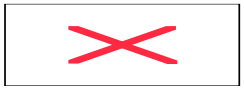


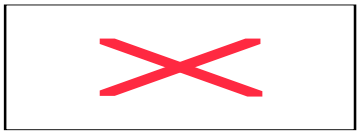
Bank is solvent, capital injection required





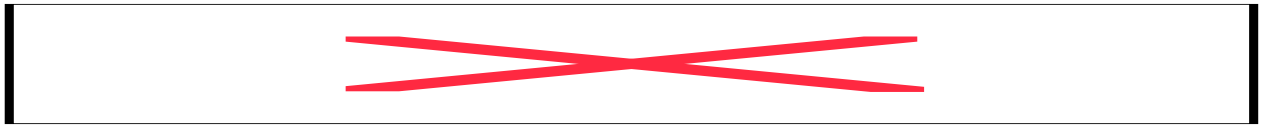
Bank is bankrupt





..Bank Model

- Securitizing (illiquid assets→tradable securities)
  - Condition for capital injection/accumulation:

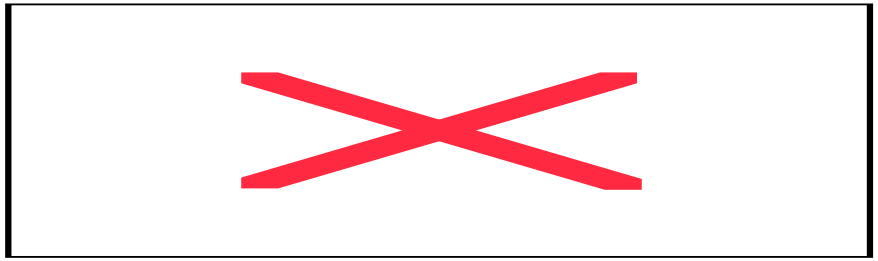


α: proportion of securitized asse[illegible]s

if M > 0 → capital injection is needed

if M < 0 → capital accumulation

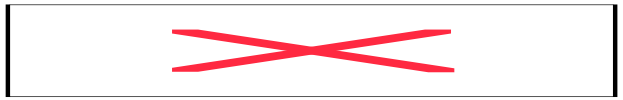
  - Asset accumulation process with securitization:

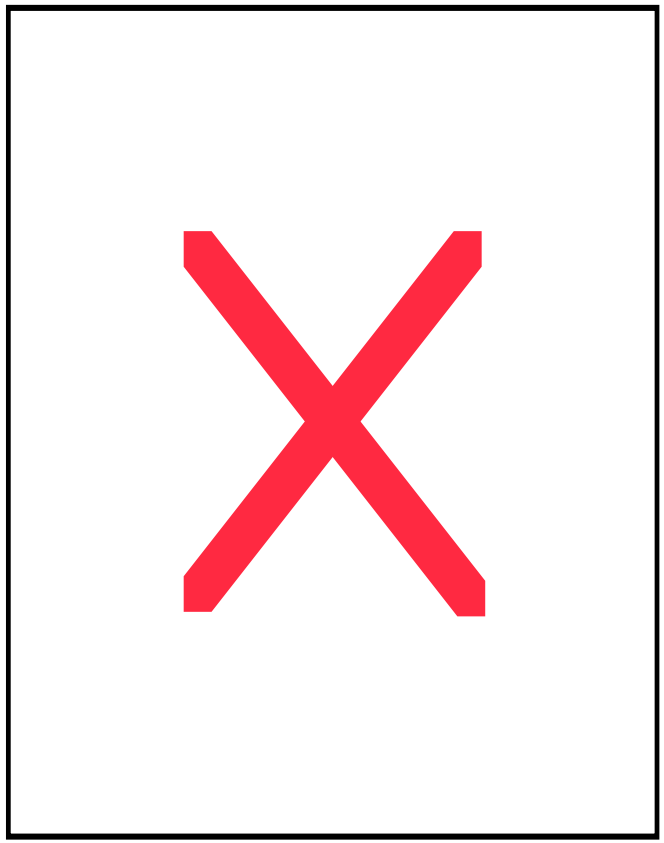


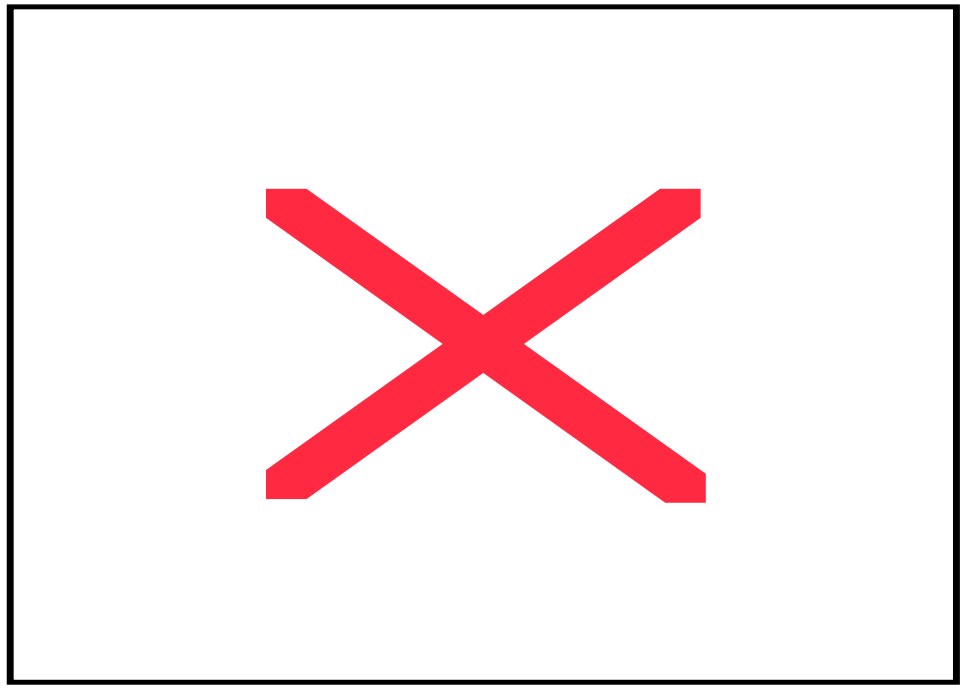
, where $C(\alpha)A_t$ denotes the

– **Optimal securitization ratio (minimising capital injections/ maximising capital accumulation):**

Costs of MBS

 is Coupon Rate on MBS.





Citibank Report 2007

Sub-prime Market

MBS over Loan on Real Estate

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2001.6	0.427332242	0.236253407
2001.9	0.393723897	0.205321179
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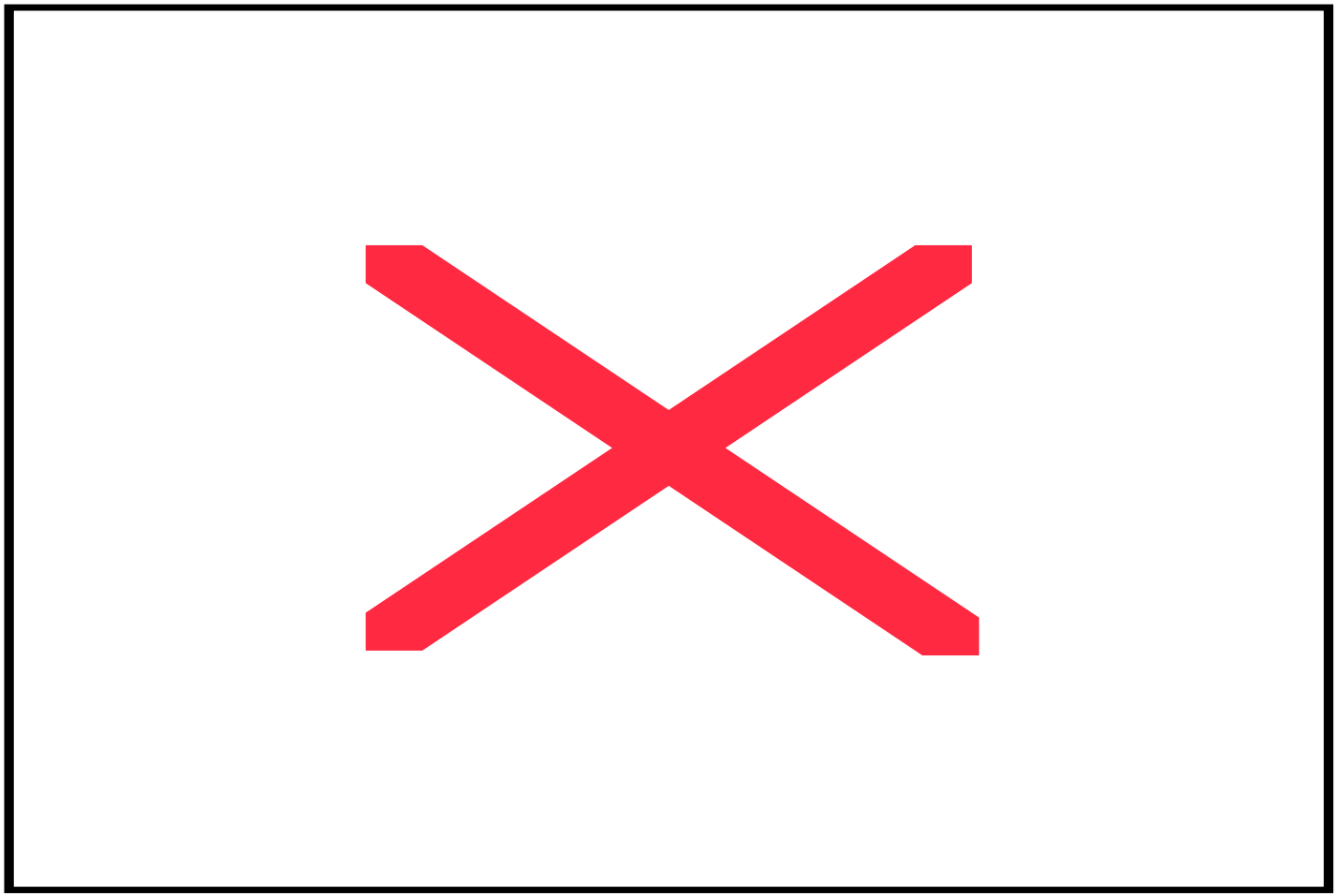
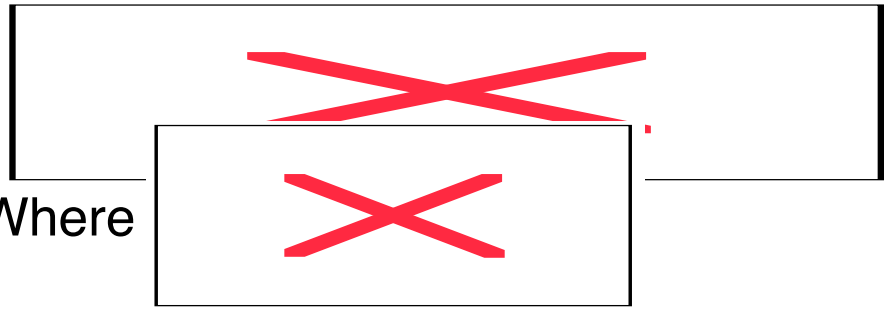
2004.3	0.037408302	0.112385321
2004.6	0.038606	0.127830593
2004.9	0.035673732	0.134108553

Sub-prime: Exploding ARM

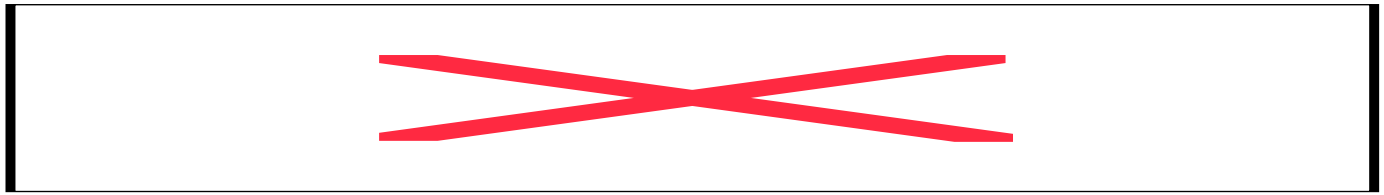


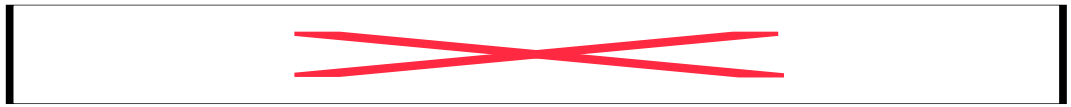
Dynamic Model Applied to Sub-prime

The Asset accumulation process:

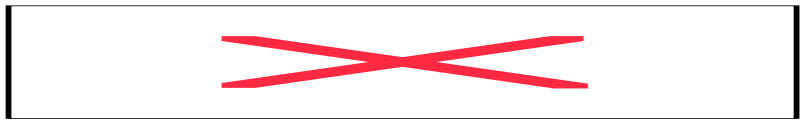


Where

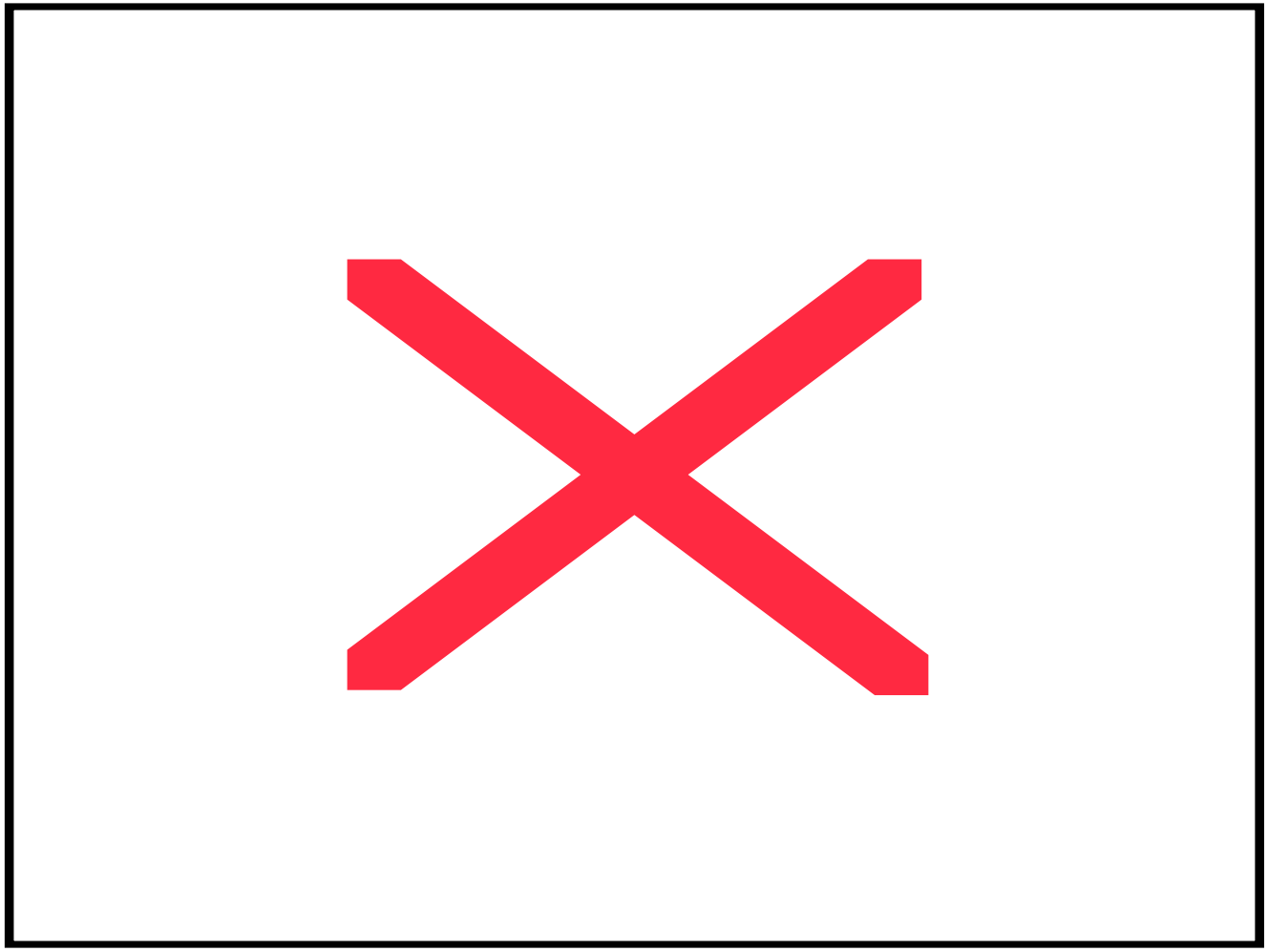




For the capital replenish in 5 years horizon



Capital Accumulation



ra = 15% and rd = 3% (for BB-) ; ra= 11%; rd=3% (BB) ; ra= 7.5% , rd= 3% (BBB);
ra = 5% rd = 3% (AA)

Insurance Model

- **The economic problem facing LAPFs**
  - **How to value their assets and liabilities when the assets are liquid and subject to market value while liabilities are not**
  - **Must be able to ensure there are always sufficient cash flow from the assets to meet the promised liability payment**
  - **Should be capable of delivering these pensions at the lowest economic cost to the sponsor**
- **Assumptions**
  - **A liability driven discrete time model**
  - **There are legal protections for fund members**
  - **The optimal asset allocation problem is solving backwards (the solvency determination process is**

Section 2 :Insurance Model

- **The basic ALM solvency analysis model**
  - **Initial endowment of assets (A^{LAPF}) to meet liabilities:**

$A^{LAPF} \geq C + k$

	Life insurance schemes	Pension schemes
where C:	The expected market of the liabilities	The expected value of claim payments under the scheme rules
and k:	The provision for adverse deviations provided as risk capital or equity	The margin added to the expected value of future claim payments by the actuary in establishing the scheme sponsor's contribution to the fund

Initial assets can be re-expressed as:

$A^{LAPF} \geq (1+\rho)*C$, where $\rho = k/C$ → solvency margin

If actual assets > A^{LAPF} → we have an initial surplus

otherwise → the fund is solvent and closes

….Insurance Model

- **..The basic ALM solvency analysis model**
  - **End of period solvency condition (traditional assets/credit assets)**

,

: traditional assets, :

credit assets, L_t: liabilities, and : the cost of any particular investment strategy

where

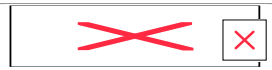
  - **Impact of solvency analysis on fund capital reserves**

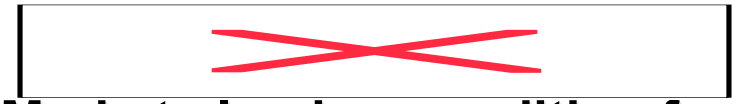
Assuming a legal protection for scheme sponsors in the event of insolvency, an initial capital reserve K such that k K is defined by

$$K_t = (1+ r^{global})^* \max(0, K_{t-1}+ St)$$

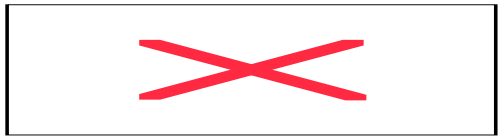
r^{global} represents the risk free rate

Market clearing

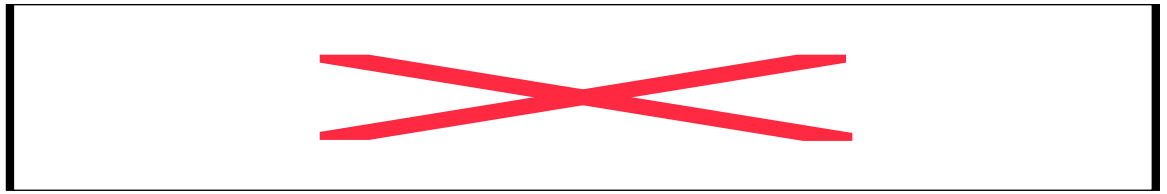
- **Solving**  **for x given a quadratic cost function**  **where is constant, the optimal demand for credit assets by LAPFs is obtained by:**



- **Market clearing condition for credit asset cash flow in the calibrated model with both banking and LAPF sectors:**

 ,if 

If  Fire sale on Credit Asset,



Influences on the optimal asset allocation of LAPFs:

- The spread between returns on credit assets and traditional assets
- As securitization rate in the banking sector increases, returns on credit assets increase and so does demand for such assets by LAPFs
- More stringent regulatory pressures on LAPFs through an increase in ρ will ultimately reduce the demand for credit assets

LAPF Portfolio & Equity with Credit Assets

Gamma=90%

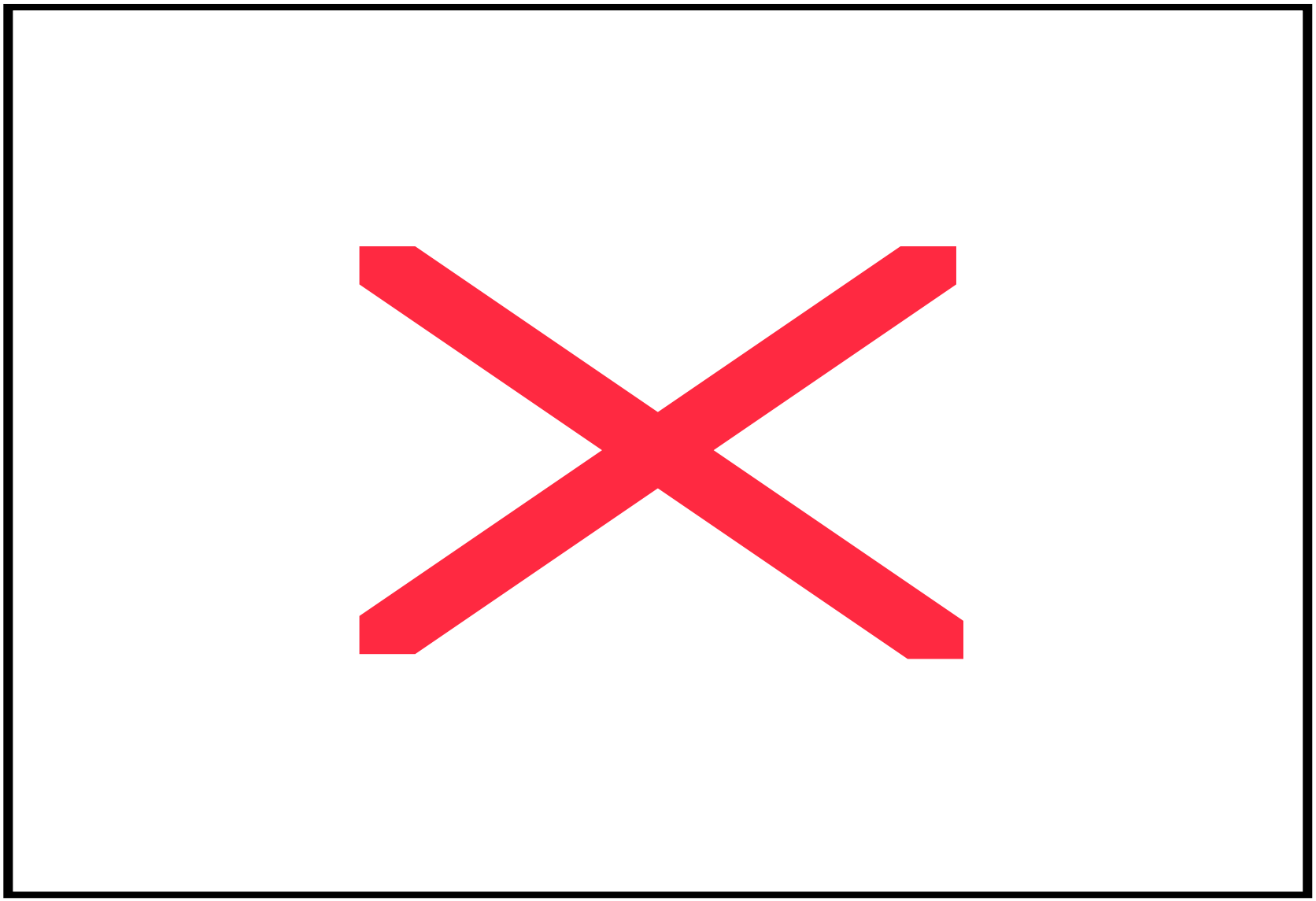
°°	Asset	Liability	Optimal x	r Credit	r E	Surplus
Year 0	100	92	°°	°°	°°	°°
Year 1	100.596	94.76	0.3925	−0.2369	−0.2448	−26.178
Year 2	98.9839	97.6028	0.3862	0.1439	0.1362	14.82203
Year 3	93.0362	100.5309	0	0	0.0754	8.255988
Year 4	78.6531	103.5468	0	0	0.1671	−21.0867
Year 5	47.9359	106.6532	0	0	0.1045	−27.8249

Gamma=93%

°°	Asset	Liability	Optimal x	r Credit	r E	Surplus
Year 0	100	92	°°	°°	°°	°°
Year 1	104.5692	94.76	0.6023	−0.2327	−0.2448	−28.7152
Year 2	110.7908	97.6028	0.6381	0.1489	0.1362	15.0111
Year 3	120.1779	100.5309	0.6922	0.0892	0.0754	8.6255
Year 4	135.7018	103.5468	0.7816	0.1827	0.1671	18.6449
Year 5	163.2011	106.6532	0.94	0.1233	0.1045	12.2005

Rho=17%, rA=10%,A0=100,L0=92

Solvency Analysis For LAPFs



Note: High Dutch Insurance Supervisory Board Solvency Margin (rho=30%) does not help.

Concluding Remarks

- Subprime lender with default rates in excess of 10% will be insolvent by year 4.5.

- Default on MBS resulting in insolvency of originator can result in huge loss of value. Entire portfolio of these can becomes worthless.

- Institutions with large portfolios up to X=38% of sub-prime credit assets (with gamma=90% and above) will be insolvent by year 2.

High Dutch Insurance Supervisory Board Solvency Margin (rho=30%) does not help.

- **Future research to fully incorporate CDO structure**
- **Bear Raids**
- **Mark to market accounting**
- **The short money market**
- **Central Banks**