Basel II and Financial Stability

Reserve Bank of New Zealand
Workshop on Financial Sector Balance Sheets and Vulnerability to Financial Crisis

September 25, 2006

by

Paul Kupiec

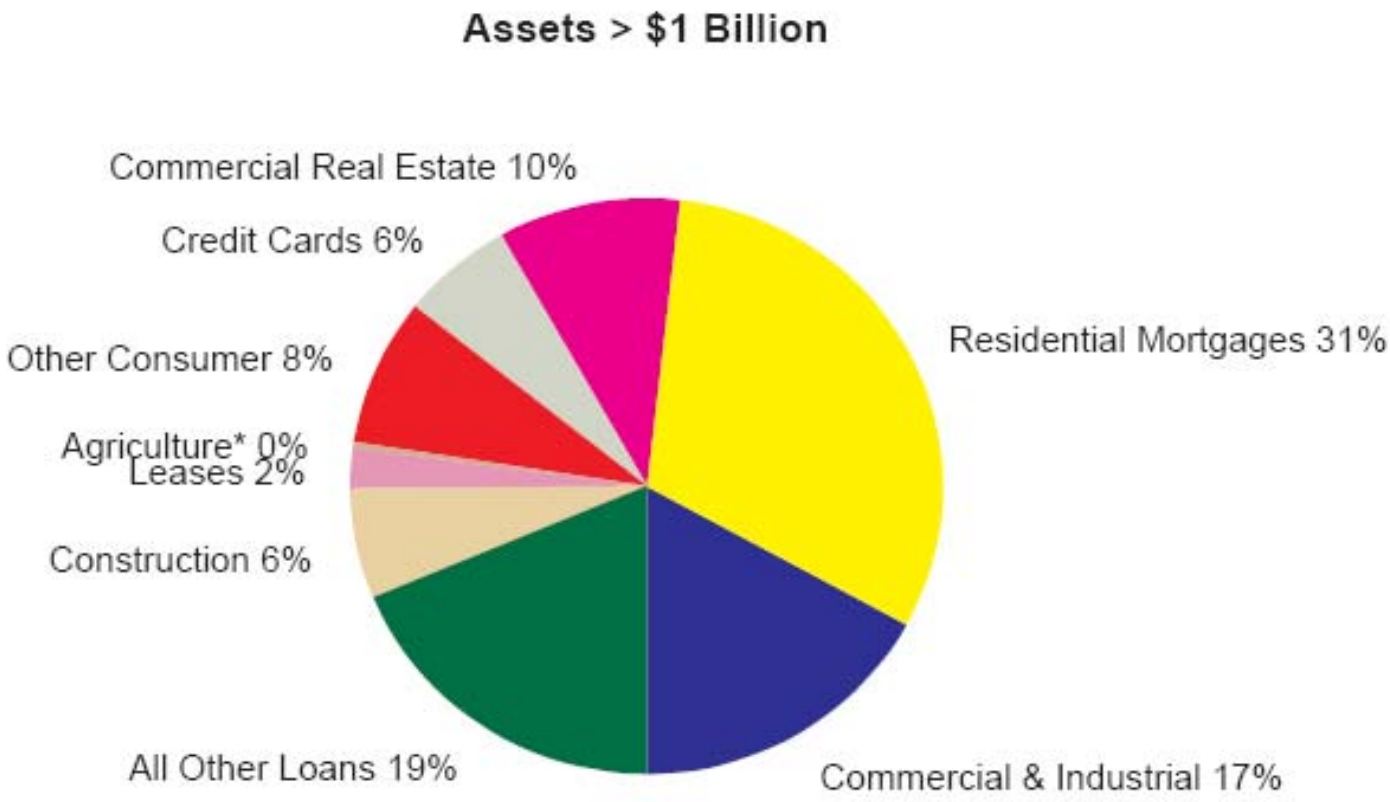
Division of Insurance and Research, Federal Deposit Insurance Corporation.

Talk Objectives

- Review briefly developments in US mortgage markets and banks as they relate to US financial stability
- Evaluate implementation of Basel II against supervisory goals
  - Enhancing financial stability
  - Basel AIRB as standard for sound risk measurement practice
- Provide additional focus on Basel II and residential mortgages credit risk

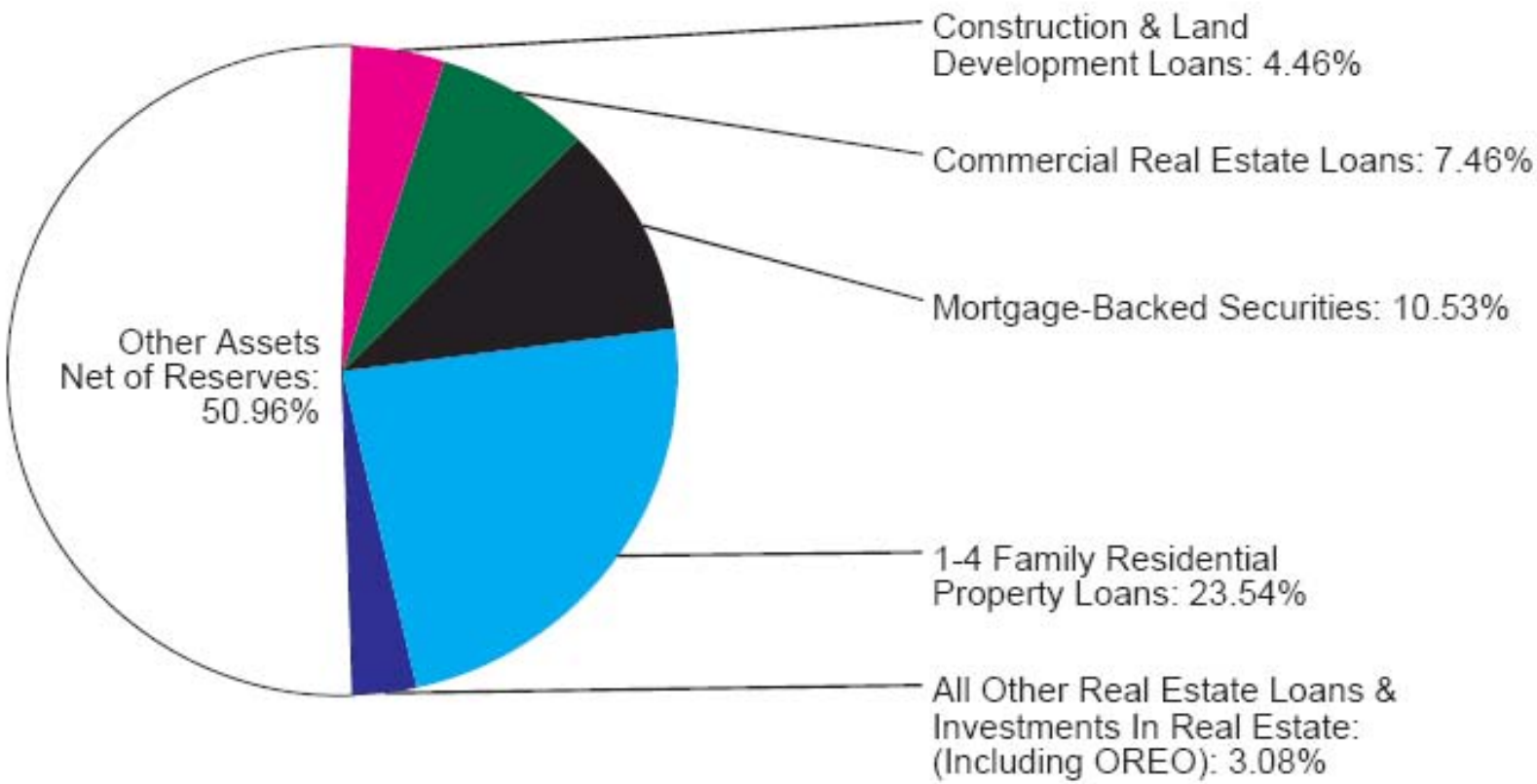
US Mortgage Market and Banking Developments

FDIC Insured Large Institution Asset Composition, June 2006



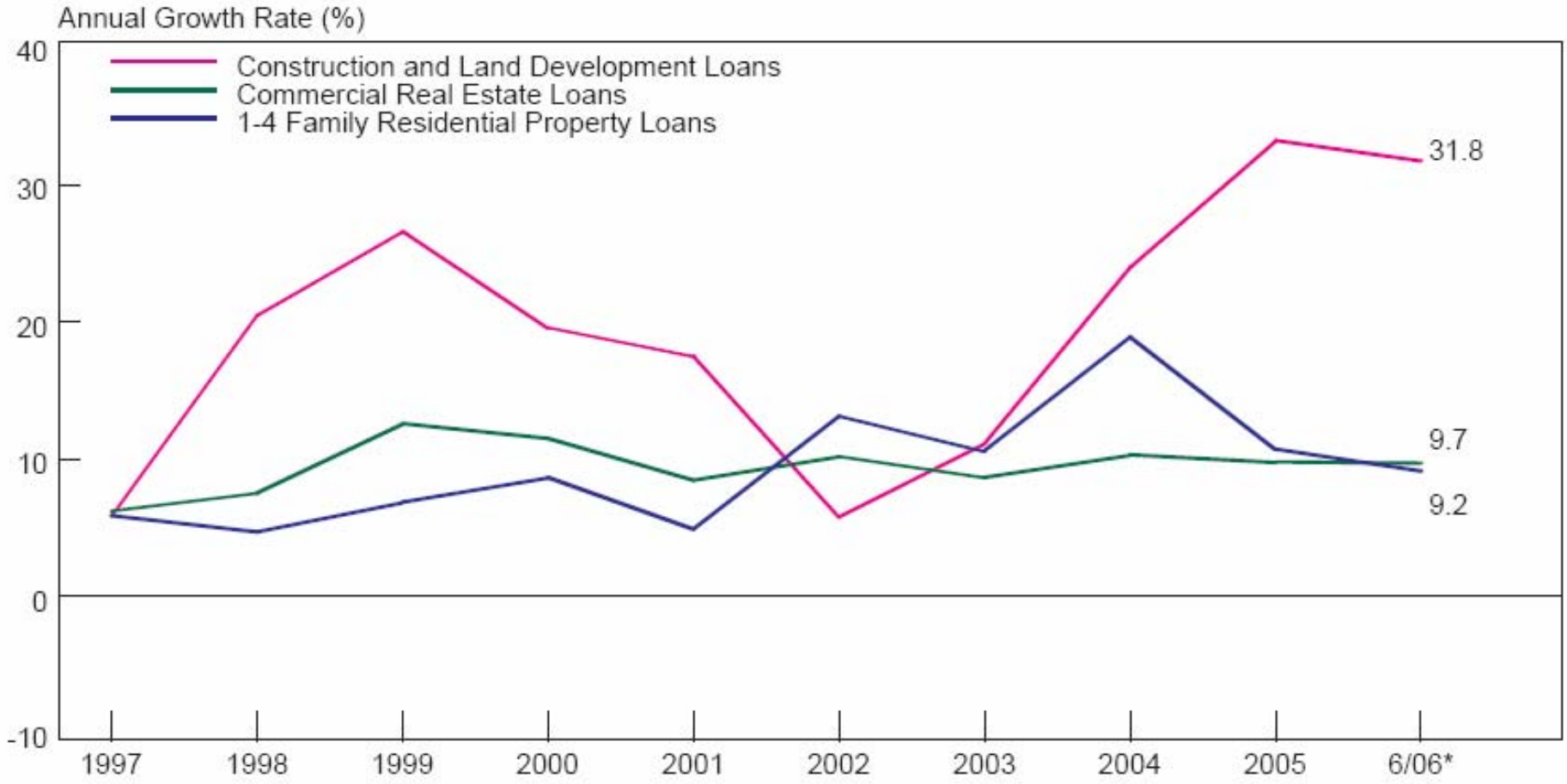
Real Estate Assets as a Percent of Total Assets

June 30, 2006



Real Estate Loan Growth Rates*

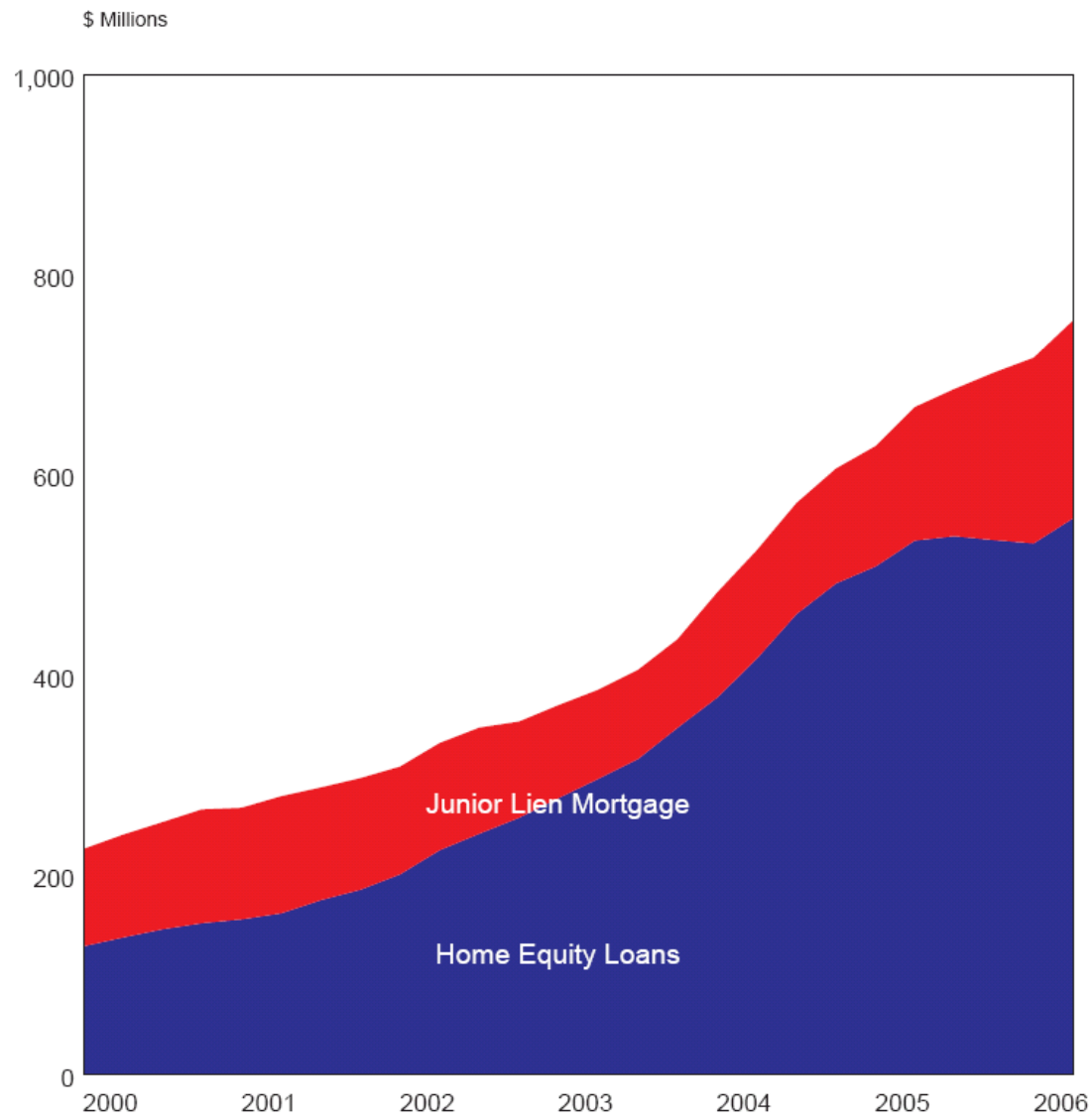
1997-2006



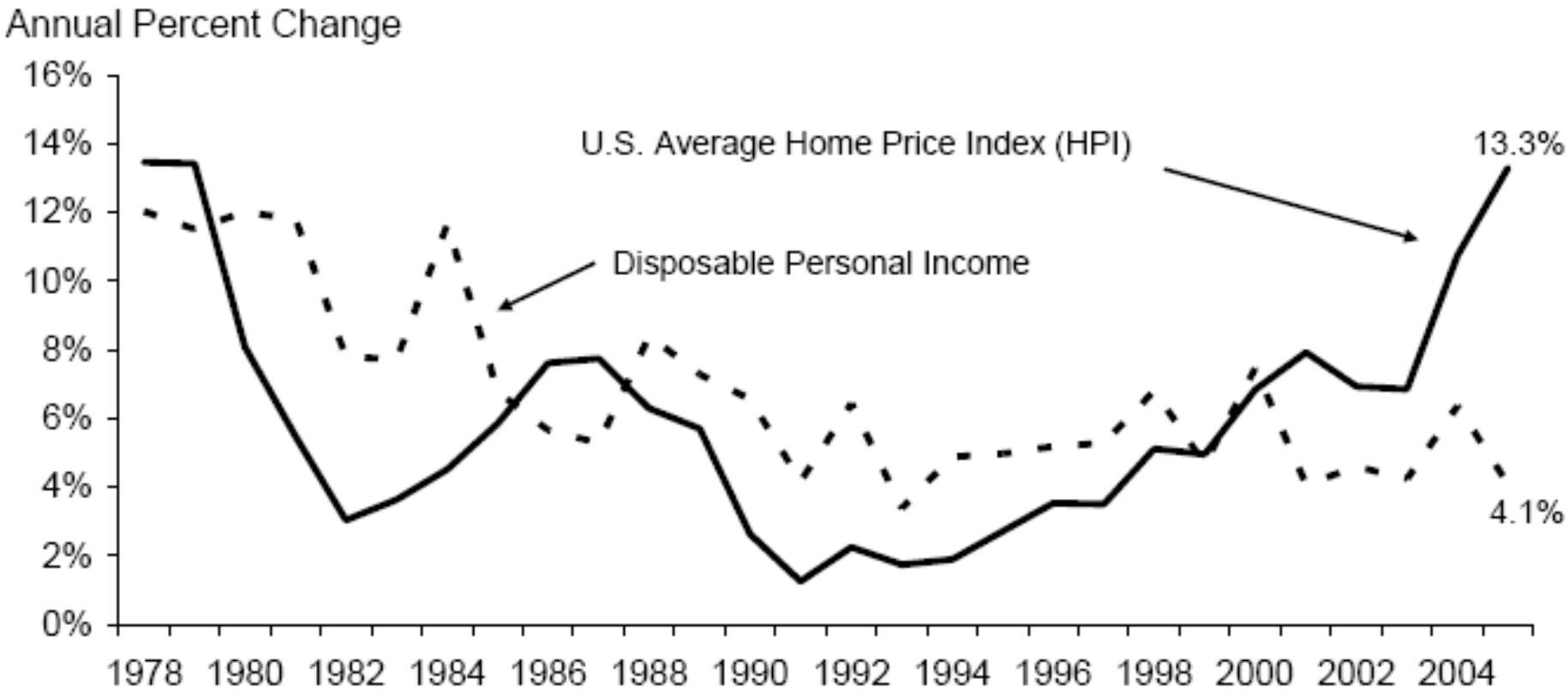
* Growth Rate for the most recent twelve-month period.

Home Equity and Junior Lien Loans

2000 - 2006

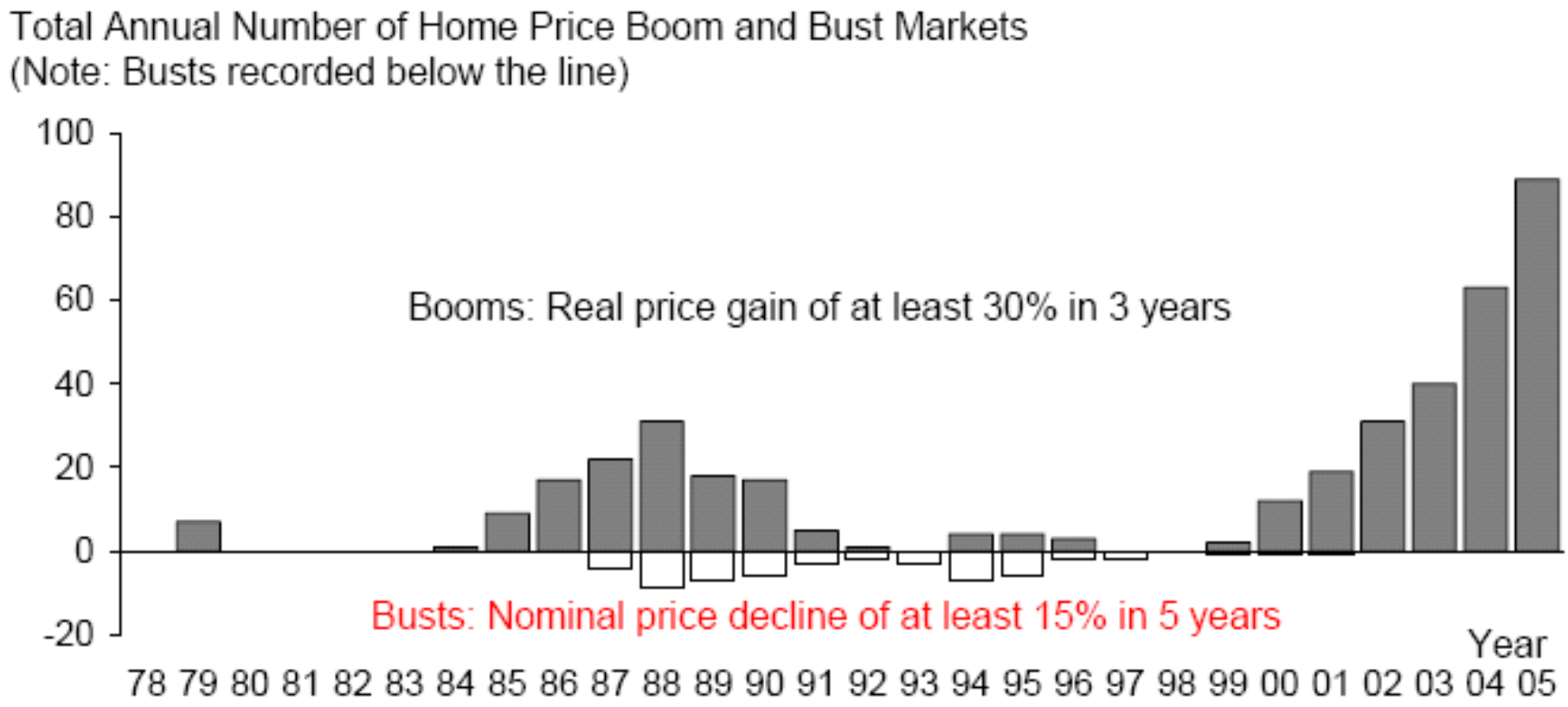


Recent U.S. Home Price Increases Have Outpaced Income Gains by a Wide Margin



Source: OFHEO, Bureau of Economic Analysis.

The Number of U.S. "Boom" Housing Markets Nearly Tripled to 89 Between 2002 and 2005



Source: FDIC analysis based on OFHEO house price index (HPI). See C. Angell and N. Williams, "U.S. Home Prices: Does Bust Always Follow Boom?" FDIC, FYI, February 10, 2005.

Do Busts Follow Booms?

- Sometimes, but not a strong relationship
  - In 35 of 54 boom mkts ID'd in an FDIC study, prices fell in at least one five years following boom
  - in only 9 markets did prices decline by at least 15%
- Booms often have strong fundamental factors at play
- Busts explained by "special factors" causing local economic distress
  - energy-sector problems that beset Houston, Anchorage, AK; Casper, WY; Grand Junction, CO; Lafayette, LA; Oklahoma City, OK; and five metropolitan areas in Texas in the late 1980s.
  - New England to slowdown in commercial real estate construction and the effects of the 1990-91 recession
  - Southern California to defense industry cutbacks & 1990-91 recession
  - Peoria, IL from 1984 through 1988 to distress in the U.S. farm sector
  - Honolulu, HI from 1996 through 2001 to distress in the Japanese economy
- This time?

Mortgage Underwriting Trends

- Supervisory surveys find reduced underwriting standards
- 43% of first time home buyers had 100% LTV in 2005 (Nat Assoc of Realtors)
- Increase in homes bought for investment purposes (vs. owner occupied)
  - 25 percent in 2004; 28 percent in 2005
- Increased use of “no doc / low doc ” loans
- Increased use of “piggy backs”
- Innovative mortgage products used to qualify buyers in “hot” markets
- Innovative products & sub prime gain market share

Mortgage Product Trends

- 30-year fixed rate dominate through 2003
- Rates rose, ARM share increased
  - ARM share of conventional mortgages in 2004 and 2005 > 30 percent
  - ARM share moderated to 25 percent 2006.6
- Subprime loan originations doubled from 2003 to 2004.6 (from 9 to 19 percent)
  - Large share of subprime are securitized
  - ARM share among securitized subprime mortgages nearly 80 percent.

Mortgage Trends

- IO only and option ARMS originations grew dramatically in 2004-5
  - Options ARMS: Four payment options
    - Minimum payment: teaser rate (often 1 %, payment increases each year, e.g., by 7.5%)
    - Interest only payment option available for some extended period (e.g., 5 or 7 years)
    - 15 year fully amortizing payment
    - 30 year fully amortizing payment
- Minimum payment resets when LTV reaches trigger (e.g., 110% LTV-125% LTVs)

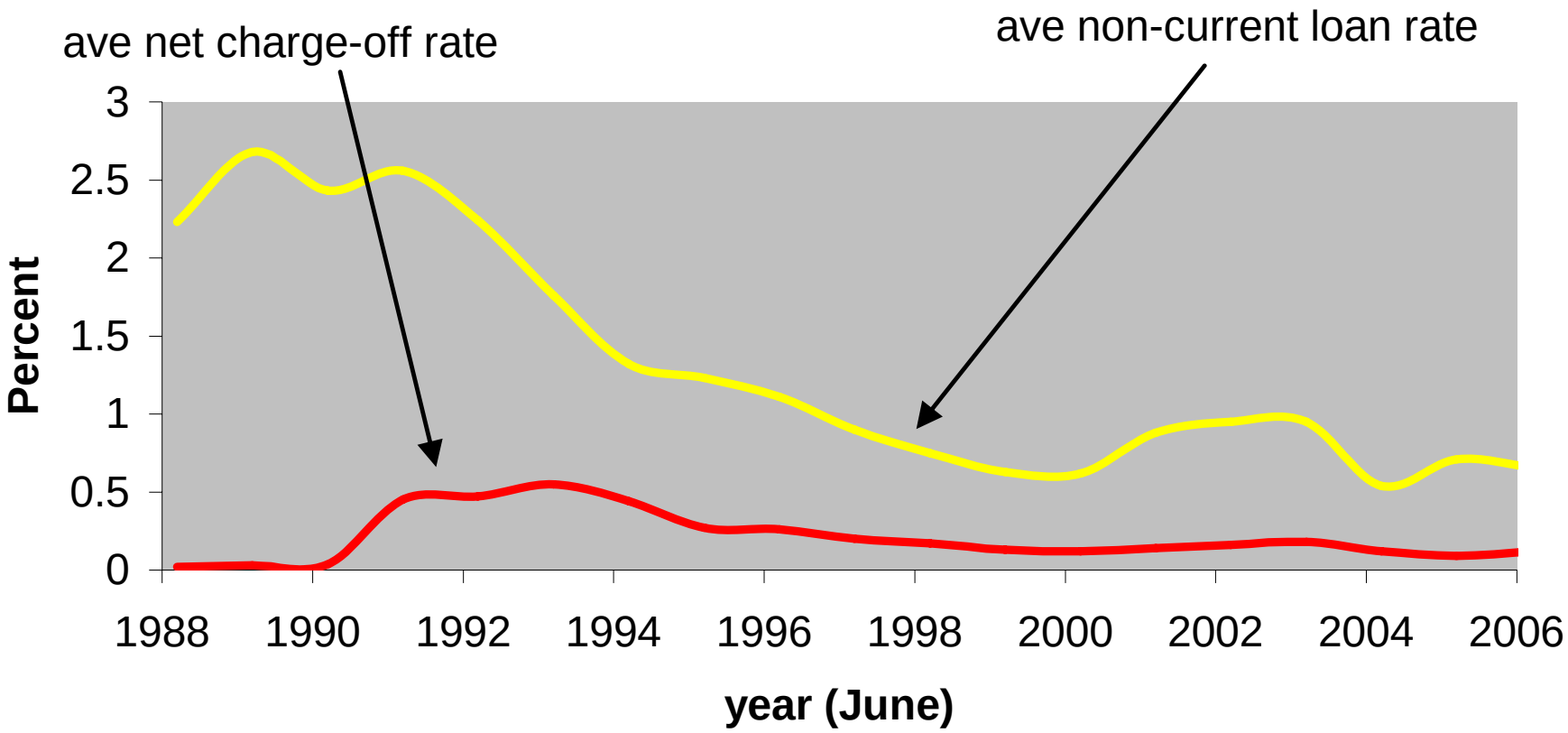
Option ARM Issues

- Combo of mortgage and a home equity line of credit
  - These products offered in NZ for a long time
- Problem?—used to “stretch” into otherwise unaffordable property
  - more than 80 percent of option ARMS are currently making only minimum payments
    - Negative “amming’ made worse by increase in short term rates
    - High proportion likely to trigger payment resets
    - What happens then?
      - Payment set by 30 year amortization
      - Loan LTV underwater
    - House price appreciation has moderated or stopped in many areas
      - Homeowners were “banking” on continued price appreciation
      - Weak home value gains limit ability to refi
    - Lax underwriting standards lead many observers to expect high default rates

Option ARMs and Bank Exposure

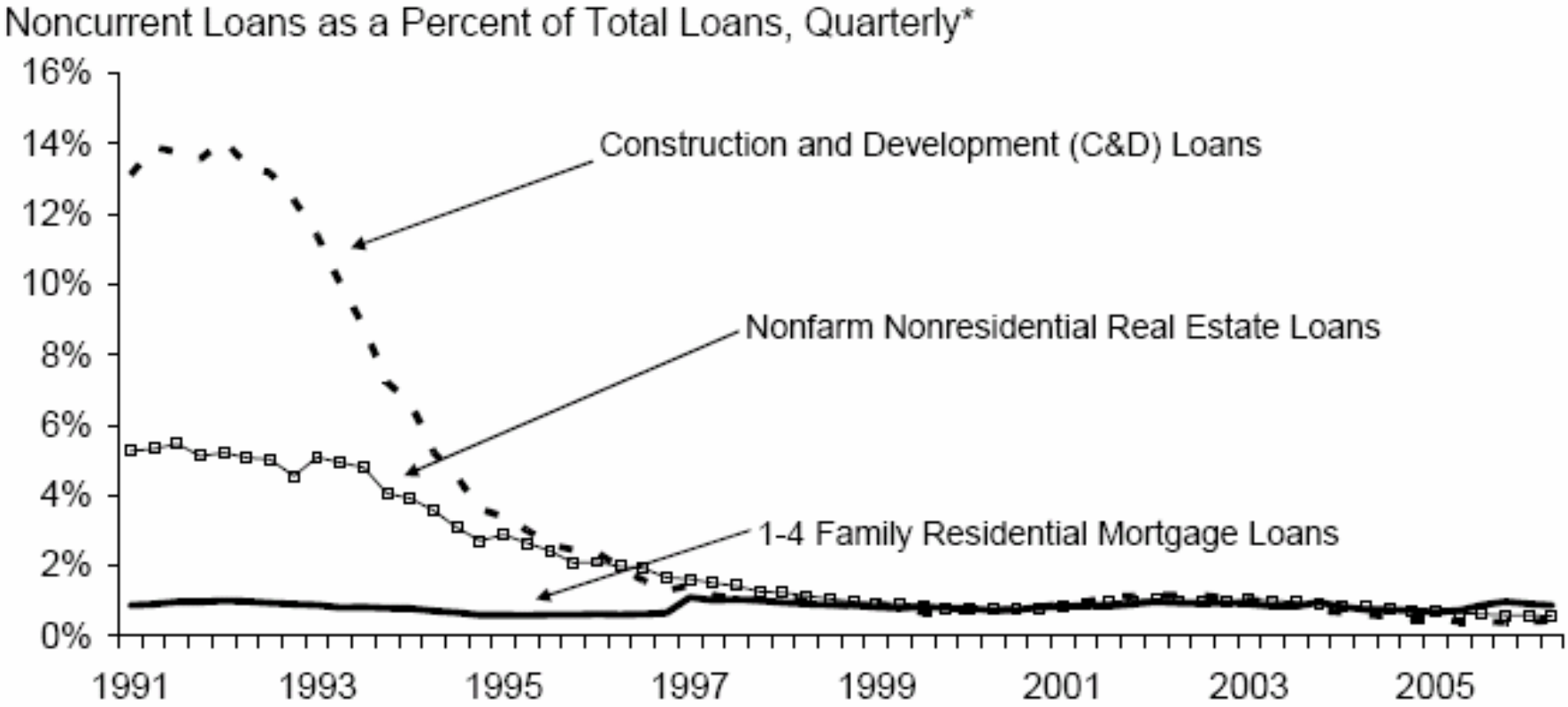
- Many Option Arms have been securitized
  - Estimate of between 40-50 percent of the collateral behind private label MBS in 2004-2005.
    - PIK MBS…Question: Do they find there way back on bank balance sheets??
- On-balance sheet option ARMS create “phantom (or non cash) ” bank earnings
  - Negative amm represents earned interest income
    - OK by GAAP
    - Counts as regulatory capital
    - Collection may become an issue
  - In short order, negative amm as a share of earnings has grown to a big potential issue at a few “shops”

Performance of FDIC-Insured Specialized Mortgage Institutions



Residential mortgages have a relatively good performance record in downturns

Noncurrent Rates for Home Mortgage Loans Have Stayed Far Below Rates for Other Real Estate Loans in Times of Distress



Source: FDIC. * Noncurrent loans = loans 90 days or more past due or in nonaccrual status.
Data for these individual loan types began to be collected in 1991.

Net Charge-offs as a Percent of Average Loans and Leases

By Asset Concentration Group

1988 - 2006, Annualized

Year to Date	International Banks	Agricultural Banks	Credit Card Lenders	Commercial Lenders	Mortgage Lenders	Consumer Lenders	Other Specialized < $1 Billion	All Other < $1 Billion	All Other > $1 Billion
06/06	0.55	0.14	3.15	0.17	0.12	0.94	0.70	0.15	0.19
06/05	0.70	0.13	4.26	0.22	0.09	1.16	0.32	0.29	0.19
06/04	1.13	0.15	5.03	0.32	0.12	1.29	0.50	0.27	0.29
06/03	1.42	0.20	5.36	0.56	0.18	0.90	0.45	0.28	0.58
06/02	1.49	0.24	6.42	0.67	0.16	1.04	0.51	0.28	0.76
06/01	0.60	0.20	3.86	0.56	0.14	1.08	0.48	0.27	0.71
06/00	0.48	0.16	3.80	0.39	0.12	0.18	0.46	0.21	0.50
06/99	0.46	0.19	4.18	0.39	0.13	0.54	0.20	0.26	0.43
06/98	0.47	0.15	4.84	0.33	0.17	0.69	0.70	0.24	0.55
06/97	0.21	0.19	4.66	0.31	0.20	0.98	0.30	0.24	0.74
06/96	0.40	0.18	4.04	0.32	0.26	0.79	0.13	0.22	0.44
06/95	0.20	0.10	2.99	0.35	0.27	0.40	0.43	0.17	0.34
06/94	0.73	0.10	3.14	0.43	0.44	0.51	0.13	0.15	0.38
06/93	1.24	0.16	3.99	0.75	0.55	0.68	0.48	0.32	1.14
06/92	1.71	0.31	4.95	0.96	0.47	0.71	0.55	0.42	1.03
06/91	2.30	0.28	4.71	1.23	0.45	0.83	0.69	0.55	1.03
06/90	2.80	0.39	3.91	1.05	0.36	0.69	0.80	0.54	0.80
06/89	1.13	0.44	3.66	0.59	0.03	0.32	0.69	0.43	0.36
06/88	0.76	0.65	3.64	0.85	0.02	0.44	0.76	0.49	0.43

Percent of Loans Noncurrent By Asset Concentration Group

1988 - 2006

	International Banks	Agricultural Banks	Credit Card Lenders	Commercial Lenders	Mortgage Lenders	Consumer Lenders	Other Specialized < $1 Billion	All Other < $1 Billion	All Other > $1 Billion
06/06	0.90	0.88	1.83	0.58	0.66	0.72	0.73	0.76	0.63
12/05	0.99	0.82	1.75	0.62	0.71	0.62	0.77	0.79	0.69
12/04	1.29	0.92	1.95	0.63	0.54	0.64	0.98	0.86	0.74
12/03	2.24	1.15	2.04	0.88	0.95	1.07	0.97	1.07	0.95
12/02	2.76	1.20	2.15	1.15	0.95	1.46	1.59	1.01	1.29
12/01	1.95	1.16	1.94	1.27	0.88	1.49	0.88	0.97	1.24
12/00	1.40	0.98	1.92	1.02	0.62	1.36	0.72	0.82	1.01
12/99	1.34	1.05	1.94	0.79	0.63	1.27	0.92	0.77	0.93
12/98	1.14	1.13	2.16	0.82	0.75	1.23	0.94	0.88	0.87
12/97	0.96	1.01	2.16	0.92	0.90	1.26	1.08	0.84	0.89
12/96	1.01	1.15	1.98	1.00	1.11	1.66	1.27	0.91	0.92
12/95	1.63	1.03	1.67	1.09	1.23	1.25	1.20	0.89	1.03
12/94	1.98	0.97	1.37	1.32	1.32	1.09	1.36	0.88	0.98
12/93	3.24	1.16	1.80	2.13	1.76	1.27	1.92	1.14	1.74
12/92	5.48	1.40	1.92	3.14	2.24	1.91	2.35	1.43	2.36
12/91	6.30	1.65	2.16	4.23	2.56	2.10	2.40	1.78	2.93
12/90	6.39	1.74	2.05	4.24	2.43	1.94	2.25	1.78	2.48
12/89	5.47	2.00	1.96	3.43	2.68	2.22	3.81	2.10	6.24
12/88	5.69	2.34	1.76	3.02	2.23	1.61	3.34	2.16	5.43

On to topic 2:

Will Basel II Improve Financial Stability?

Basel II Supervisory Objectives
(BCBS June 2006)

- **Strengthen the soundness and stability of the international banking system**
- **Promote the adoption of stronger risk management practices**
- Institute more risk-sensitive capital requirements that are conceptually sound
- Provide a detailed set of minimum requirements designed to ensure the integrity of bank internal risk assessments
- Broadly maintain the aggregate level of capital requirements
- Prevent capital adequacy regulation from becoming a significant source of competitive inequality among internationally active banks
- Create incentives for the adoption of the more advanced framework approaches.

Outline of Remainder of Presentation

- Explain/review origins of AIRB framework
- Compare Basel AIRB calibration assumptions with credit risk literature
- Implications of calibration: QIS 4 & QIS 5
- Should we worry about capital reductions?
- YES! AIRB understates capital needs.
- So why AIRB understates capital.

How to set capital?

- Logic of the AIRB capital rule
  - Need enough capital to "cover" credit losses that may materialize
  - Basel II "soundness standard—99.9 percent
- Capital $\geq$ 99.9 percent quintile of bank credit loss distribution
  - Enough capital to sustain the bank should it experience a very large and improbable credit loss
  - There is a BIG issue here we will come back too
    - Missing capital buffer for bank interest expense

Origin of the AIRB rule

- Problem:
  - Need method for approximating a credit portfolio's loss distribution
    - It cannot be too complicated
- Oldrich Vasicek designed model to do this (late 1980s)
  - Asymptotic single factor model of portfolio credit risk
    - Also called the Gaussian copula model
    - Mimics features of an economic model of credit risk but is far easier to compute
    - Expressions for Portfolio credit loss distributions calculated using full equilibrium asset pricing model relationships are very complicated
      - *(see Kupiec 2006b for an example)*

Gaussian Credit Risk Model Assumptions

- $\tilde{V}_i$ is a std Gaussian (normal)
  - ρ determines default correlation

$$\begin{cases} \tilde{V}_i = \sqrt{\rho}\,\tilde{e}_M + \sqrt{1-\rho}\,\tilde{e}_i \\ \tilde{e}_M \sim \phi(e_M) \\ e_i \sim \phi(e_i), \\ E(\tilde{e}_i\,\tilde{e}_j) = E(\tilde{e}_M\,\tilde{e}_j) = 0 \;\forall\, i, j \end{cases}$$

- Firm *i* defaults on its debt when $\tilde{V}_i < D_i$
- The unconditional probability of default is $PD = \Phi(D_i)$.

- The loss given default, *LGD*, is exogenous to the model.

Portfolio Risk

Portfolio composed of N credits with identical:

- initial market values of \$1
- correlations ρ
- default thresholds $D_i = D$.
- define and indictor function: $\tilde{I}_i = \begin{cases} 1 & if \quad \tilde{V}_i < D \\ 0 & otherwise \end{cases}$

$\tilde{I}_i \mid e_M$ = the indicator RV conditional on e_M

$$E\left(\tilde{I}_i \mid e_M\right) = \Phi\left(\frac{D - \sqrt{\rho}\, e_M}{\sqrt{1-\rho}}\right), \quad \forall i$$

Conditional on common factor realization

$$E\left(\left(\tilde{I}_i \mid e_M\right)\left(\tilde{I}_j \mid e_M\right)\right) = 0, \quad \forall\, i \neq j.$$

Conditional Independence

Asymptotic Portfolio

- Let $\tilde{X}$ = the proportion of credits that default in a portfolio $\tilde{X} = \dfrac{\sum_{i=1}^{n} \tilde{I}_i}{n}$

- Strong Law of Large Numbers requires:
  - $\lim_{n\to\infty}\left(\tilde{X} \mid e_M\right) = \lim_{n\to\infty} \left(\dfrac{\sum_{i=1}^{n}\left(\tilde{I}_i \mid e_M\right)}{n} \right) \xrightarrow[a.s.]{} E\left(\tilde{I}_i \mid e_M\right) = \Phi\left(\dfrac{D - \sqrt{\rho}\, e_M}{\sqrt{1-\rho}} \right)$

- So the probability distribution for $\tilde{X}$ is determined by $\tilde{e}_M$

$$\Pr\left[\tilde{X} \le x\right] = \Pr\left[\tilde{e}_M \ge \frac{D - \Phi^{-1}(x)\sqrt{1-\rho}}{\sqrt{\rho}} \right]$$

Gaussian Credit Loss Model

- Manipulation and substitution $\Rightarrow$ portfolio default rate distribution

$$\Pr\left[\tilde{X} \le x\right] = \Phi\left(\frac{\sqrt{1-\rho}\;\Phi^{-1}(x) - \Phi^{-1}(PD)}{\sqrt{\rho}}\right), \quad x \in [0,1]$$

- **Portfolio Loss Rate = default rate x LGD=** $LGD \cdot \tilde{X}$

Critical Loss Rate Value: Find x^* such that $\Pr\left[\tilde{X} \le x^*\right] = \alpha$

❾ Inverse portfolio cumulative loss rate distribution

$$LGD \cdot x^* = LGD \cdot \Phi\left(\frac{\sqrt{\rho}\;\Phi^{-1}(\alpha) + \Phi^{-1}(PD)}{\sqrt{1-\rho}}\right)$$

Unexpected Loss Capital

$$LGD \cdot \Phi\left(\frac{\sqrt{\rho}\ \Phi^{-1}(\alpha)+\Phi^{-1}(PD)}{\sqrt{1-\rho}}\right)-PD \cdot LGD$$

Capital for a soundness standard of 99.9%

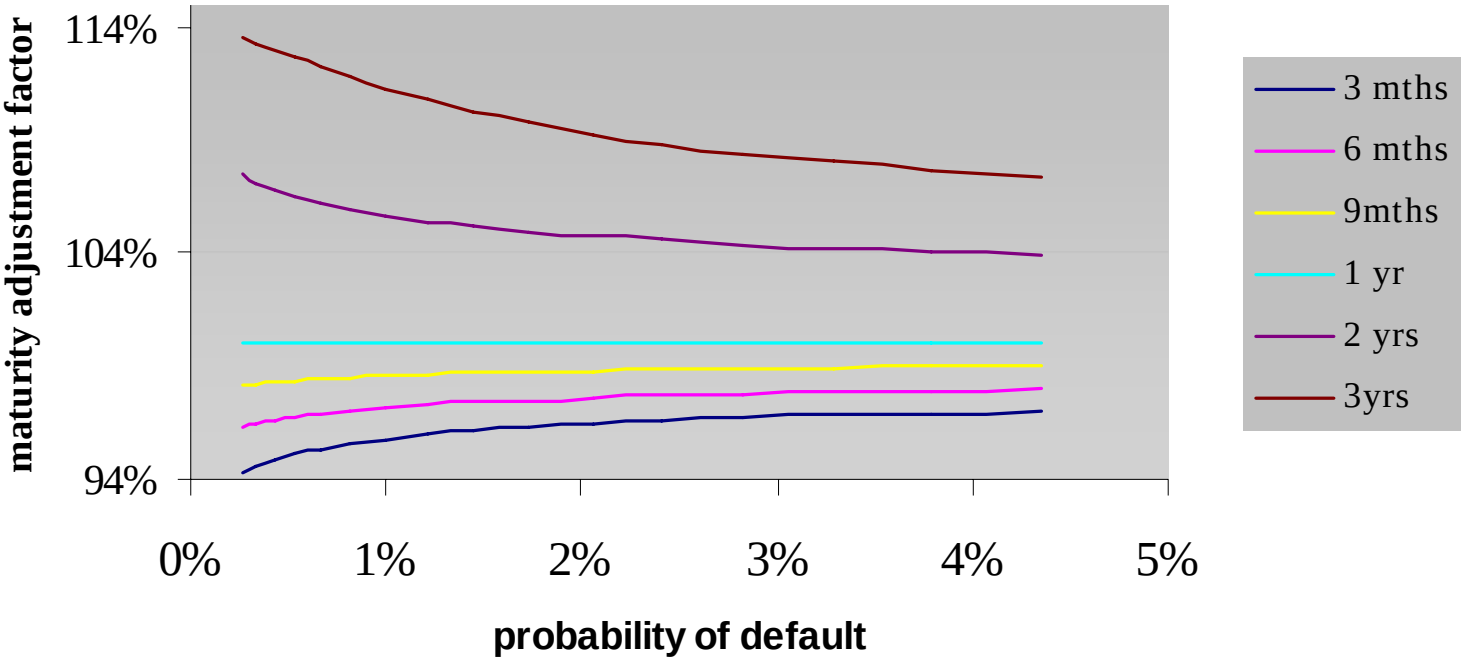
$$LGD \cdot \Phi\left(\frac{\sqrt{\rho}\ \Phi^{-1}(.999)+\Phi^{-1}(PD)}{\sqrt{1-\rho}}\right)-PD \cdot LGD$$

This formula sets minimum regulatory capital in Basel II A-IRB approach after:

- **a maturity adjustment for corporate…**
- **rho is assigned by regulatory rule**

Maturity Adjustment

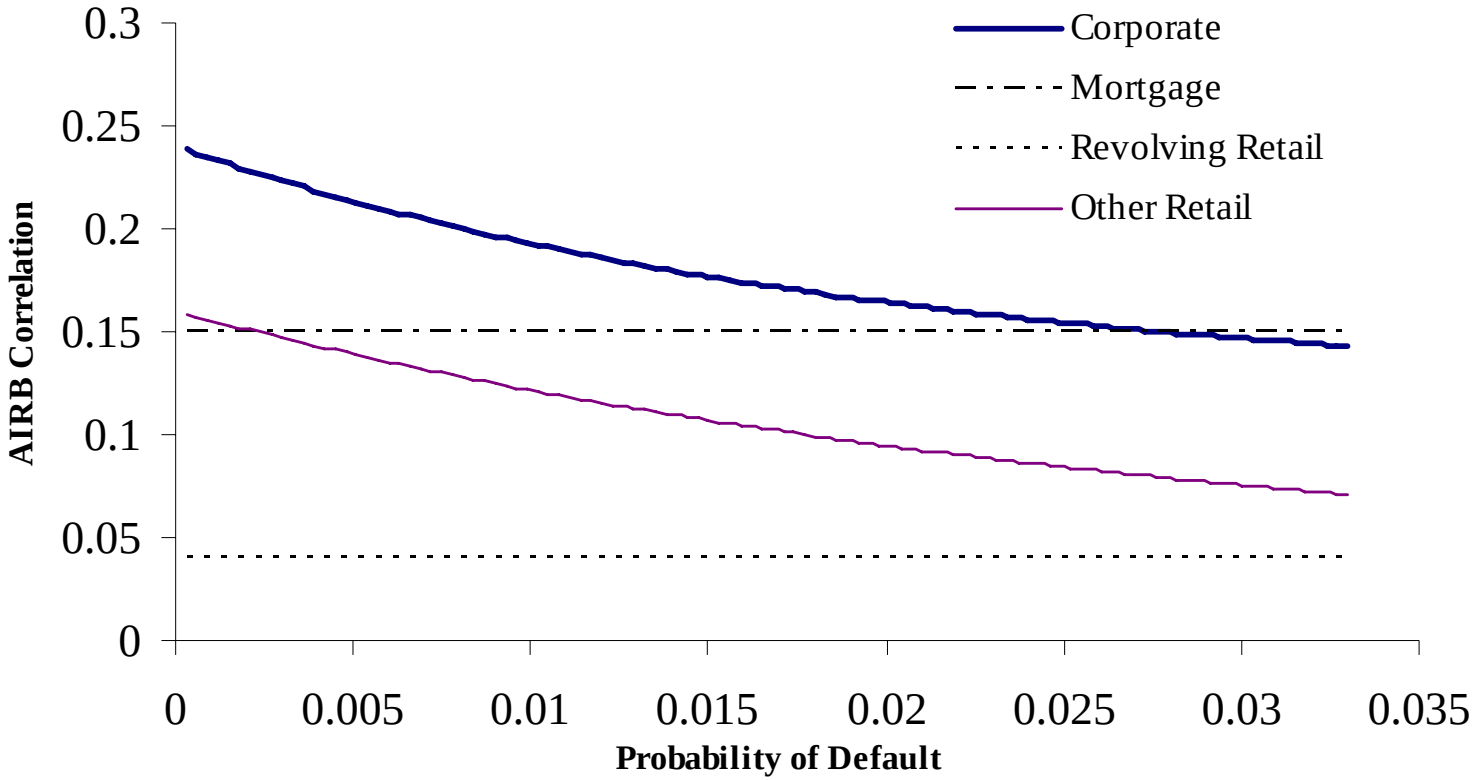
Figure 1: Maturity Adjustment Factors for Corporate, Bank and Sovereign Credits



Ad hoc adjustment calibrated so that AIRB mimics Moody's KMV Portfolio Manager capital assignments for credits of different maturity.

Regulatory Correlation Function

Figure 2: Basel II US AIRB Correlation Assumptions



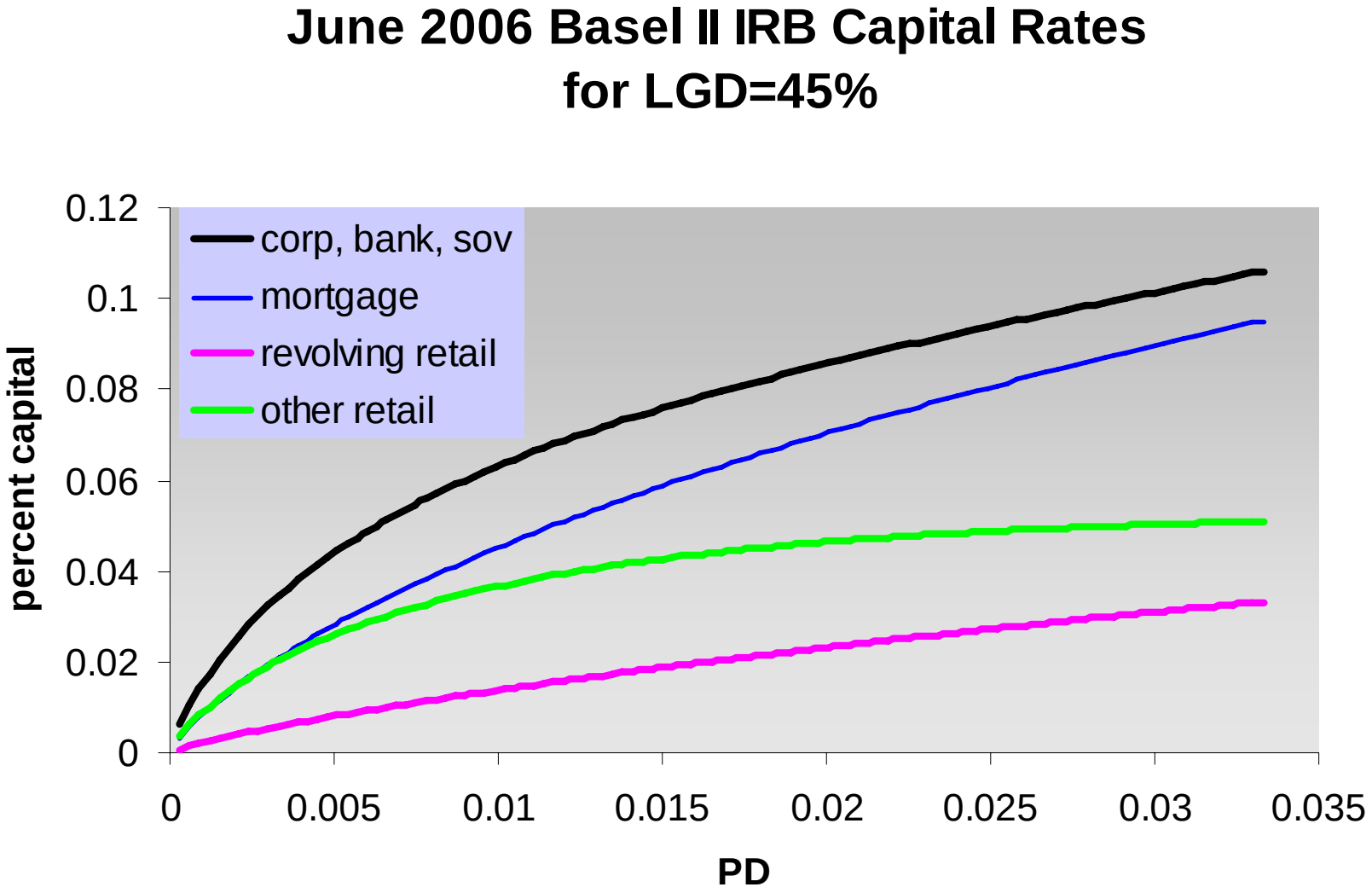
Correlations and Capital

- **For fixed PD & LGD**

lower correlation➘ lower capital

- Correlations calibrated by the BCBS [see BCBS July 2005] using G10 bank data that suggested:
  - (1) default correlation increase with firm size
  - (2) default correlations decrease as *PD* increases.
- Wholesale correlations set to mimic data patterns:
  - ➘bounded below 24% for lowest *PD*s; bounded above by 12% for highest *PD* exposures
- Retail correlations [See BCBS 2005, p. 14] "reverse engineered" so that AIRB capital approx equal to capital assigned by the internal capital models of a group of large internationally active banks

Capital & AIRB Correlation Assignment



A Closer Look at Mortgages under Basel II

Estimates of US Mortgage Capital Requirements under Basel II

mortgage pool LTV / FICO	estimated 10-yr annualized default rate (pct)	estimate downturn LGD (pct)	risk weight	estimate of Basel II capital (pct)	capital reduction from Basel I (pct)
70 / 620	0.27	16	0.09	0.72	82
70 / 660	0.16	16	0.06	0.48	88
70 / 700	0.1	16	0.04	0.32	92
70 / 740	0.07	16	0.03	0.24	94
80 / 620	0.51	25	0.21	1.68	58
80 / 660	0.31	25	0.15	1.2	70
80 / 700	0.2	25	0.11	0.88	78
80 / 740	0.15	25	0.08	0.64	84
90 / 620	1	33	0.46	3.68	8
90 / 660	0.62	33	0.33	2.64	34
90 / 700	0.42	34	0.25	2	50
90 / 740	0.3	34	0.19	1.52	62
95 / 620	**1.38**	**36**	**0.62**	**4.96**	**-24**
95 / 660	0.87	37	0.46	3.68	8
95 / 700	0.58	37	0.35	2.8	30
95 / 740	0.43	37	0.28	2.24	44
Jumbo Prime	0.27	25	0.13	1.04	74
Alt-A Pools	0.28	35	0.19	1.52	62
Seasoned & Diversified Prime Pool	0.19	25	0.1	0.8	80

Derived from FRB/LPC mortgage model

Derived form historical 5-yr ave loss rates on pools 1993-97

Jumbo PD assumes LGD=.15

Alt-A assumes LGD=.25

LPC/FRB model est assumes FICO>700, LTV<60

Source: P. Calem and J. Follain, "The Asset-Correlation Parameter in Basel II for Mortgages on Single-Family Residences", Federal Reserve Board, Nov 2003.

AIRB Implications

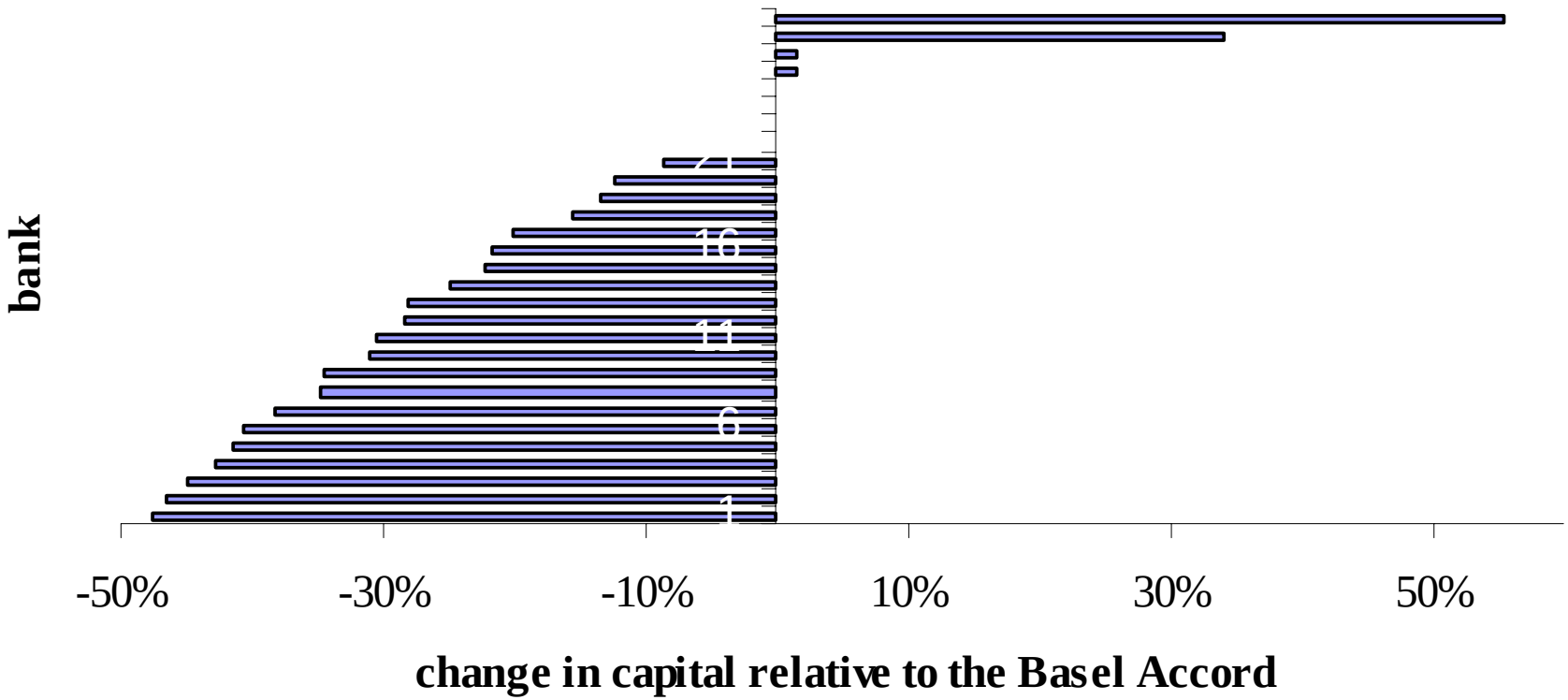
What will happen to capital under AIRB?

Capital will fall…

….probably by a large amount unless there are floors and limits

QIS 4 Results: US Banks

Figure 3: Estimates of Effective AIRB Changes in Minimum Required Capital of QIS4 Banks



QIS 4 Results

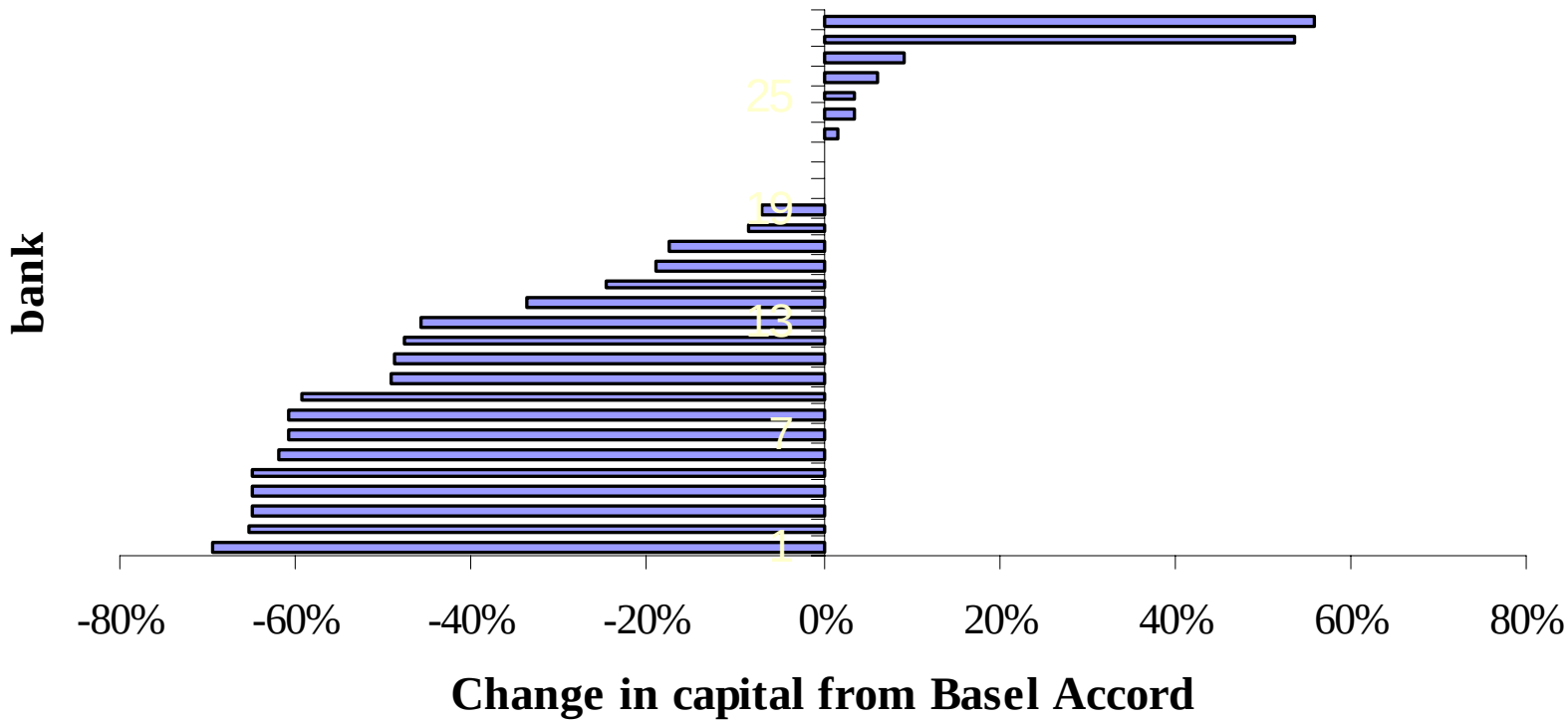
- QIS 4 shows:
  - minimum regulatory capital for 26 participating institutions falls by 15.5 in aggregate
    - median reduction in capital is 26 percent
    - median reduction in required Tier I capital is 31 percent.
  - banks report widely divergent capital estimates for positions with substantially similar risks
    - Syndicated loan analysis
    - Mortgage portfolio survey

QIS 4

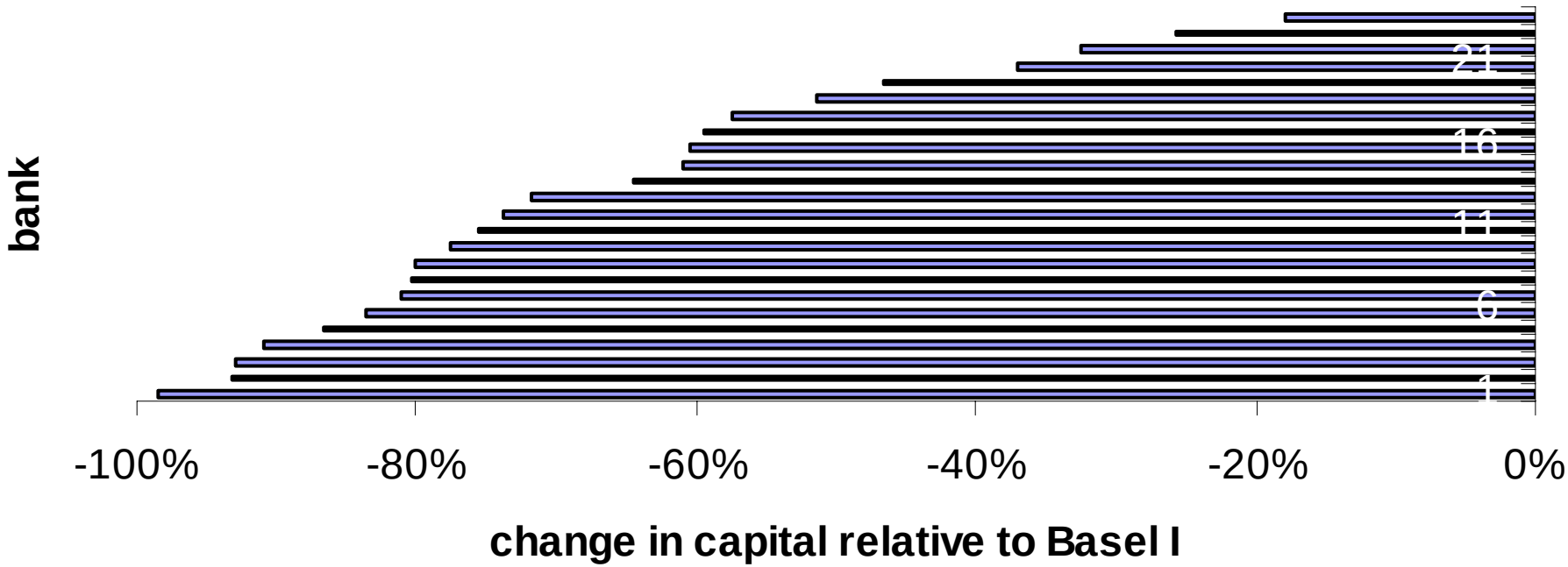
- Does AIRB fix “regulatory arbitrage”?
  - Jones (2000), Mingo (2000) JBF
  - Greenspan & others in speeches
  - ❾claim: regulatory arbitrage related to securitization activity is undermining the safety and soundness standards set under the 1988 Basel Accord

AIRB capital for securitizations

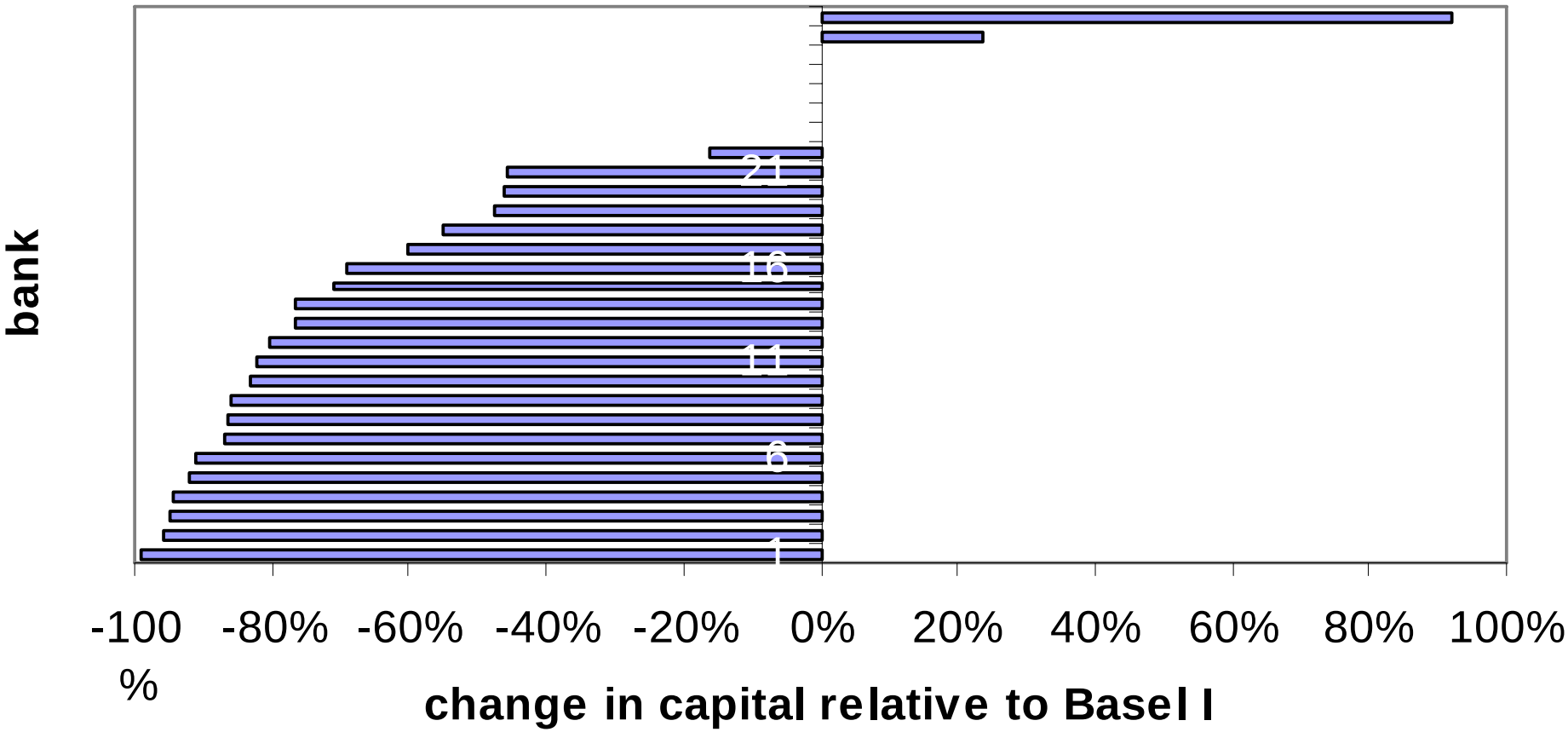
Figure 4: QIS 4 Estimates of AIRB Change in Capital for Securitization Exposures



QIS 4 Change in Required Capital for Mortgages under the AIRB



QIS 4 Change in Capital for HELOCs



QIS 5 Results: Europe &

- Overall, capital declined at Group 1 banks an average of 7.1 percent under the AIRB approach
  - Smaller banks, so called Group 2 banks, primarily nationally focused institutions, posted much larger declines in minimum regulatory capital **because of their large exposure to mortgages**
- Within Europe
  - Group 1 banks posted average capital declines of 8.3 percent under the AIRB
  - Group 2 banks declines averaged 26.6 percent under the AIRB

Evidence suggests significant capital reductions under AIRB

Should we worry about this? **(multiple choice)**

③ No, AIRB is a well-formulated capital model

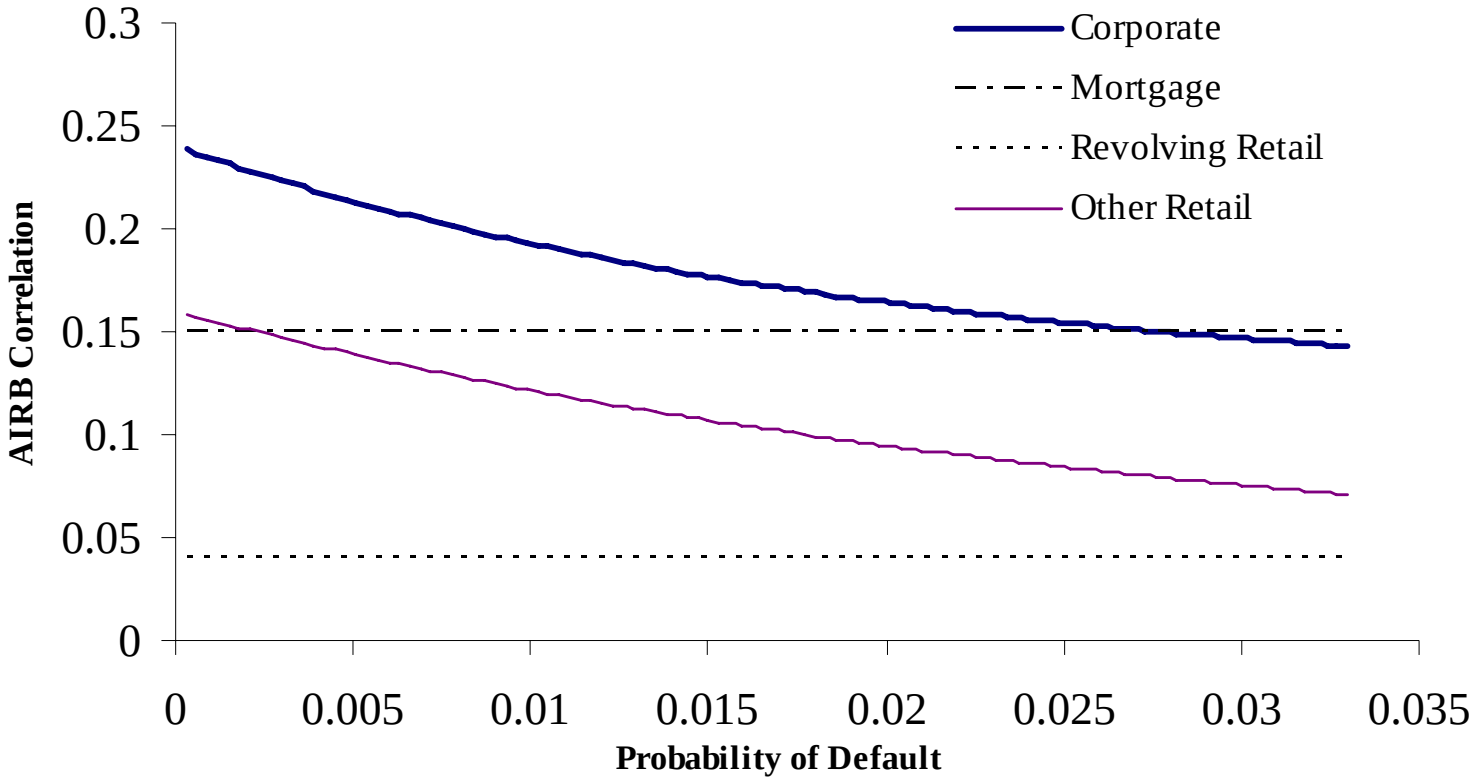
② Yes, AIRB has significant flaws that result in understated capital requirements

③ Uncertain

Discussion of AIRB Model & Calibration

Regulatory Correlation Function

Figure 2: Basel II US AIRB Correlation Assumptions



Correlation-PD Calibration Assumptions

- Complicated issue
  - Data suggests that default rate correlation increases as credit quality declines ---Opposite of AIRB calibration
    - Allen, DeLong and Saunders (2004), Cowan and Cowan (2004), Dietsch and Petey (2004), Das, Duffie, Kapadia and Saita (2004)
- **Problem:** AIRB assumes fixed default threshold, but default threshold is probably random
  - Cox (1977) stochastic barrier model
  - double stochastic intensity models of Das, Duffie, et, al.
- **Implies:** There are probably two correlations related to PD to worry about, not just one as AIRB assumes

Correlation and PD

- AIRB assumes $PD_i = \Phi\left(D_i\right)$
- Das, Duffie, et. al show $P\tilde{D}_i = \Phi\left(\tilde{D}_i\right)$

The unconditional tail loss value estimate from a double-stochastic model is likely larger than the tail loss estimate from the AIRB

❾AIRB will understate capital needs based on unconditional distribution

Examining AIRB Model Assumptions

- Strong evidence that LGDs increase when default rates are elevated
  - Studies by Frye (2000), Schuermann (2004), Araten, Jacobs, and Varshney (2004), Altman, Brady, Resti and Sironi (2004), Hamilton, Varma, Ou and Cantor (2004), Carey and Gordy (2004), Emery, Cantor and Arnet (2004)
    - show pronounced decreases in the recovery rates during recessions and periods of heightened defaults
- Implies a systematic component in LGDs

Examining AIRB Model Assumptions

- Strong evidence that draw rates on revolving lines increase as credit quality declines
  - Allen and Saunders (2003), Asarnow and Marker (1995), Araten and Jacobs (2001), and Jiménez, Lopez, and Saurina (2006)
  - suggests that obligors draw on their lines of credit as their credit quality deteriorates.
- Implies a systematic component in EADs

How Good an Approximation is the Gaussian Credit Loss Distribution?

Portfolio default rate is the single driver of credit loss uncertainty in AIRB rule

- Model ignores
  - ➢systematic risk in recovery rates
  - ➢systematic risk in draw rates on revolving lines
- Model assumes perfectly diversified portfolio
  - – Credit risk concentrations lead to different loss rate distributions….adjustment is a “pillar 2” issue
- Ignores interest on fully performing bonds

Upshot……

- AIRB loss rate distribution is inaccurate
  - Missing systematic risks generated by stochastic LGD and EAD
  - Correlations assignments questionable
  - Missing capital for concentration risk
- Unexpected loss is likely much larger that AIRB synthetic distribution suggests

Problem with using a Credit VaR measure to set capital….it forgets to pay interest on a banks funding debt

- *This is a problem with the logic used to set capital*
- *This problem compounds issues created because the AIRB model inaccurately measure the true tail values of bank credit loss distributions*

In addition to covering UL, a bank needs capital to cover its interest expenses

- Minimum capital = 99.9% critical value of portfolio credit loss distribution

❾AIRB capital rule omits capital necessary to pay bank interest expenses

To avoid default:

Minimum Capital=UL+EL+Bank Interest Expense

How important are these weaknesses in the AIRB approach?

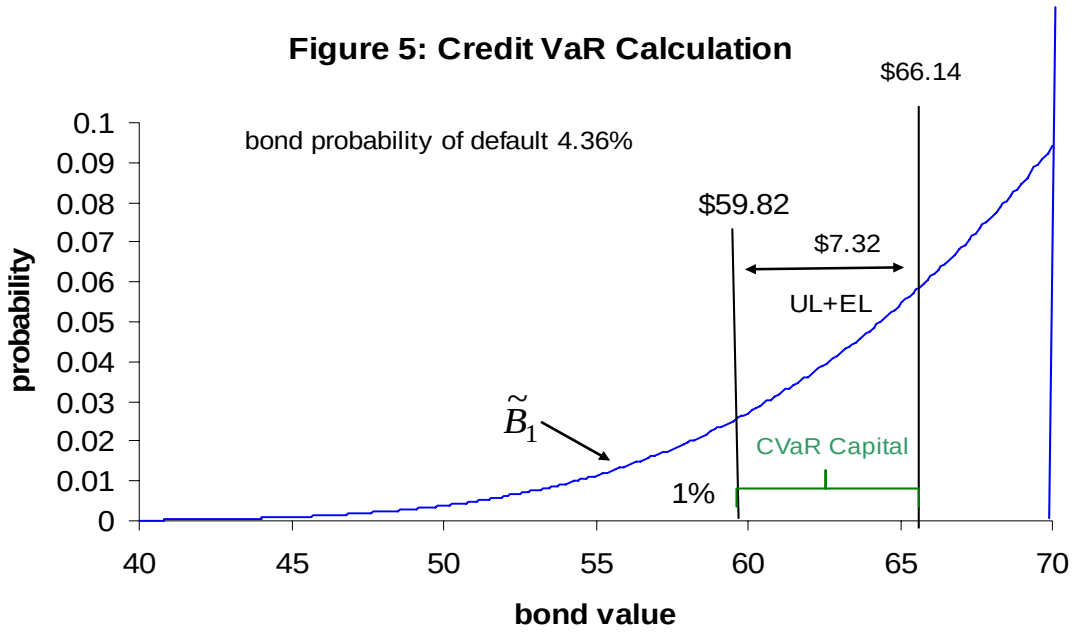
Pretty Important

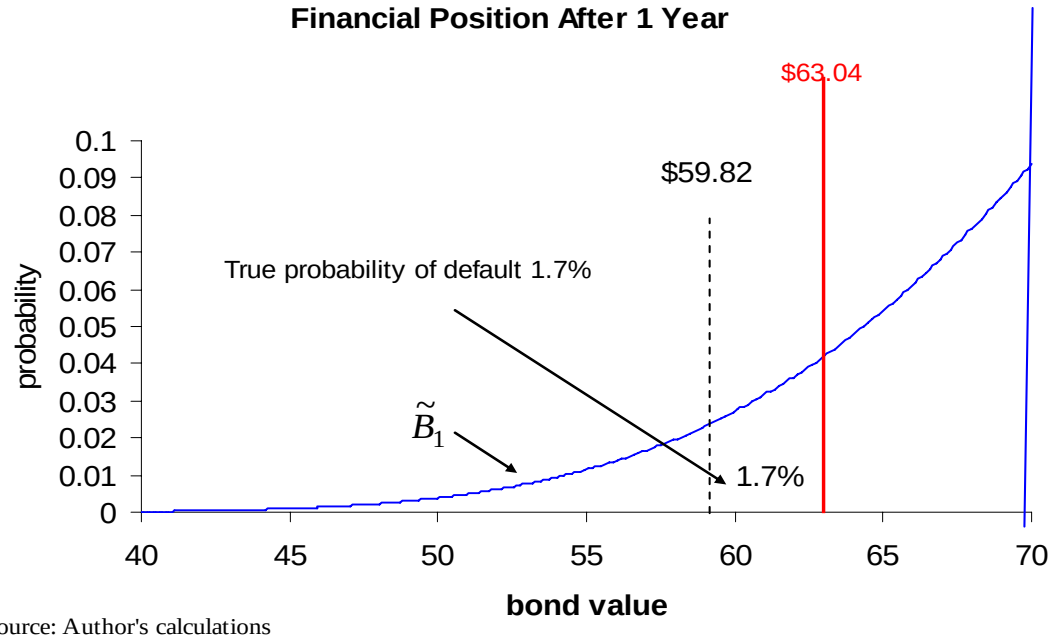
AIRB capital assignments are substantially understated

AIRB Rule Omits Capital for Bank Interest Expense

Importance of Interest Expense

- Bank buys bond
  - Bond cost $66.14
  - Matures in 1-year, pays $70
- 99% Credit VaR Capital Calculation
  - Only 1 percent of outcomes <$59.82
  - $66.14-$59.82 = $7.32 = CVaR capital
- Actual probability of default is 1.7%





Source: Author's calculations

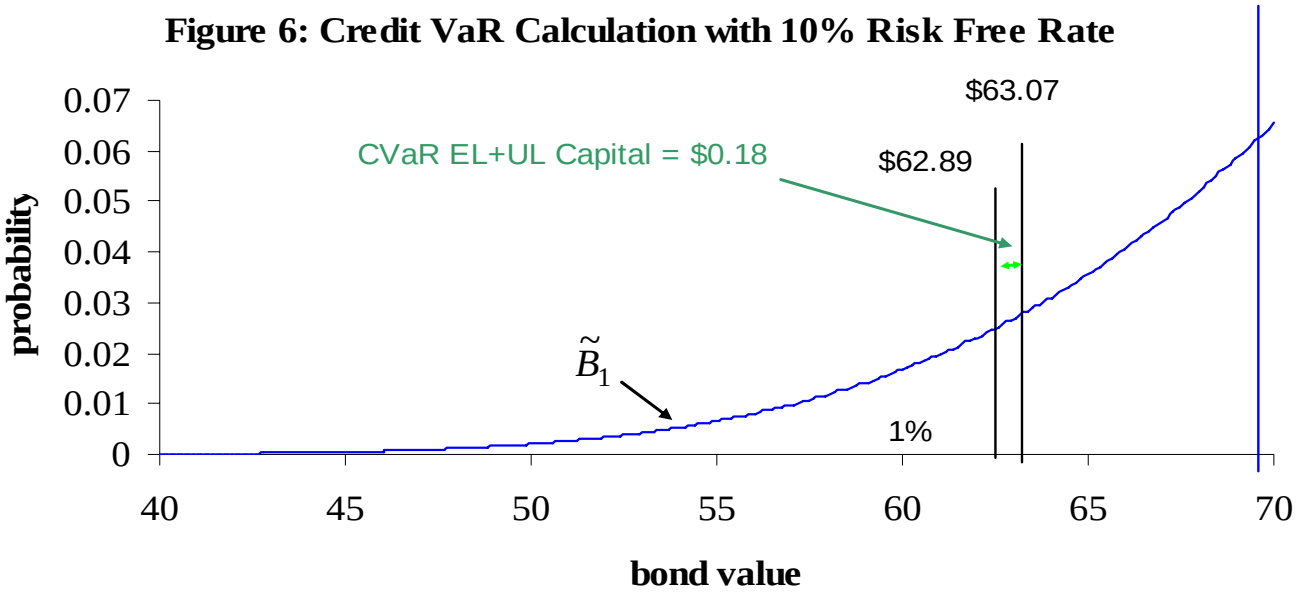
Omission of Interest Expense

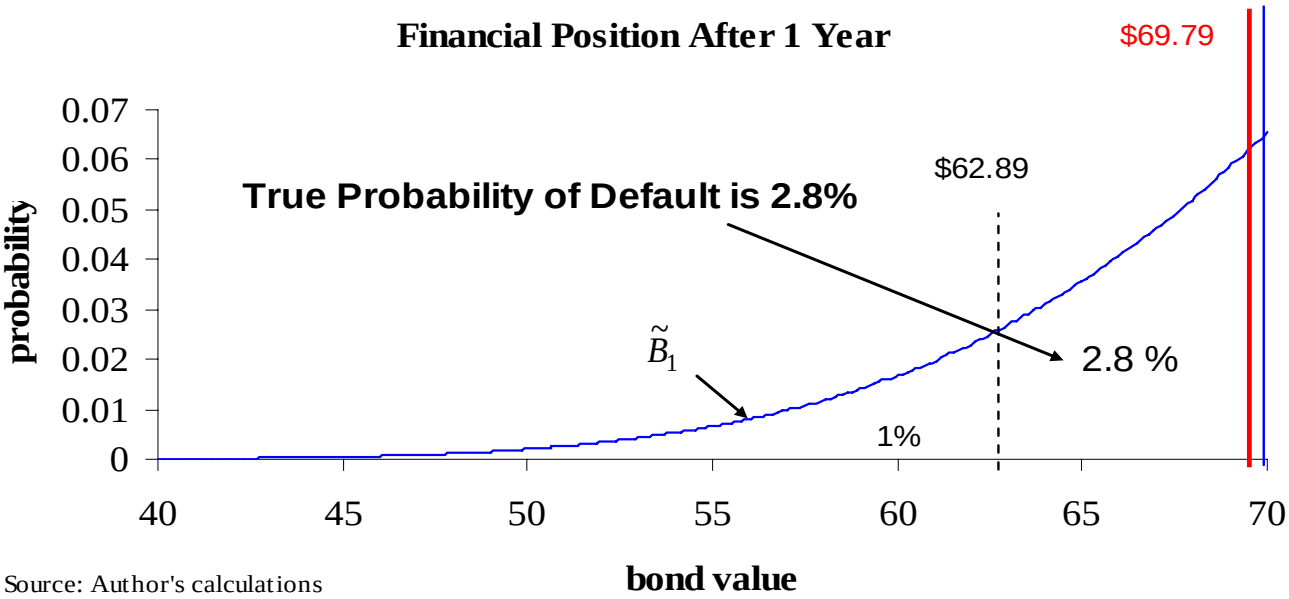
- Understates Capital Needs
- Makes AIRB capital rule procyclical
- Soundness Standard Varies over the Business Cycle
  - New important source of procyclicality not yet recognized in the literature analyzing Basel II
- Consider last CVaR example, but assume that the 1-year Treasury rate goes from 5% to 10%

Procyclicality

- Bond now costs $63.07
- CVaR tail value $62.89
- CVaR Capital falls to $0.18 because interest rates increased by 5 percent
- When interest rates are 5%
  - CVaR Capital = $7.32
- When interest rates go to 10%
  - CVaR Capital = $0.18

Figure 6: Credit VaR Calculation with 10% Risk Free Rate





Source: Author's calculations

CVaR Capital & Interest Rate

- CVaR rule sets lower capital solvency standard fro the bank as the level of interest rates increase
  - Problem—AIRB rule forgets to pay interest on bank debt
  - this expense should be in the capital rule and increase as interest rates increase to maintain the target soundness standard

AIRB Rule & Procyclicality

- As central bank is raising interest rates to curb bank lending—AIRB rule will cut soundness standard, increase safety net subsidy, and encourage bank lending

- As central bank lowers interest rates to accelerate lending, the AIRB rule will raise the soundness standard, decrease the safety net subsidy, and discourage bank lending

Recognizing Portfolio Interest Income

Q: Doesn’t this offset the problem of forgetting interest expense?

Ans: Partly, but not entirely

Including interest income and interest expense

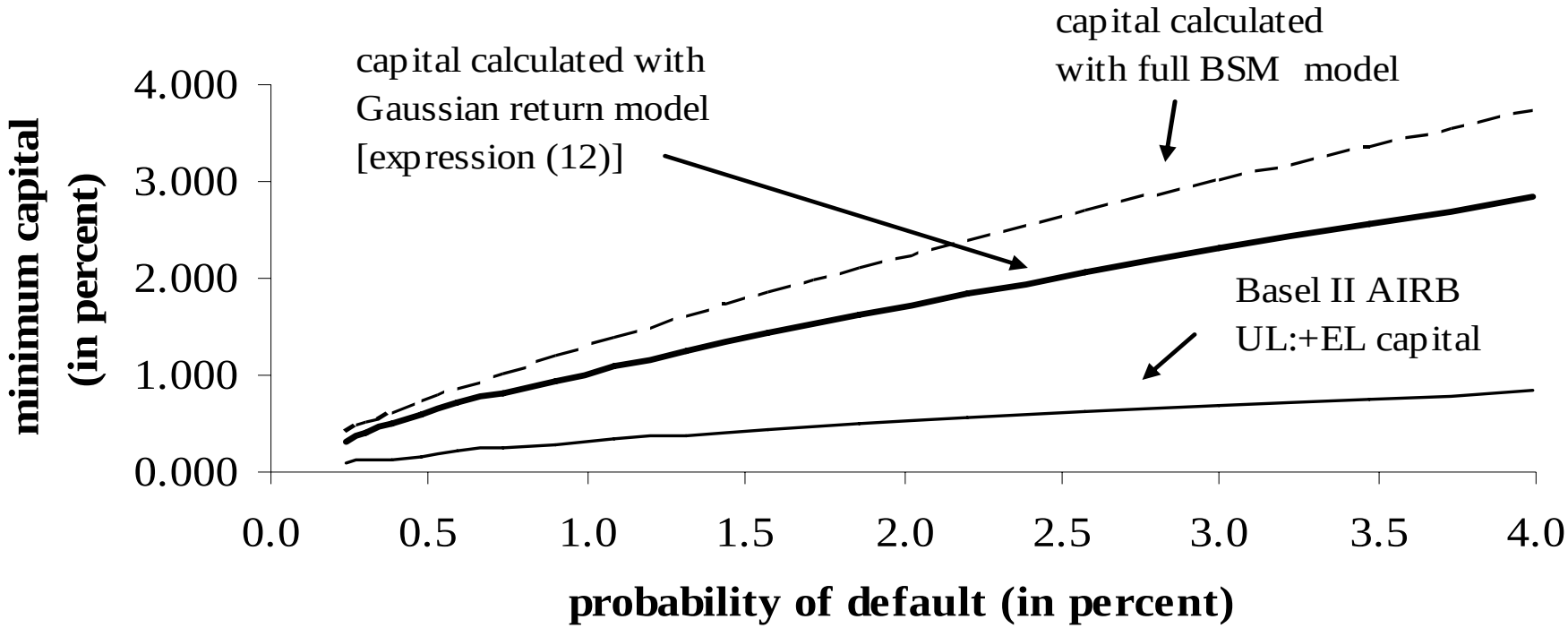
If *YTM* is the yield to maturity on a generic credit in a portfolio

$$\tilde{R}_p = YTM - (YTM + LGD)\,\tilde{X}$$

Going through the same math as the Basel AIRB, and including capital for bank interest expense, Kupiec (2006a shows) capital rule is

$$K(\alpha) \approx \frac{YTM + LGD}{1 + YTM}\,\Phi\left(\frac{\Phi^{-1}(PD) + \sqrt{\rho}\,\Phi^{-1}(.999)}{\sqrt{1-\rho}}\right)$$

Figure 3: Capital Requirements Recognizing Bank Interest Income and Expense



Source: Author's calculations

Once both interest income and interest expense are recognized:

Capital requirements are higher than AIRB rule

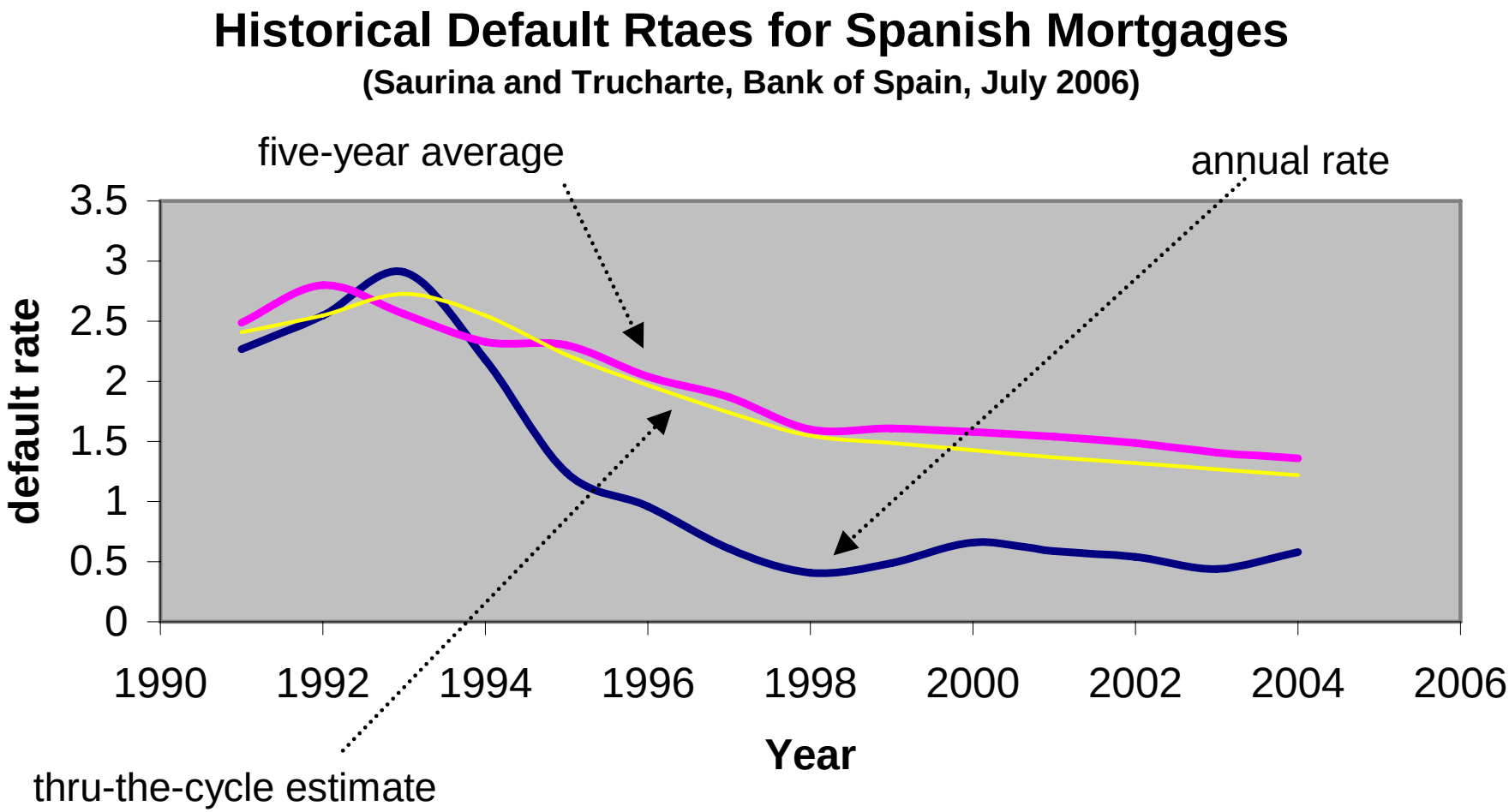
(assuming equilibrium interest margin)

Well-known Sources of Procyclicality in Basel II

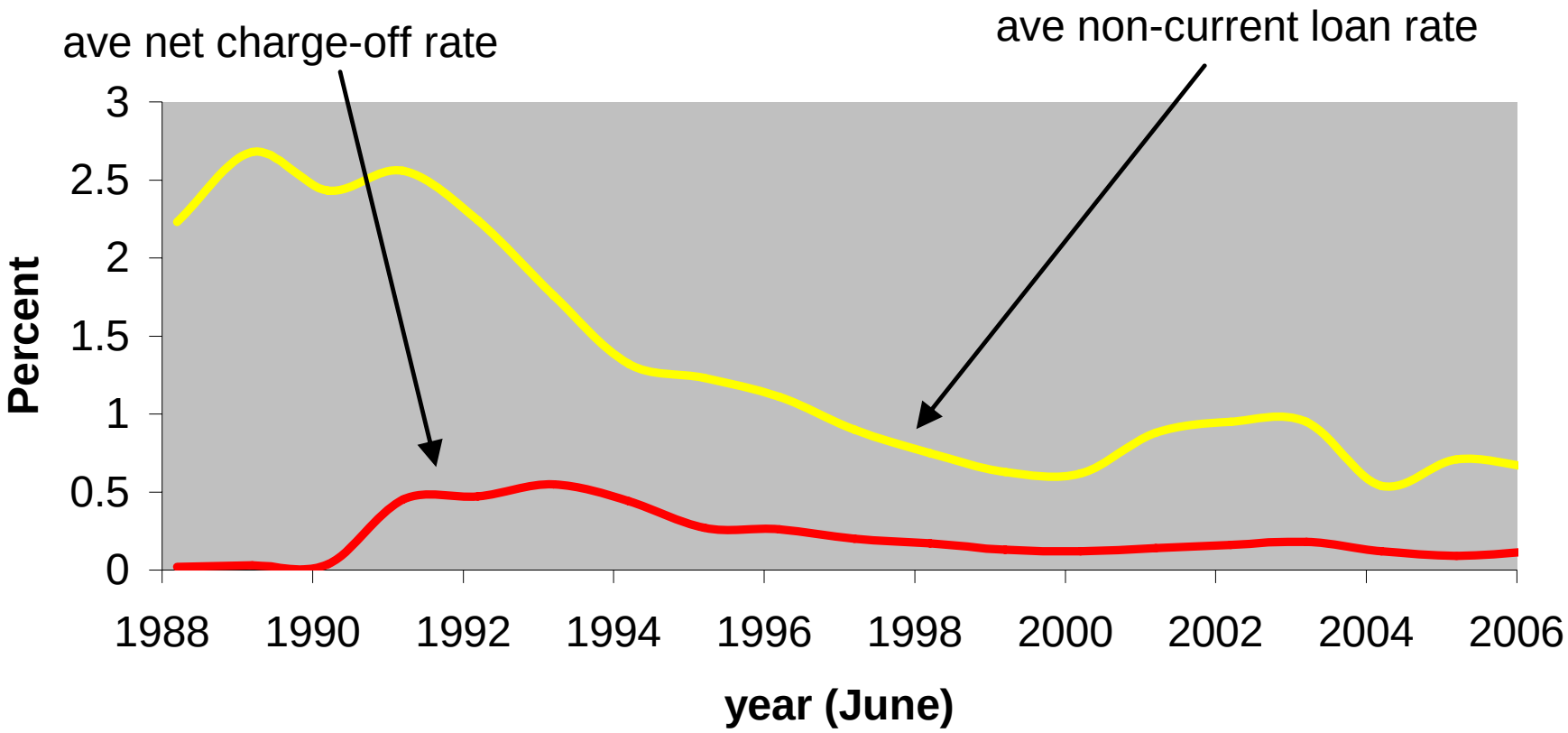
PDs increase as economic conditions weaken

PDs decline as economic conditions improve

AIRB Procyclicality and Mortgages



Performance of FDIC-Insured Specialized Mortgage Institutions



Should we care about procyclicality?

- Natural by-product of risk sensitivity
- If it is costly for banks to raise capital
  - the cyclical variation in minimum regulatory capital may lead to reductions in supply of bank credit when it is most needed to spur economic growth
- Bank's private costs of capital will elevated if they benefit from a safety net subsidy
  - Safety net lowers their funding costs
  - Increase in required capital lowers subsidy on all outstanding debt
  - The higher required capital the smaller this effect

AIRB Measurement Issues

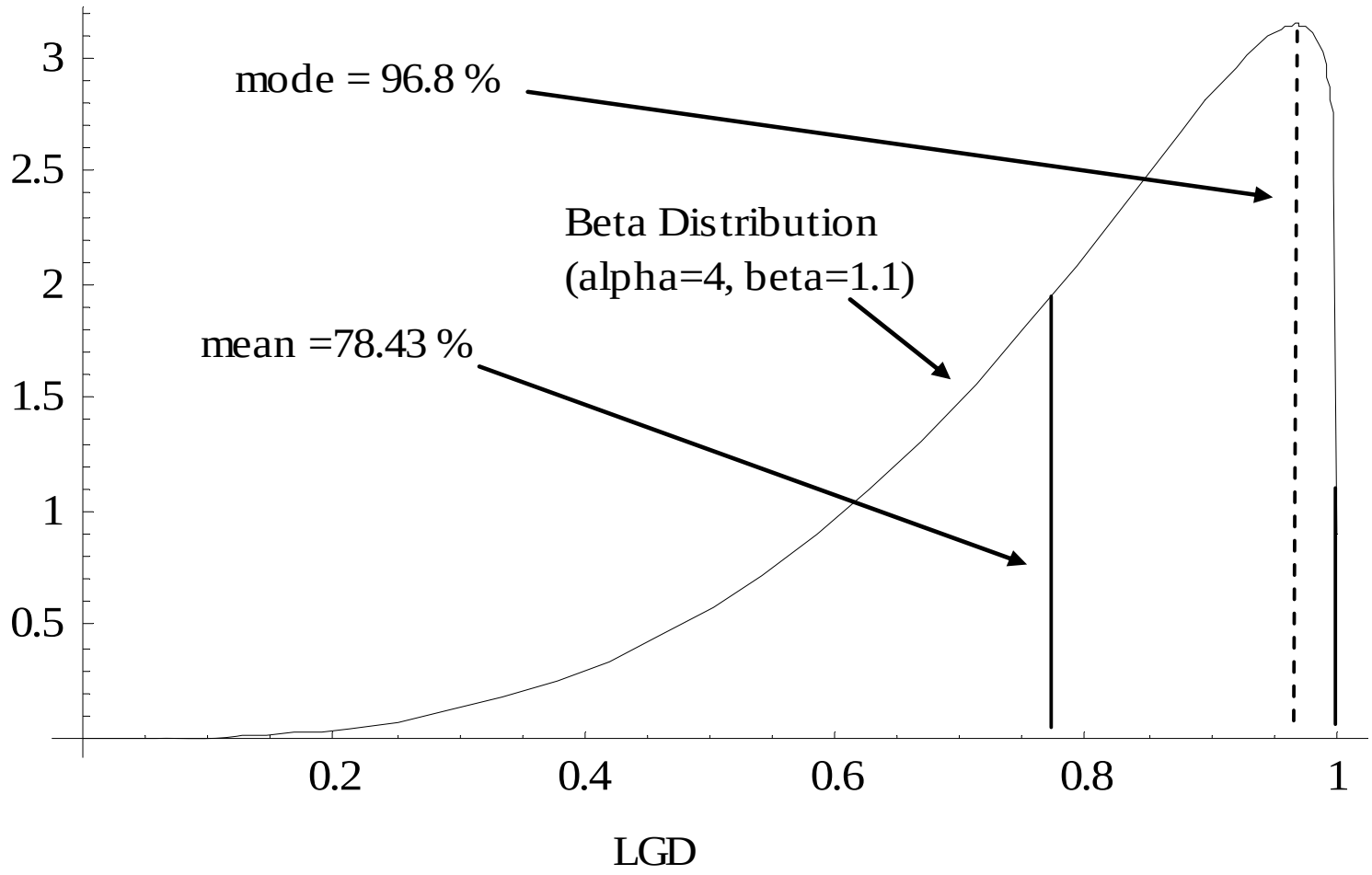
LGD and *EAD* are random and include systematic risk

Recognizing Systematic Risk in LGDs

Generalized Single Factor Gaussian Model [Kupiec 2006c]

- *LGD* is random and realization is driven by a single common factor
- Must approximate the unconditional *LGD* distribution to be able to a get closed form expression for capital for ***any*** shaped *LGD* distribution in the Gaussian model
  - Step function approximation
  - Step Function Gaussian copula

Unconditional LGD Distribution B



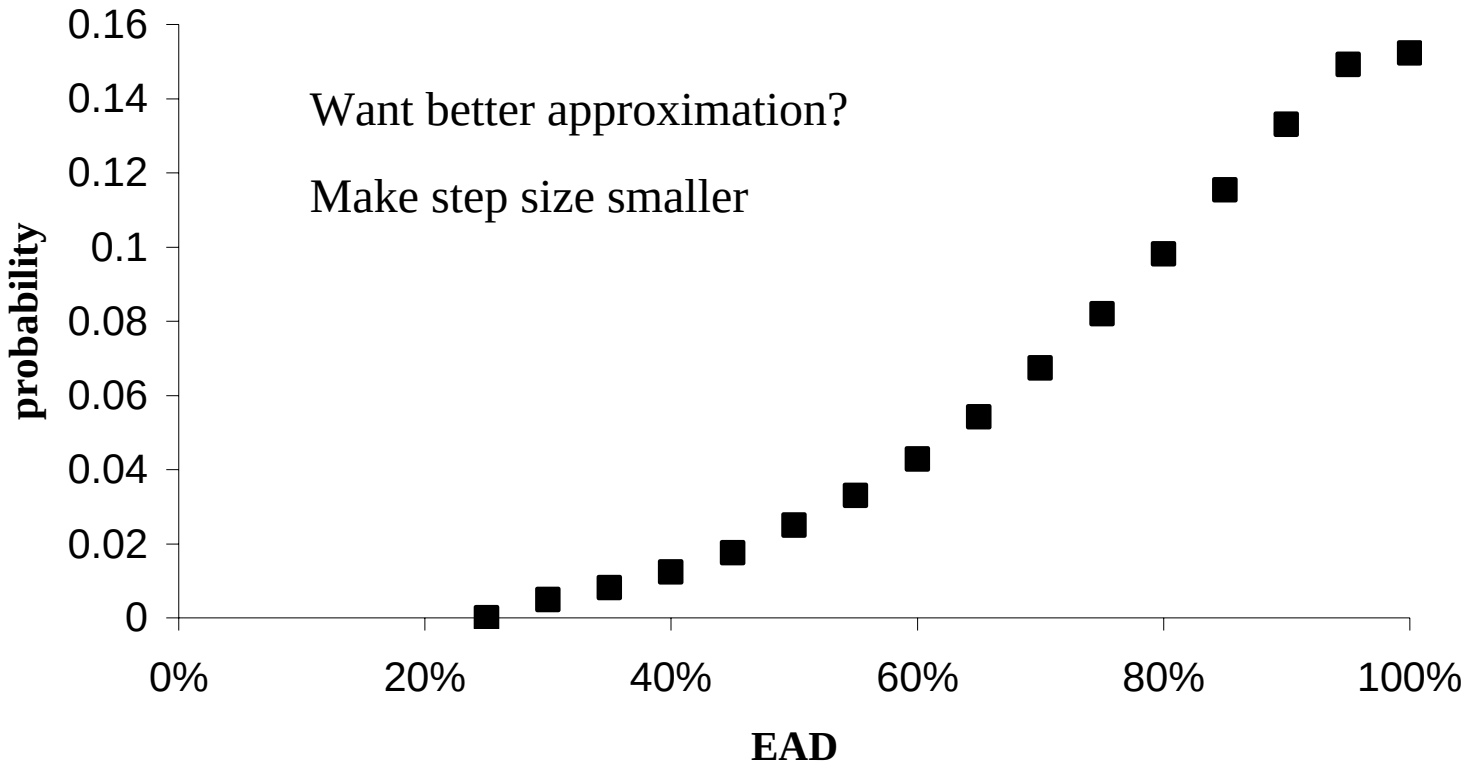
Step Function Approximation for LGD
Distribution B, Beta(4,1.1)

draw rate thresholds	cumulative probability of draw level	cummulative probability of draw increment	threshold for $\tilde{Y}$
25%	0.47%	0	2.599
30%	0.96%	0.50%	2.340
35%	1.78%	0.81%	2.102
40%	3.01%	1.23%	1.879
45%	4.76%	1.75%	1.669
50%	7.26%	2.50%	1.457
55%	10.55%	3.29%	1.251
60%	14.83%	4.28%	1.044
65%	20.25%	5.42%	0.833
70%	26.98%	6.73%	0.613
75%	35.18%	8.20%	0.380
80%	45.00%	9.82%	0.126
85%	56.54%	11.54%	-0.165
90%	69.85%	13.31%	-0.520
95%	84.77%	14.92%	-1.026
100%	100.00%	15.23%	

Step size 5%

Threshold value for latent variable

Step Function Approximation for LGD Beta (4,1.1) Distribution



Modeling Random LGD

- Use Vasicek latent Gaussian factor for PD

$$\begin{cases} \tilde{V}_i = \sqrt{\rho}\,\tilde{e}_M + \sqrt{1-\rho}\,\tilde{e}_i \\ \tilde{e}_M \sim \phi(e_M) \\ e_i \sim \phi(e_i), \\ E(\tilde{e}_i\,\tilde{e}_j) = E(\tilde{e}_M\,\tilde{e}_j) = 0 \;\forall i, j \end{cases}$$

- Default threshold

$$\tilde{V}_i < D_i$$

- Probability of default

$$PD = \Phi(D_i).$$

Introduce New Latent Factor for *LGD*

$$\tilde{Y}_i = \sqrt{\rho_Y}\,\tilde{e}_M + \sqrt{1-\rho_Y}\,\tilde{e}_{iY}$$

$$\tilde{e}_M \sim \phi(e_M)$$

$$e_{iY} \sim \phi(e_{iY}),$$

$$E(\tilde{e}_{iY}\,\tilde{e}_{jY}) = E(\tilde{e}_M\,\tilde{e}_{jY}) = E(\tilde{e}_{iY}\,\tilde{e}_j) = 0 \;\forall\, i, j.$$

- $\tilde{Y}$ factor drives *LGD* realizations

$$\tilde{LGD}_i = \begin{cases} LGD_0 & \text{for } \tilde{Y}_i > B_{i1} \\ LGD_0 + \Delta LGD & \text{for } B_{i2} < \tilde{Y}_i < B_{i1} \\ LGD_0 + 2\Delta LGD & \text{for } B_{i3} < \tilde{Y}_i < B_{i2} \\ LGD_0 + 3\Delta LGD & \text{for } \tilde{Y}_i \le B_{i3} \end{cases}$$

- Thresholds for the increments in the step function approximation

Define an Indicator Function for Each Step

$$\tilde{I}_i = \begin{cases} 1 & if \quad \tilde{V}_i < D_i \\ 0 & otherwise \end{cases}, \quad \tilde{H}_{ij\,ij} = \begin{cases} 1 & if \quad \tilde{Y}_i < B_{ij} \\ 0 & otherwise \end{cases}, \quad for \;\; j = 1,2,3.$$

Table 1: Probability Distribution Approximation for *LGD*

Loss Step Function Increment	LGD Level	Probability Threshold for Latent Variable $\tilde{Y}_i$
0	LGD_0	
ΔLGD	$LGD_0 + \Delta LGD$	$\Phi(B_{i1})$
$2\,\Delta LGD$	$LGD_0 + 2\,\Delta LGD$	$\Phi(B_{i2})$
$3\,\Delta LGD$	$LGD_0 + 3\,\Delta LGD$	$\Phi(B_{i3})$

LGD Model

$$\tilde{LR}_i = \tilde{I}_i \left(LGD_{i0} + \Delta LGD \sum_{k=1}^{3} \tilde{H}_{k1} \right)$$

- Loss Rate on a Credit

$$E\left(\tilde{I}_i \mid e_M\right) = \Phi\left(\frac{D - \sqrt{\rho_d}\, e_M}{\sqrt{1-\rho_d}} \right),$$

- Conditional value of default indictor

$$E\left(\tilde{H}_{il} \mid e_M\right) = \Phi\left(\frac{B_{il} - \sqrt{\rho_Y}\, e_M}{\sqrt{1-\rho_Y}} \right)$$

- Conditional value of individual LGD step triggers

Portfolio

$$\widetilde{LR}_P \mid e_M = \left(\frac{\sum_{i=1}^{N} \left(\widetilde{LR}_i \mid e_M \right)}{N} \right)$$

- Portfolio loss rate conditional on e_M

Asymptotic portfolio

$$\lim_{N\to\infty} \left(\widetilde{LR}_P \mid e_M \right) = \lim_{N\to\infty} \left(\frac{\sum_{i=1}^{N} \left(\widetilde{LR}_i \mid e_M \right)}{N} \right) \xrightarrow[a.s.]{} E\left(\tilde{I} \mid e_M \right) \cdot \left(LGD_0 + \Delta LGD \sum_{k=1}^{3} E\left(H_k \mid e_M \right) \right)$$

Inverse of the Unconditional Portfolio Loss Rate Distribution

$$LR_p(\alpha) = \Phi\left(\frac{\Phi^{-1}(PD) + \sqrt{\rho_d}\ \Phi^{-1}(\alpha)}{\sqrt{1-\rho_d}} \right) \cdot \left(LGD_0 + \Delta LGD\ \ B(\alpha)\right), \quad \text{for } \alpha \in [0,1],$$

$$B(\alpha) = \sum_{l=1}^{M} \Phi\left(\frac{\Phi^{-1}\left(\sum_{i=0}^{l} PLGD_{M-i} \right) + \sqrt{\rho_Y}\ \Phi^{-1}(\alpha)}{\sqrt{1-\rho_Y}} \right)$$

Interpretation $\left(LGD_0 + \Delta LGD \;\; B(\alpha)\right)$

when $\rho_Y \to 0$, $\left(LGD_0 + \Delta LGD \;\; B(\alpha)\right) \to E\left(\tilde{LGD}\right)$

when $\rho_Y > 0$, "stress" or "downturn" LGD

Stress LGD can be interpreted as the expected value of new LGD distribution where probability is shifted from lower LGD realizations to higher LGD realizations

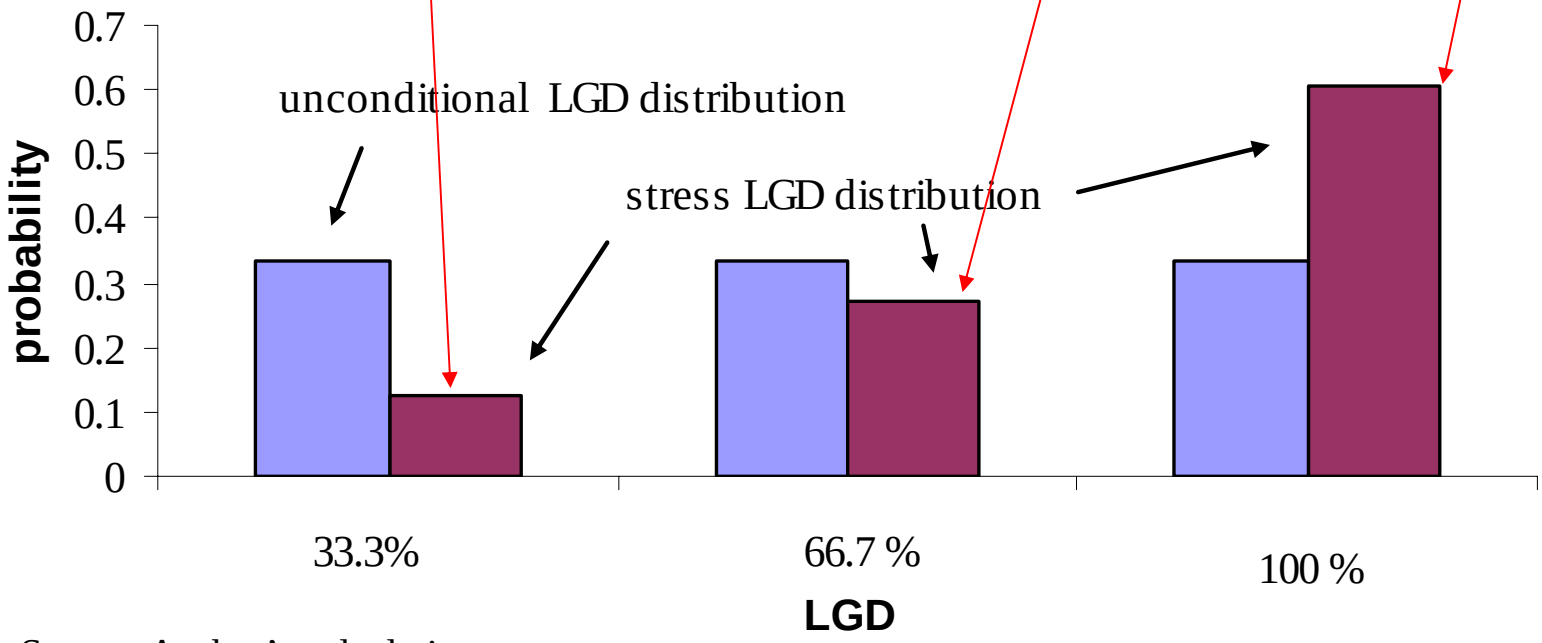
Stress LGD Calculation

$$\Phi\left(\frac{\Phi^{-1}(.6667)+\sqrt{.05}\,\Phi^{-1}(.999)}{\sqrt{1-.05}}\right)$$

$$1-\Phi\left(\frac{\Phi^{-1}(.6667)+\sqrt{.05}\,\Phi^{-1}(.999)}{\sqrt{1-.05}}\right)-\Phi\left(\frac{\Phi^{-1}(.333)+\sqrt{.05}\,\Phi^{-1}(.999)}{\sqrt{1-.05}}\right)$$

$$\Phi\left(\frac{\Phi^{-1}(.333)+\sqrt{.05}\,\Phi^{-1}(.999)}{\sqrt{1-.05}}\right)$$

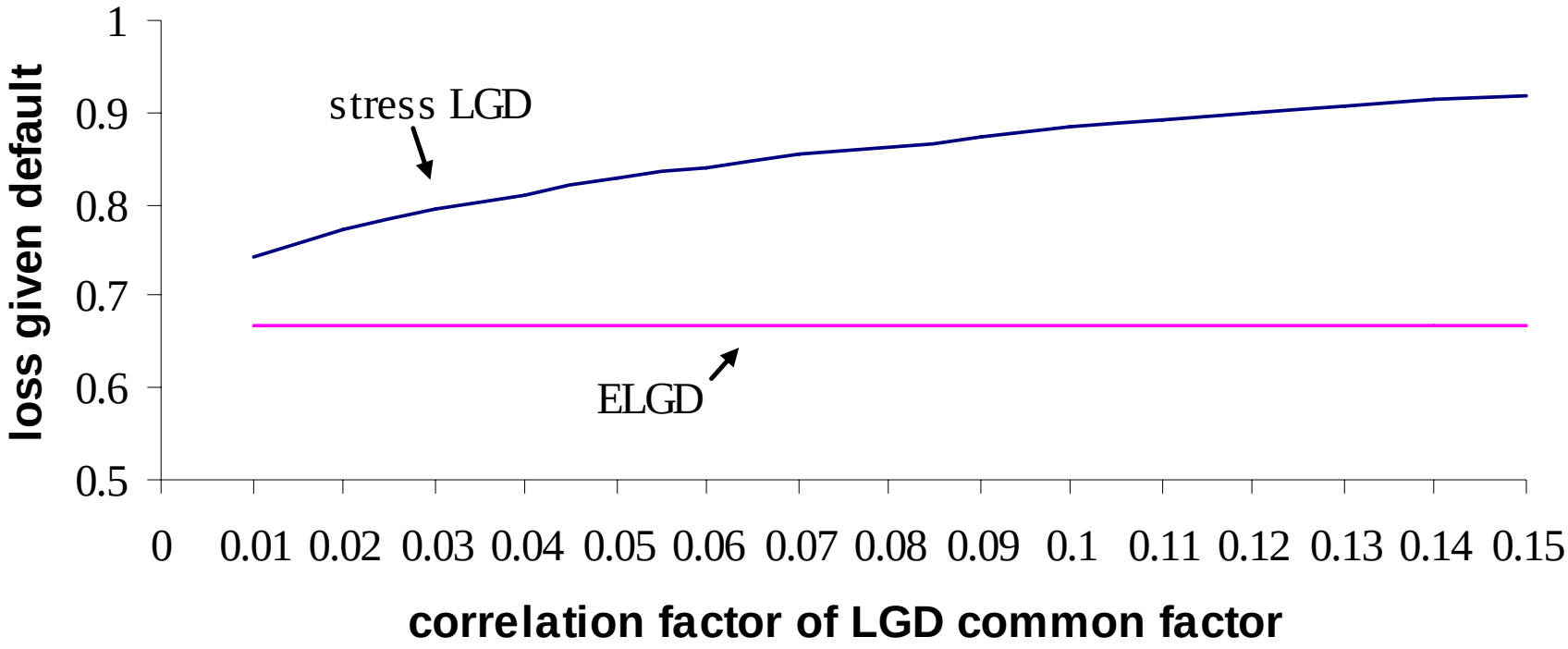
Figure 8: Unconditional and Stress LGD Distributions



Source: Author's calculations

Stress LGD=expected value of maroon distn

Figure 9: Correlation and Stress LGD



Capital when LGDs are positively correlated

$$K(\alpha) \approx \frac{YTM + E\left(LGD^{S}\right)}{1 + YTM} \Phi\left(\frac{\Phi^{-1}(PD) + \sqrt{\rho}\,\Phi^{-1}(.999)}{\sqrt{1-\rho}}\right)$$

Requires substantially more capital than Basel AIRB

- Recognizes interest income on portfolio
- Includes capital for bank interest expense
- Includes capital for systematic risk in LGDs

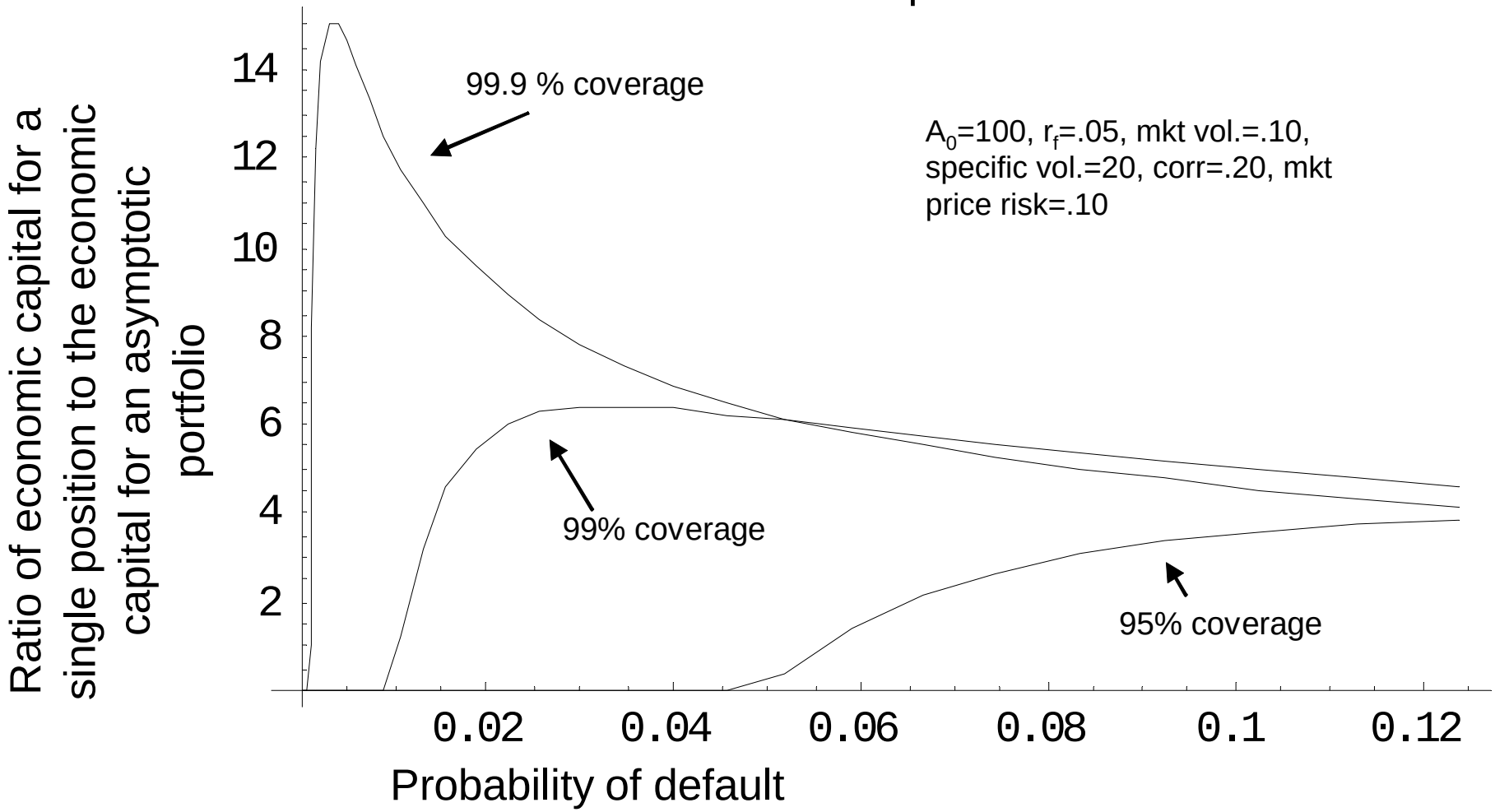
Systematic Risk and *EAD*s

- The AIRB is derived assuming *EAD*s as known quantities
  - Some qualitative adjustments in guidance
- When *EAD*s are random they will also require additional capital if *EAD* realizations are correlated
- *EAD* systematic risk will change the capital rule

“Stress EADs”

- Can use step function approach to model random *EAD*s
- Method will produce a “stress *EAD*” that is larger than a simple average *EAD* of the random *EAD* distribution
- This approach is developed in Kupiec(2006c)
- Important omitted factor for setting capital on HELOCs and Option ARMs

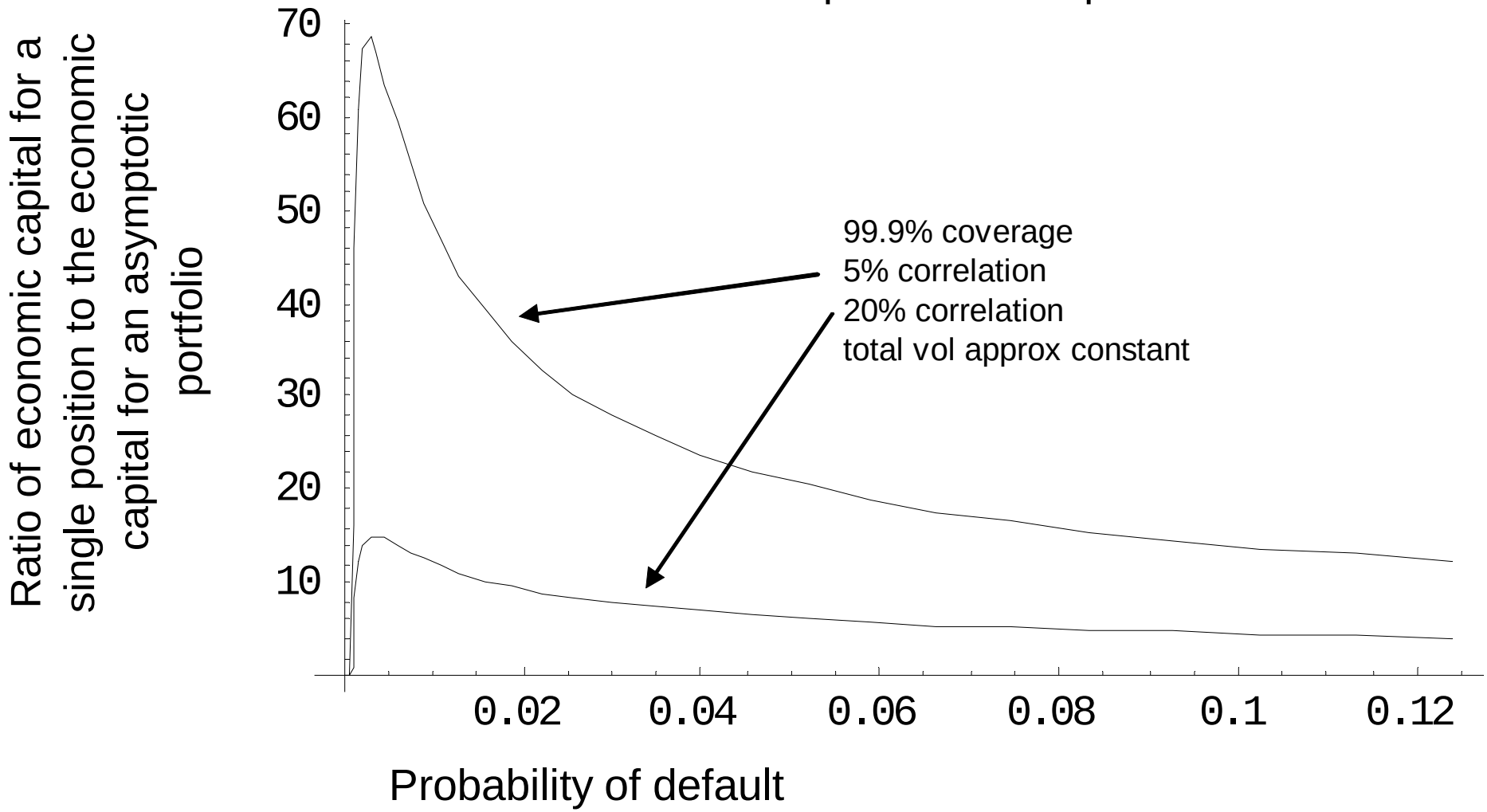
The Potential Importance of Specific Risk for Credit Portfolio Capital Alloctions



Specific Risk (Concentration Risk) is Really Important for Credit Risk Capital Allocation

Especially when targeting 99.9% solvency rate as in Basel II

Portfolio Correlation Characteristics Determine the Potential Importance of Specific Risk



Conclusion

- Little evidence suggest that AIRB approach will enhance (increase) minimum capital standards
- AIRB omits formal consideration of many basic risk factors that determine bank capital needs
- AIRB understates risk and capital needs
- Omitted factors are important for understanding and measuring the risk in complex financial institutions

Can’t Pillar 2 Fix these Issues?

- Unlikely and risky “solution”
- Capital modeling for credit is new science
- Judgment plays key role as data are limited
- High quality human capital is scarce
- Standards are evolving & approaches vary
- Pillar 2 requires bank examiners to argue obscure theoretical issues with bank quants and high-dollar industry consultants
  - *Bad bet if you are using my money*

AIRB capital becomes upper bound on bank internal capital estimates

- **Senior management thinks a "good" risk manager gets bank business "done" using the least capital**
- *Very few understand model details*
- *Undercapitalization costs materialize later*
- *Sound risk measurement practices that require more capital are always dismissed in bank internal debates when a recognized "benchmark" requires less capital [Kupiec's Law]*
  - *Bankers never argue that regulatory capital requirements are too low*

Legal Issues

- AIRB rule becomes safe harbor in legal debates
- Minimum standard for sound risk measurement practice no longer debatable in court
  - Removes possibility to recover losses resulting from reckless financial management practices
  - compliance with the AIRB establishes that firm followed “sound risk measurement policies”
- **May removes market discipline, not enhance it**