Monetary Economics

Lecture 17: background and overview of the global financial crisis

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2nd Semester 2014

This lecture

- Background and overview of the global financial crisis.
- Readings
  - Brunnermeier, "Deciphering the liquidity and credit crunch 2007-2008" *Journal of Economic Perspectives*, 2009
  - Cecchetti, "Crisis and response: the Federal Reserve in the early stages of the financial crisis" *Journal of Economic Perspectives*, 2009
  - Coval, Jurek and Stafford "Economics of structured finance" *Journal of Economic Perspectives*, 2009

  Readings available from the LMS

This lecture

1- Unfolding of the crisis, 2007–2008

2- Policy responses

- conventional monetary policy
- unconventional monetary policy
  (liquidity programs, "quantitative easing" etc)
- fiscal policy

3- More background on trends in banking in the run-up to the crisis

- securitisation, structured finance etc

Background

- Low interest rates in mid 2000s. Large capital inflows to US
- Complacency about risk due to "great moderation"
- Lending boom
- Trends in banking contribute to extent of lending boom

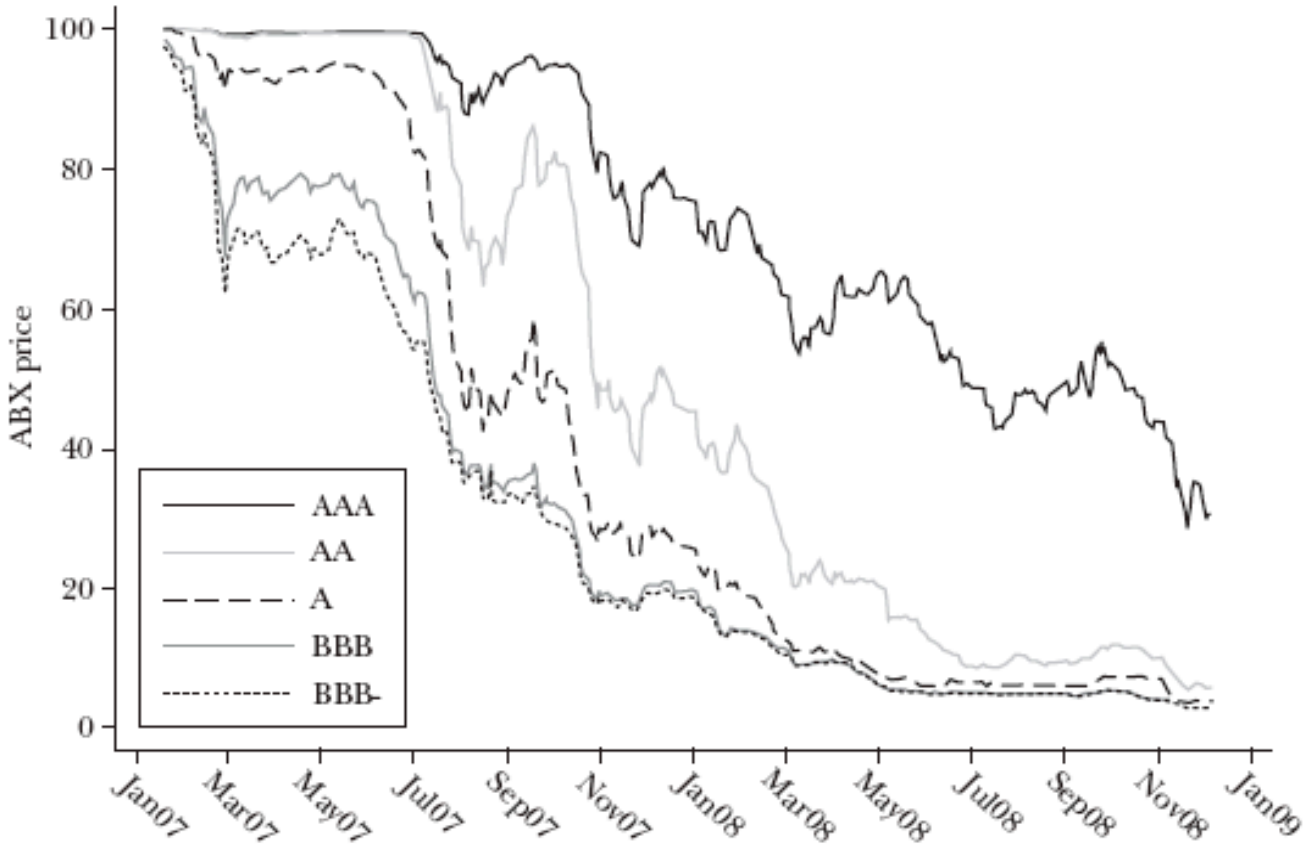
  (i) innovation in securitisation and structured finance, demand for highly-rated products increased demands for assets that can be pooled, reduced costs etc for borrowers, subprime

  (ii) greater levels of maturity mismatch

  In short, lending standards deteriorate

Subprime mortgage crisis breaks in early 2007

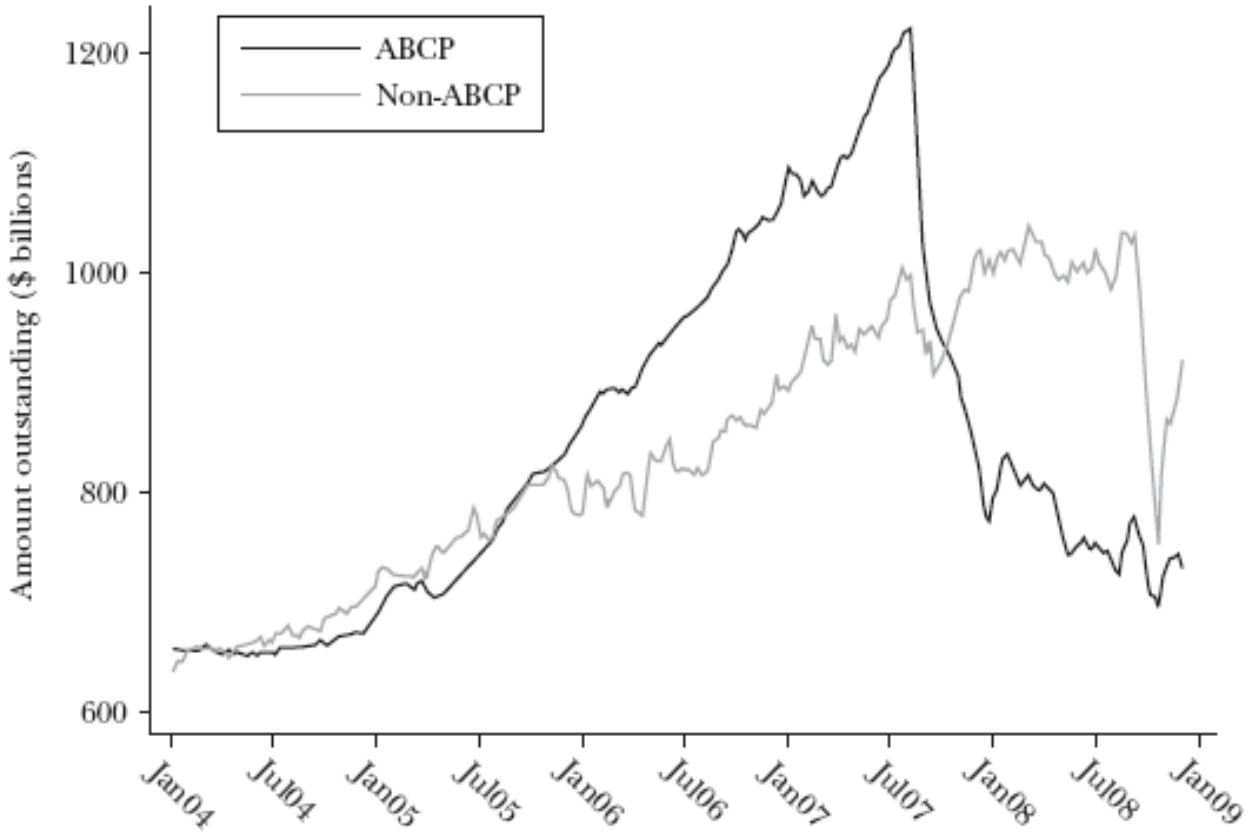
Decline in Mortgage Credit Default Swap ABX Indices
(the ABX 7-1 series initiated in January 1, 2007)



To buy protection against default, pay upfront fee of 100−ABX price. Previous sellers of CDS suffer losses as index falls. Source: Brunnermeier (2009).

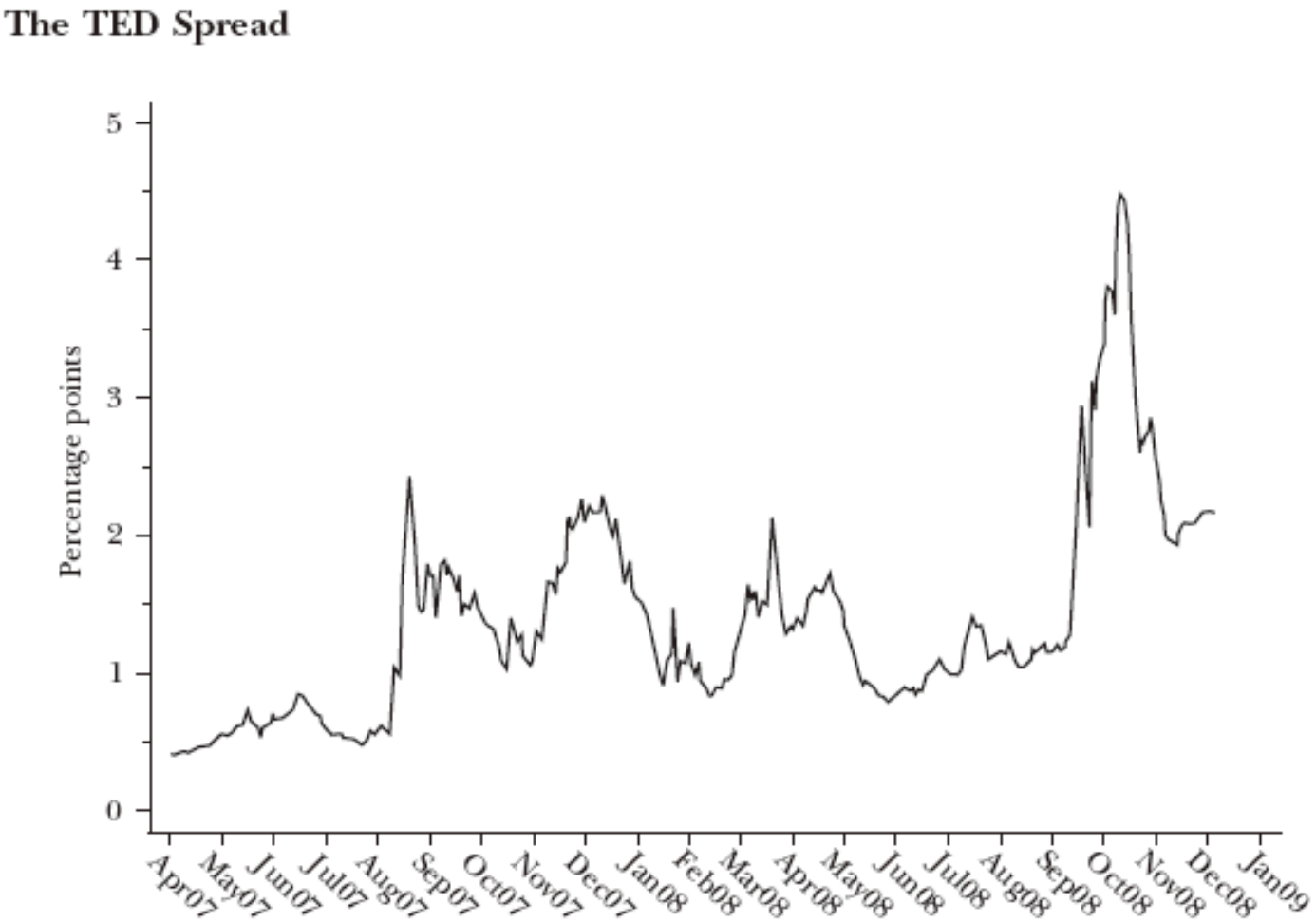
Demand for asset-backed paper dries up

Outstanding Asset-Backed Commercial Paper (ABCP) and Unsecured Commercial Paper



As crisis builds through July-August 2007, investors unwilling to hold asset-backed commercial paper (since collateralised largely by securitised mortgage products). Source: Brunnermeier (2009).

Interbank lending freezes up



Risky interbank LIBOR rate less risk-free Treasury rate. Historically the spread has been about 50bp. Source: Brunnermeier (2009).

Policy responses

- US Federal Reserve's traditional tools
  - background on conventional monetary policy
- Further policy responses
  - unconventional monetary policy responses (liquidity programs, "quantitative easing" etc)
  - fiscal policy

The Balance Sheet of the Federal Reserve, July 2007

(in billions of dollars)

Assets		*Liabilities*	
Securities		Federal Reserve notes	$781.4
Held outright	$790.6	Commercial bank reserve balances	$16.8
Repurchase agreements	$30.3	Liabilities related to foreign official	$42.4
Loans		and U.S. Treasury deposits	
Primary lending	$0.19	Other liabilities	$5.7
Foreign exchange reserves	$20.8		
Gold	$11.0		
Other assets	$27.5		
Total assets	**$880.4**	**Total liabilities**	**$846.3**
Capital (= Total assets − Total liabilities)			**$34.1**

Source: Cecchetti (2009).

Conventional monetary policy

- Securities held outright are exclusively US Treasury bonds
- Repos used to adjust level of bank reserves
  - open market desk names terms
  - trades with "primary dealers" [19 of them in July 2007]
- Practically no direct loans to banks

Conventional monetary policy tools

- *Fed funds rate* is interest rate in overnight market for excess bank reserves at the Fed

- In open market operations, Fed buys and sells securities to keep fed funds rate at target

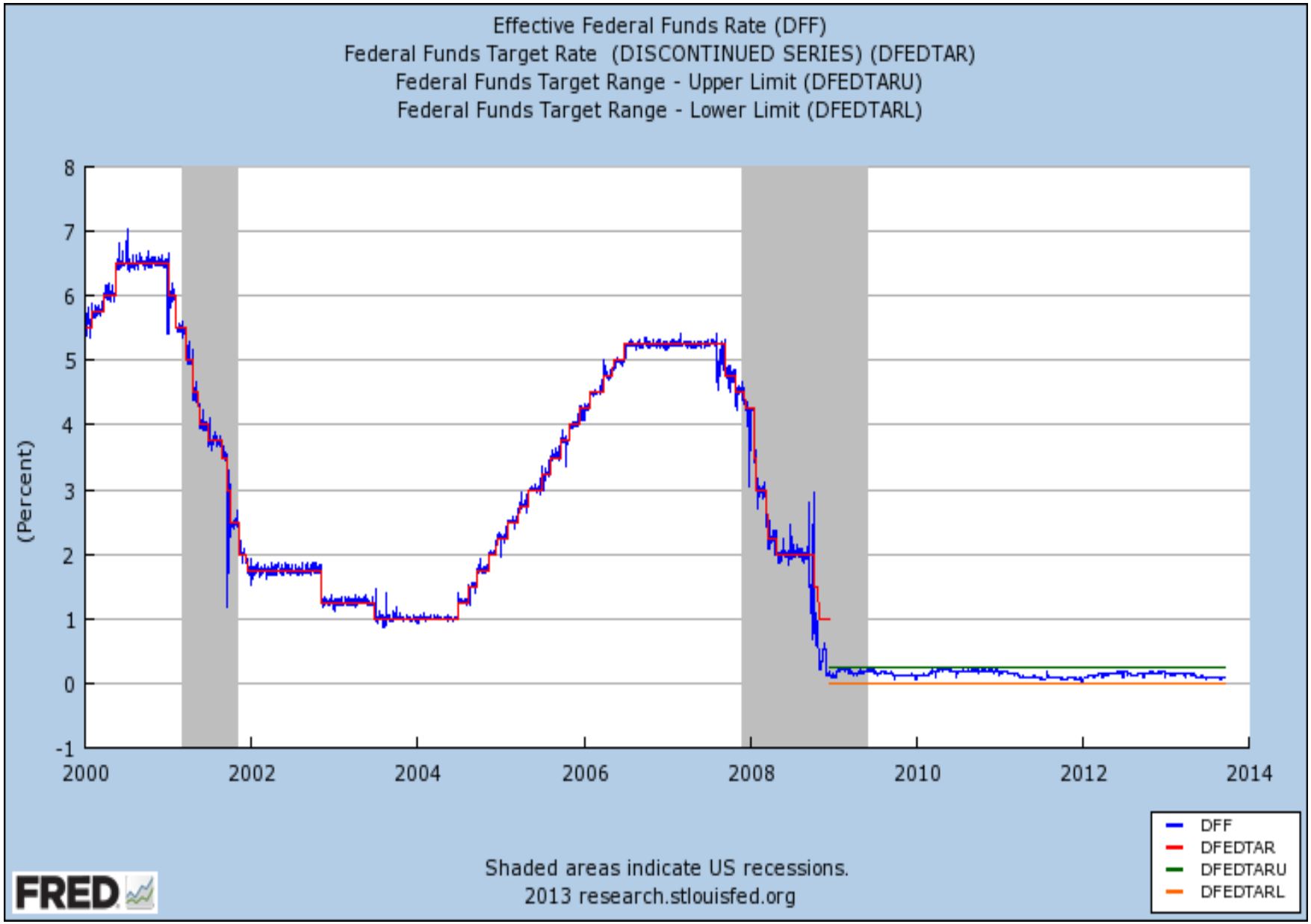
  - only primary dealers
  - high quality collateral
  - temporary [repo] or permanent [outright] operations

- *Discount rate* is interest rate on direct loan from Fed, set at premium above target fed funds rate

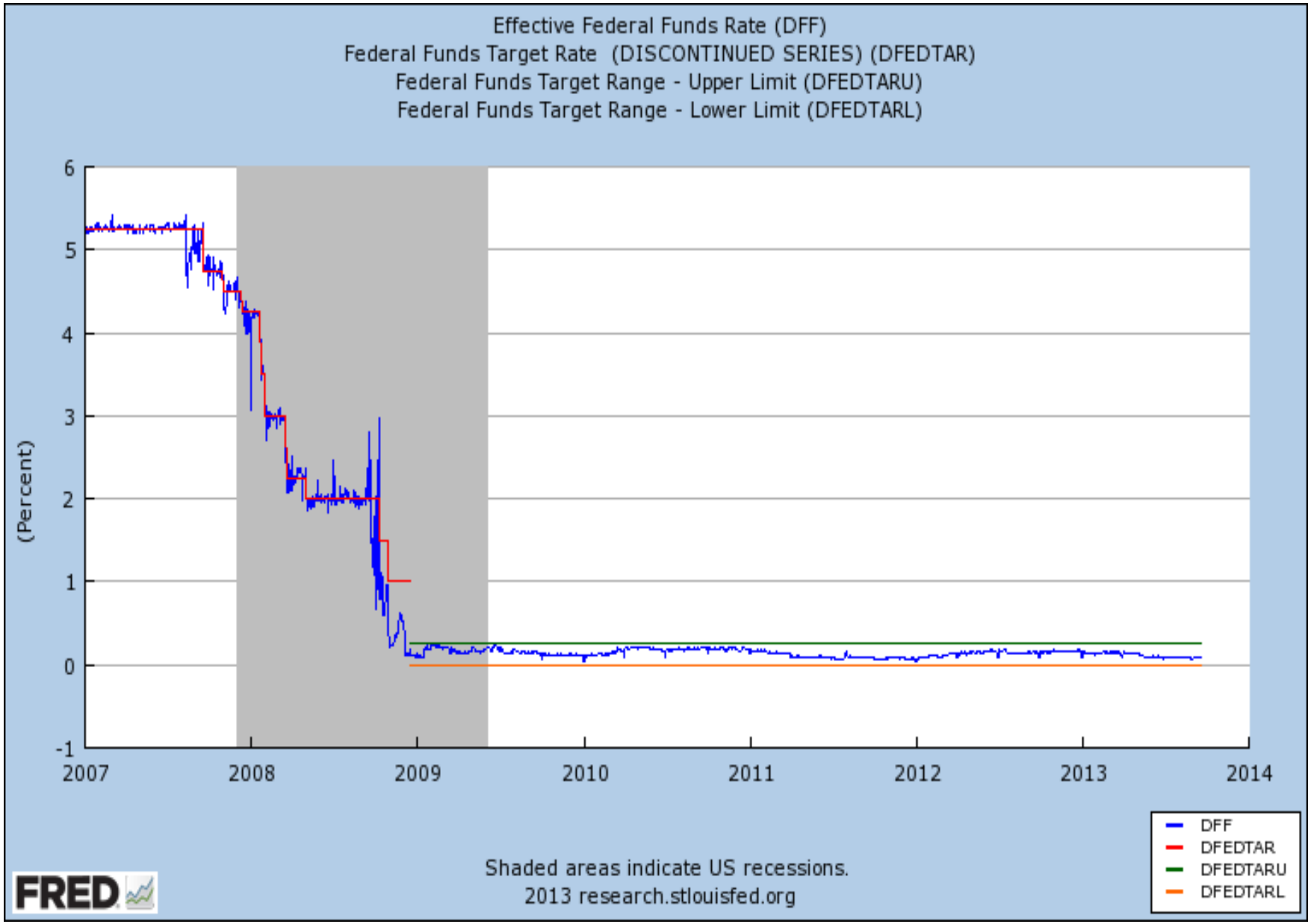
  - any commercial bank
  - much broader range of collateral
  - before crisis, rarely used

  (aka primary lending rate)

Actual and target fed funds rates



During the financial crisis



Federal Reserve balance sheet management

(1) Size of balance sheet is a policy choice

- can create liabilities to purchase assets at will
- (pure) "*quantitative easing*"

(2) Composition of assets and liabilities is also a policy choice

- changes in composition determine various interest rate *spreads* (term premia, risk premia, liquidity premia)

At first Fed response mostly consisted of (2). But turned to (1) as Lehman Brothers went bankrupt in Sept 2008

Liquidity programs

- Term Auction Facility (TAF):

  Allowed commercial banks to obtain discount window loans *anonymously* via auction. Broad range of collateral accepted

- Term Securities Lending Facility (TSLF):

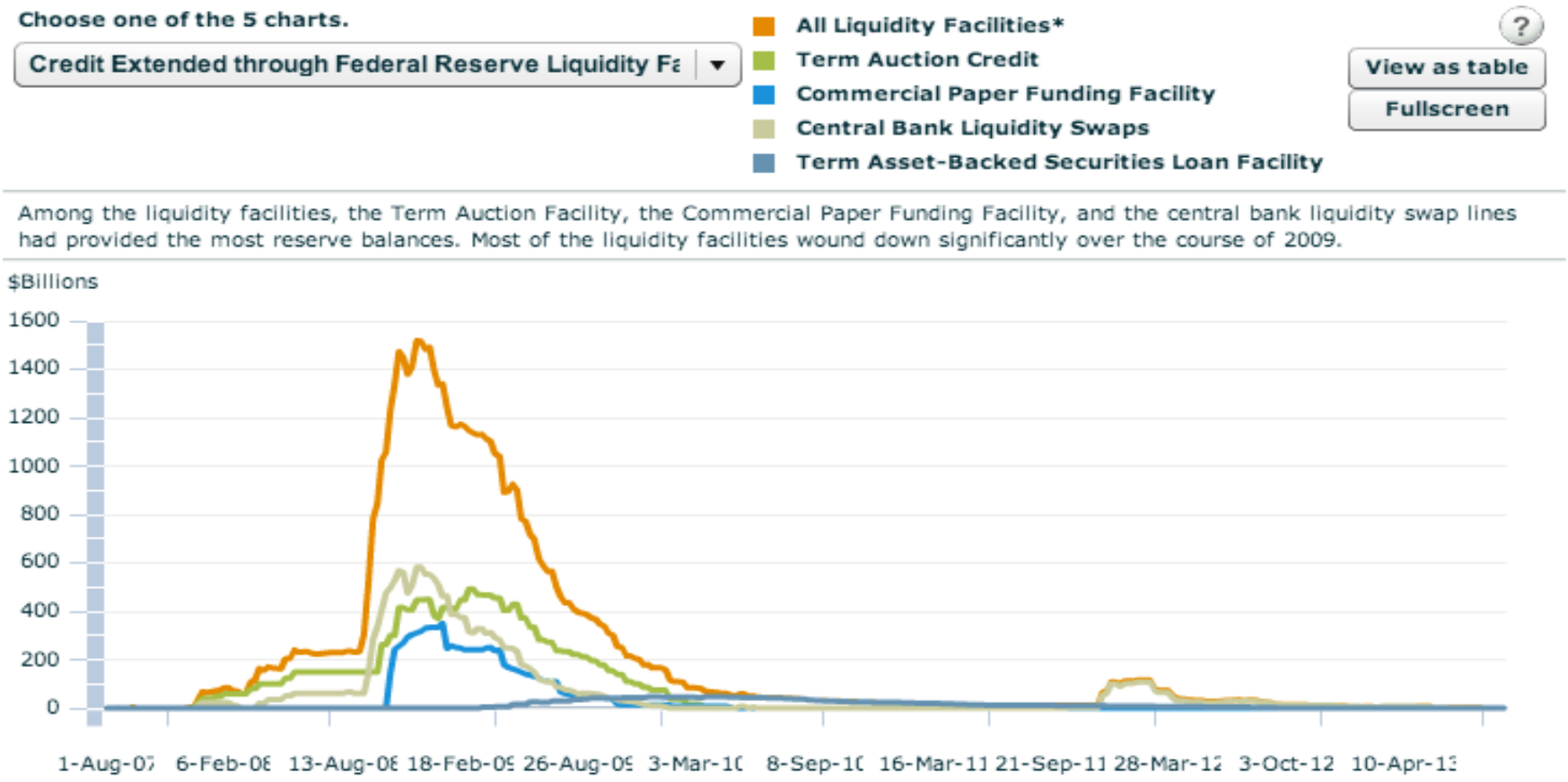
  Allowed dealers to borrow high-grade Treasury securities to ensure transactions occur. Securities lent for up to 28 days, much longer than usual. Broad range of collateral accepted

- Primary Dealer Credit Facility (PDCF):

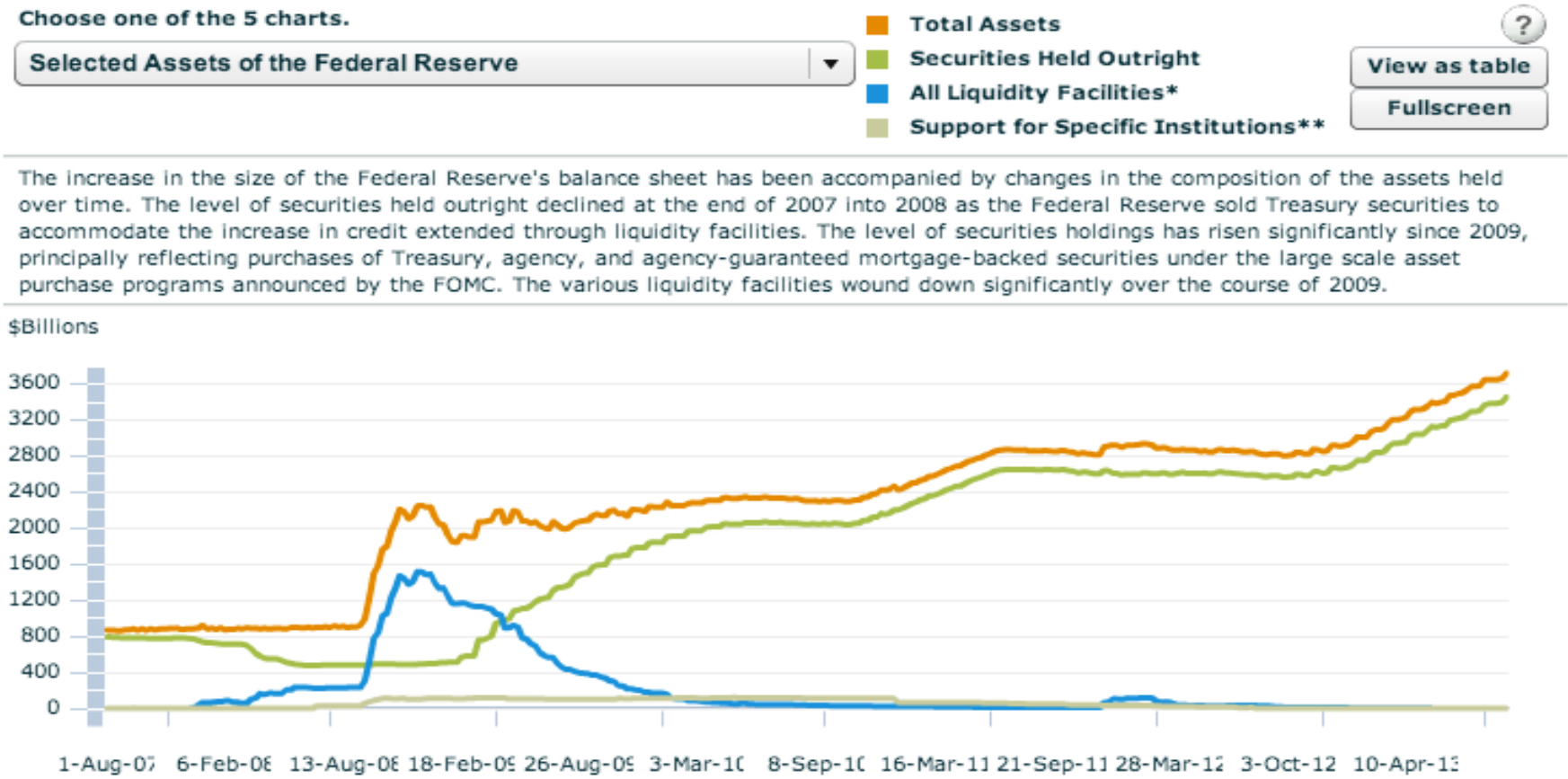
  Effectively allowed dealers to borrow from the discount window. Broad range of collateral accepted

- Other programs directed to specific asset classes or institutions [CPFF, MMIFF, TALF, Maiden Lane, etc]

Liquidity programs



Increase in Fed assets

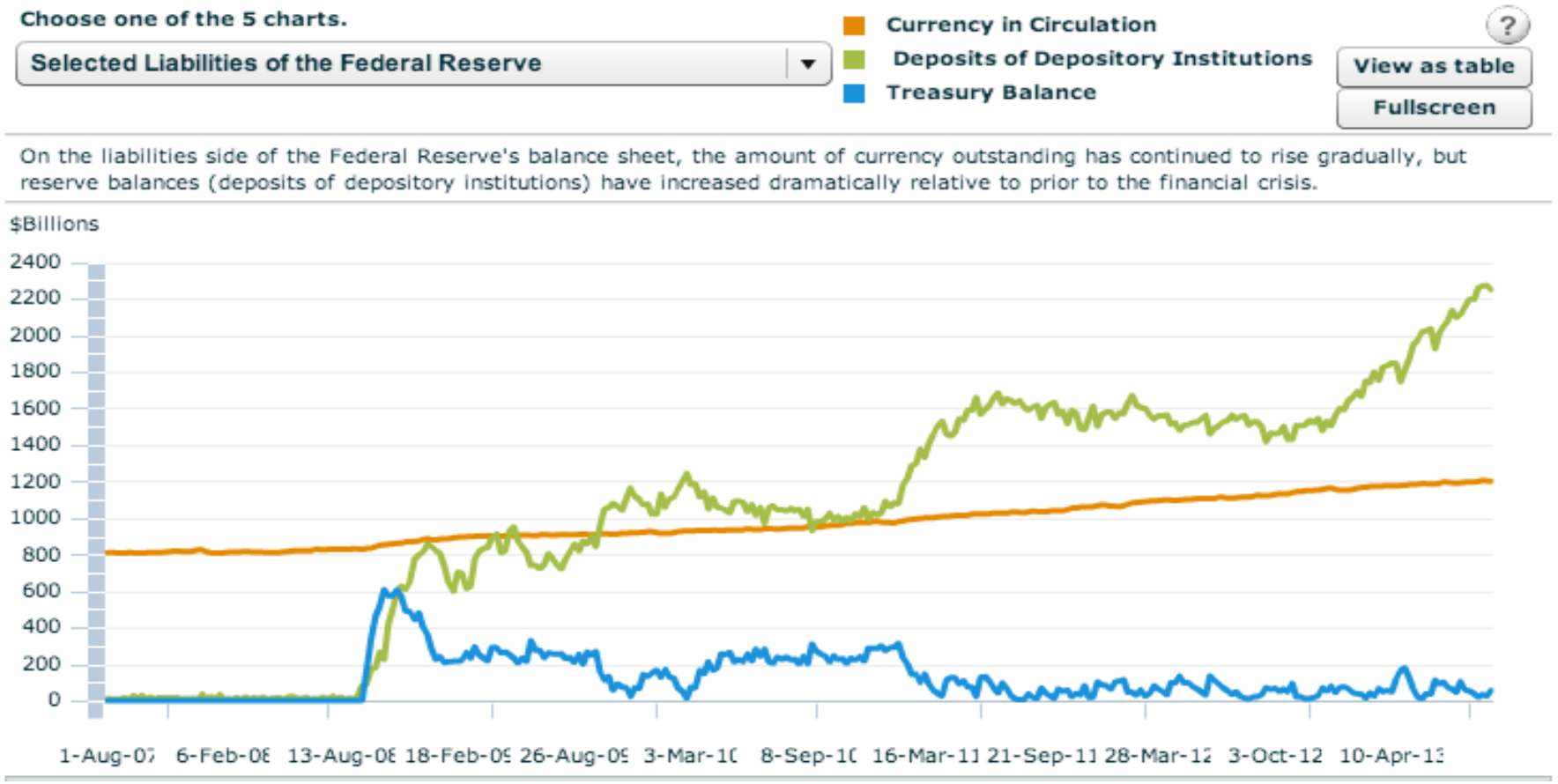


From mid-2008, balance sheet increases dramatically.

"Quantitative easing"

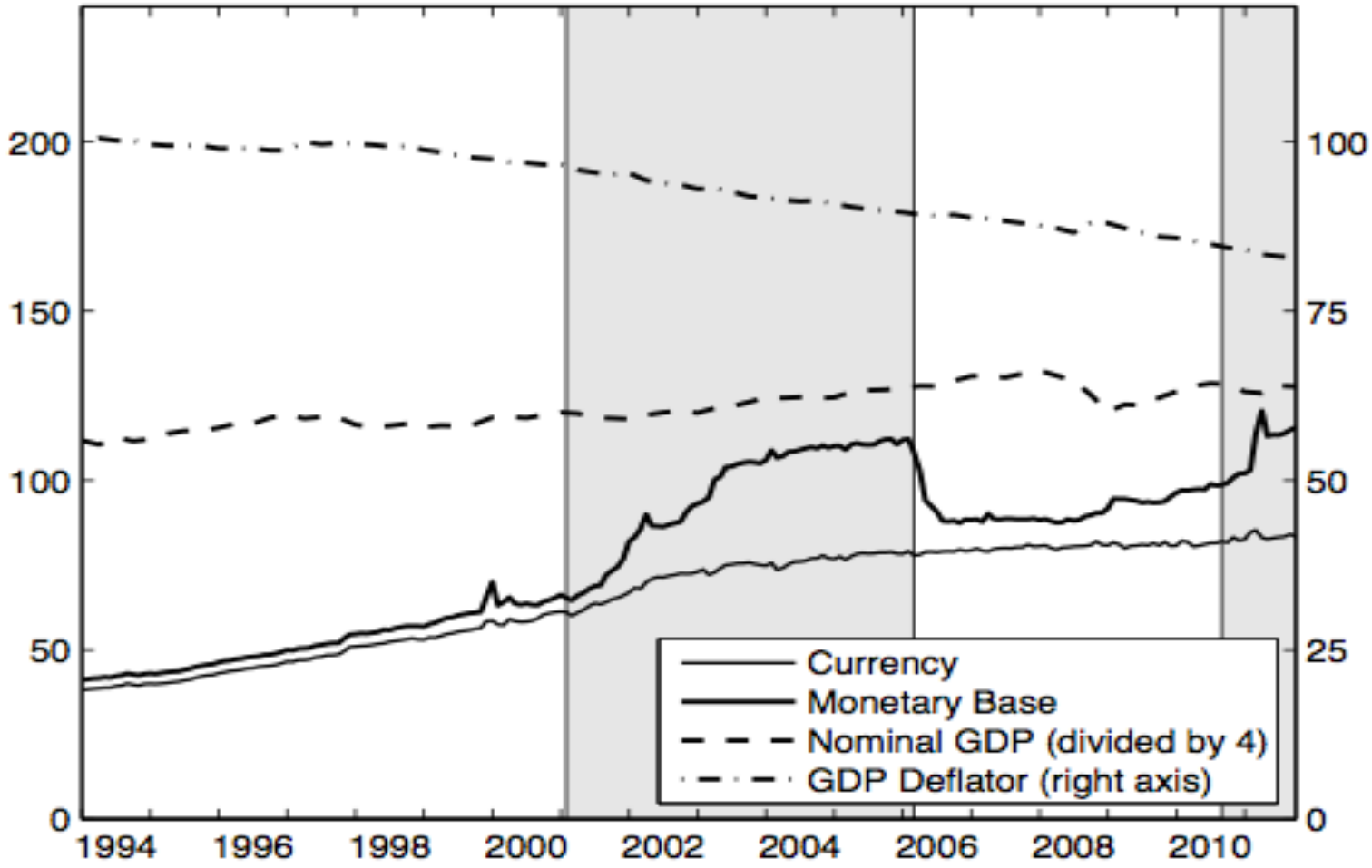
- Term originates with the Bank of Japan, 2001–2006
  - use of balance sheet policies as remedy to ZLB problem
  - specific quantity targets for supply of bank reserves
- *Pure quantitative easing*: increase in the monetary base
  (cf. classical monetarism, what matters is central bank liabilities)
- *Current usage*: rough synonym for non-standard monetary policy/balance sheet tools, especially including Fed's program of large-scale asset purchases

Increase in Fed liabilities



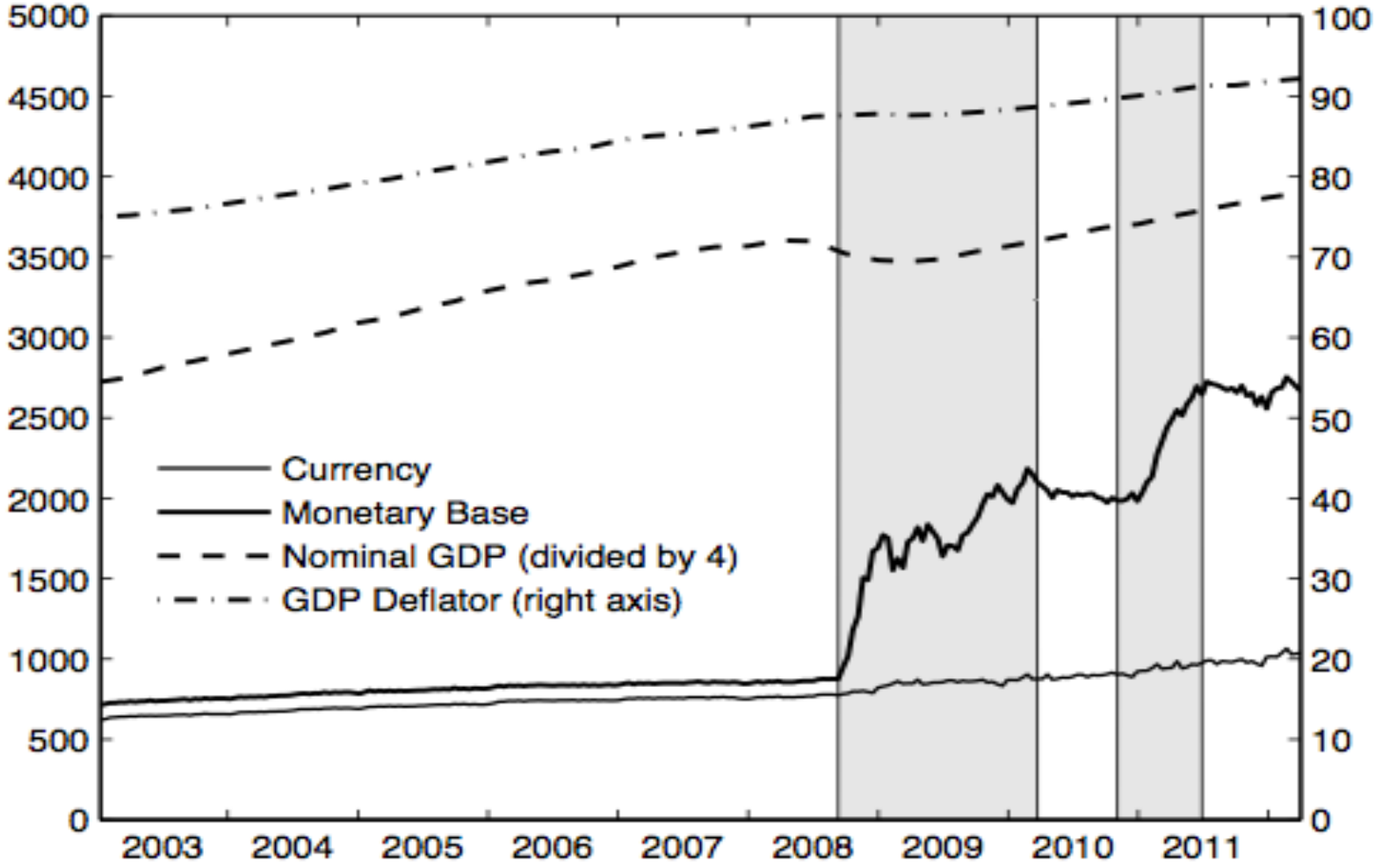
Very large increases in bank reserves and Treasury deposits at Fed.

"Quantitative easing" in Japan



Ongoing deflation, no trend increase in nominal GDP despite large increase in monetary base. Source Woodford (2012).

"Quantitative easing" in US



No trend increase in nominal GDP despite two periods of "*unusual balance sheet expansion*". Source Woodford (2012).

Fiscal policy

- Troubled Asset Relief Program (TARP):

  Fund to allow US Treasury to buy "troubled" or "toxic" assets, i.e., illiquid difficult-to-value assets. A bailout of the banking system

- Fiscal stimulus:

  From early 2008 (at least), clear that crisis was hitting the rest of the macroeconomy too

  As we have seen, fiscal policy should be especially effective when interest rates are near zero

More background: trends in banking

- Traditional banking: hold loan on balance sheet till repaid
- Modern banking: *originate and distribute*
  - loans pooled and then "*tranched*" (sliced)

    e.g., CDO – collateralised debt obligation – of various types
    CLOs, CMOs,...
  - sell credit protection

    e.g., CDS – credit default swap
    periodic fee against payment if credit event for bond or tranche

    not quite regular insurance, buyer need not have a direct interest
    ("*naked CDS*")

Securitisation

- Pass-through securitisation
  - package or pool of underlying assets
    (mortgages, bank loans, corporate debt, credit-card receivables, etc)
  - intermediary, e.g., mortgage originator, collects payments from underlying assets
  - passes consolidated payments through to holder of security (less fee)
- Structured finance
  - adds capital structure, i.e., prioritisation of claims to cash flows
  - credit enhancement

Securitisation

- Pass-through securitisation
  - individual mortgage etc not tradable in secondary market
  - bundling many cash flows creates homogeneous tradable product
  - (horizontal) portfolio diversification
- Each investor in pass-through security has equal claim to consolidated cash flow
- Only reduction in risk comes from diversification, so main benefit is creation of homogeneous tradable product (more liquid)
- Banks don't have to hold mortgages, can sell them (creates incentive problems)

Aside on diversification

- Investor with wealth W.
  Assets $i = 1, ..., N$ with IID returns R_i mean μ variance σ^2

- *Undiversified* portfolio

$$\begin{aligned} \text{mean portfolio return} = \quad & \mathbb{E}[R_i W] = \quad & \mu W \\ \text{std dev portfolio return} = \quad & \text{Std}[R_i W] = \quad & \sigma W \end{aligned}$$

- *Diversified* portfolio (equal weights)

$$\text{mean portfolio return} = \quad \mathbb{E}\left[\frac{1}{N}\sum_{i=1}^{N} R_i W\right] = \quad \mu W$$

$$\text{std dev portfolio return} = \quad \text{Std}\left[\frac{1}{N}\sum_{i=1}^{N} R_i W\right] = \quad \frac{1}{\sqrt{N}}\sigma W$$

- Positive correlation amongst R_i diminishes benefit from diversification (negative correlation enhances diversification)

Structured finance

- Begin with diversified portfolio of underlying assets
- *Prioritised capital structure* of claims to cash flows, tranches

super senior tranche	$\leftrightarrow$	least risky
$\vdots$		
mezzanine tranche		
$\vdots$		
junior or equity tranche	$\leftrightarrow$	most risky

- Sell different tranches to investors with different risk appetites (e.g., pension funds vs. hedge funds)

Example #1

- Two bonds. Each pays cash $\{0, 1\}$
- Probability of cash $= 1$ is 0.9 *independent across bonds*
- Sell junior j and senior s claims to \$1 cash flow

realization	$\{0,0\}$	$\{0,1\}$	$\{1,0\}$	$\{1,1\}$
probability	0.01	0.09	0.09	0.81
payment $\{j, s\}$	$\{0,0\}$	$\{0,1\}$	$\{0,1\}$	$\{1,1\}$

- Senior claim paid with prob 0.99, junior claim with prob 0.81
- Senior claim can be more highly rated

Example #2

- Three bonds. Each pays cash $\{0, 1\}$
- Probability of cash $= 1$ is 0.9 *independent across bonds*
- Sell junior j, mezzanine m and senior s claims to \$1 cash flow

realisation	$\{0,0,0\}$	$\{0,0,1\}$	$\cdots$	$\{1,1,0\}$	$\{1,1,1\}$
probability	0.001	0.009	$\cdots$	0.081	0.729
pay $\{j,m,s\}$	$\{0,0,0\}$	$\{0,0,1\}$	$\cdots$	$\{0,1,1\}$	$\{1,1,1\}$

- Senior paid prob 0.999, mezzanine prob 0.972, junior prob 0.729
- More assets in underlying pool $\Rightarrow$ more highly-rated tranches

More securitisation

- Do not have to stop at one round of securitisation
- Apply the same logic but now to pools of junior and mezzanine tranches (e.g., CDO-squared)
- Many common products are effectively CDO-squared
  - e.g., CMOs re-securitised from subordinated tranches of mortgage-backed securities

Example #3

- Two *pools*, each of two bonds as in first example
  Each bond pays $\{0, 1\}$, independent across bonds, prob 0.9

- Each pool has senior s and junior j claims as in first example

realisation	$\{0,0\}$	$\{0,1\}$	$\{1,0\}$	$\{1,1\}$
probability	0.01	0.09	0.09	0.81
payment $\{j, s\}$	$\{0,0\}$	$\{0,1\}$	$\{0,1\}$	$\{1,1\}$

- Combine j tranches from each pool, sell j_j and s_j claims

realisation $\{j_1, j_2\}$	$\{0,0\}$	$\{0,1\}$	$\{1,0\}$	$\{1,1\}$
probability	0.0361	0.1539	0.1539	0.6561
payment $\{j_j, s_j\}$	$\{0,0\}$	$\{0,1\}$	$\{0,1\}$	$\{1,1\}$

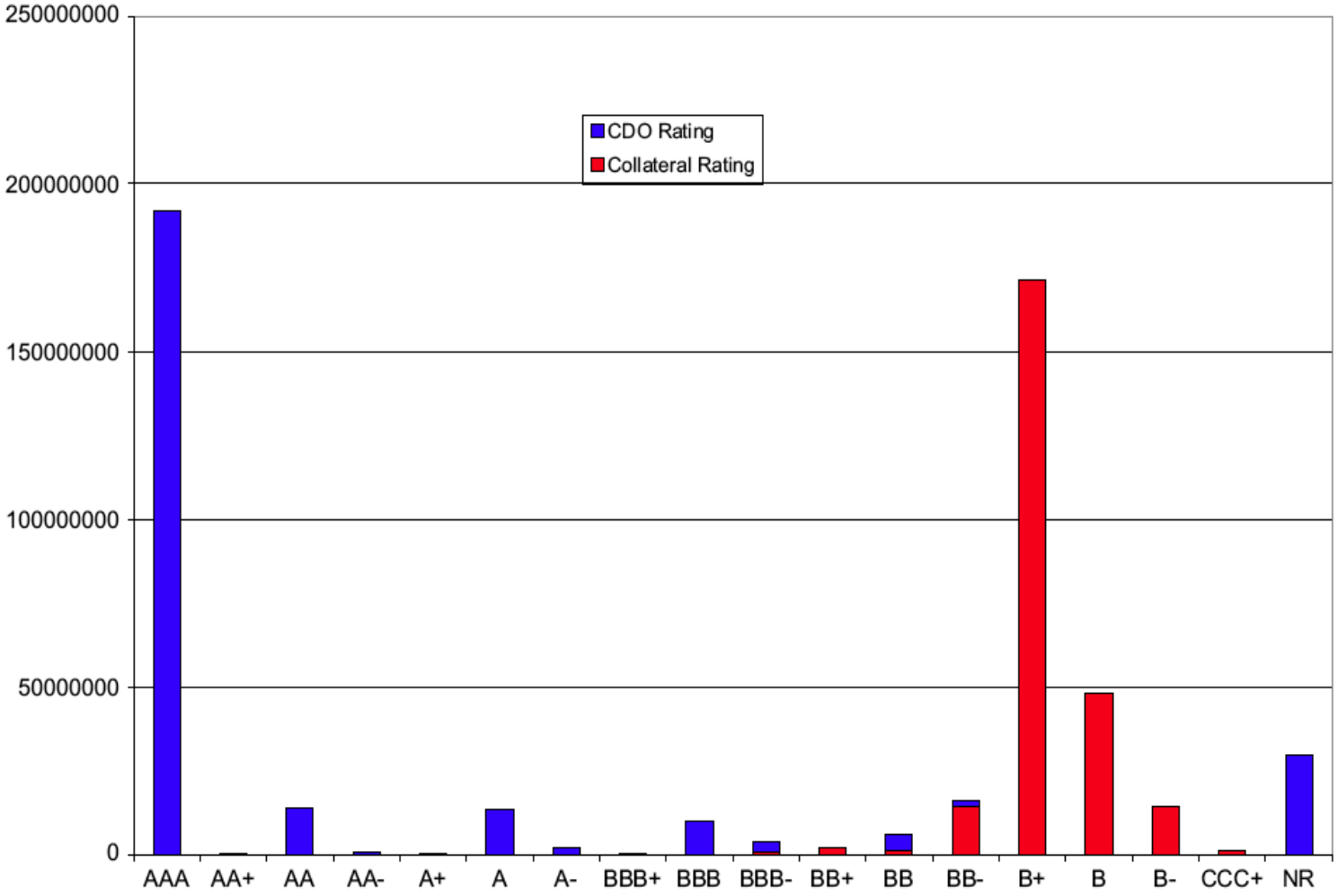
Example #3 (cont)

- Senior tranche in second round s_j gets paid unless there is at least one default in each pool
- Four underlying bonds, each with default probability 0.10
- From this, three securities each with better default probabilities
  - senior claims s_1, s_2 in first round, default prob 0.01
  - senior claim s_j in second round, default prob 0.0361

Ratings games

- Many institutional investors required to buy only rated products
- *Rating at the edge*, structure tranche cutoffs to ensure particular credit ratings, e.g., AAA
- In principle, risk shifted to those who want it and spread among many investors (pension funds vs. hedge funds)

Alchemy of CDO ratings



Source: Benmelech and Dlugosz (2009)

CDO vs underlying collateral credit ratings. Compares the credit rating of CDO tranches with average credit rating of the underlying collateral pools backing them.

Correlation

- Benefits of securitisation diminished by correlation across cash flows of underlying assets
- Rating harder than for single-name securities
- Need to take stand on *joint distribution* of cash flows across pools of underlying assets
- In fact, underlying pools of mortgages were highly similar in geographic location and in vintage, etc

Example #4

- Two bonds. Each pays cash $\{0, 1\}$
- Prob of cash $= 1$ is 0.9 but *perfectly correlated across bonds*

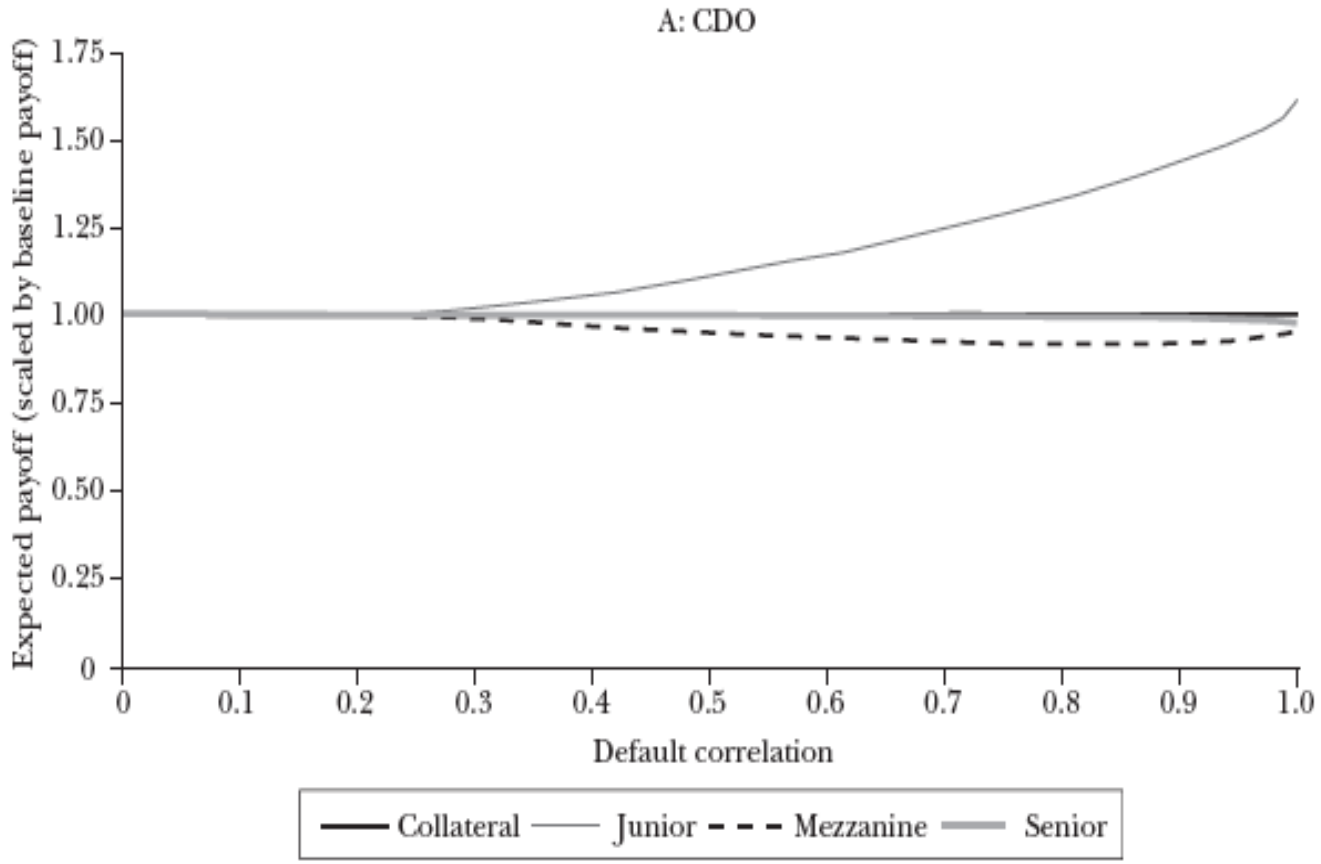
realisation	$\{0, 0\}$	$\{1, 1\}$
probability	0.10	0.90
payment $\{j, s\}$	$\{0, 0\}$	$\{1, 1\}$

- Cannot use prioritisation to protect a senior claim
- No credit enhancement

Parameter estimates

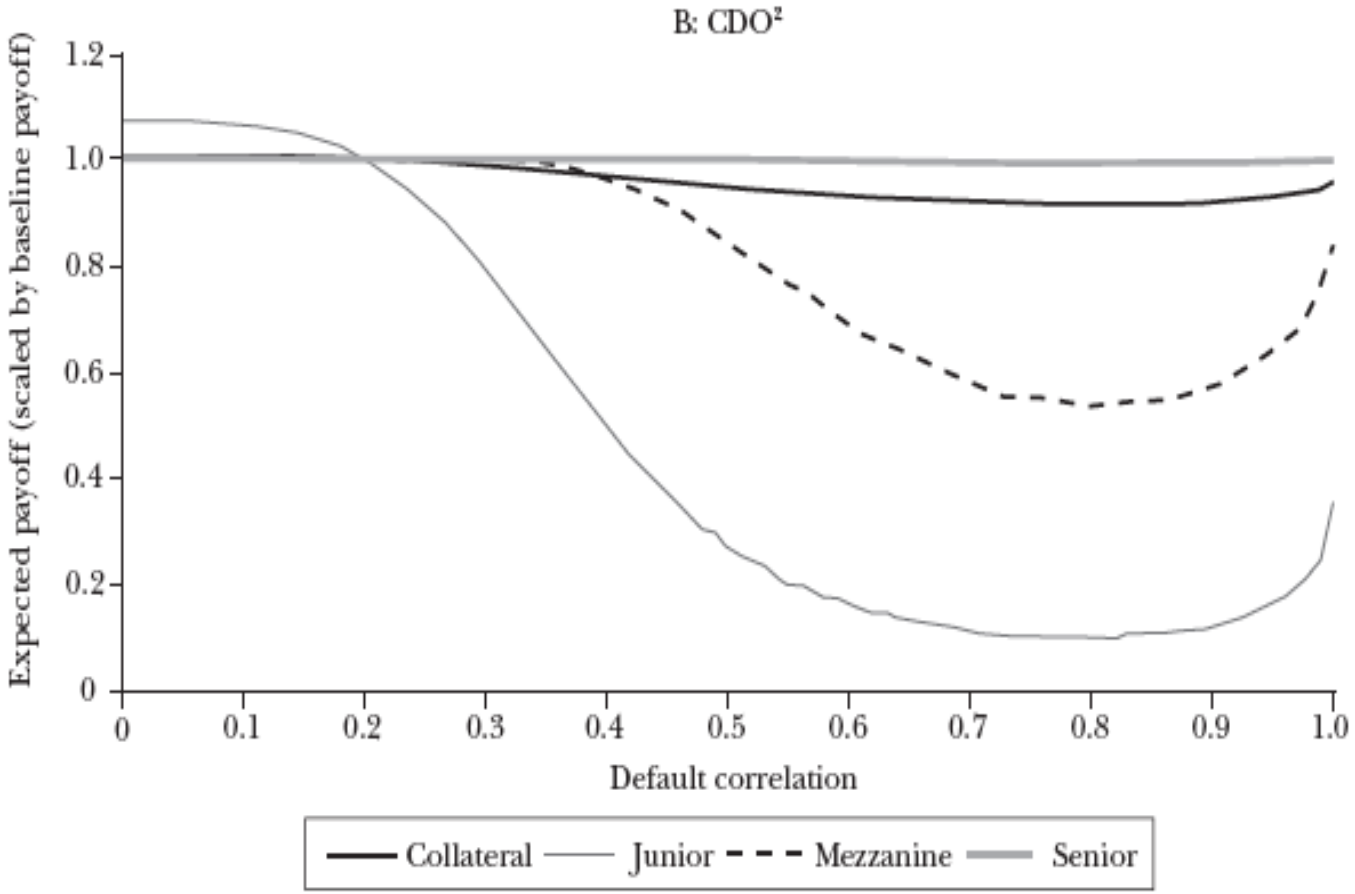
- Estimates of default probability highly sensitive to *imprecision* in parameter estimates (in particular, *default probabilities*)
- Parameter estimates gave over-optimistic assessments
  - data with modest and/or only regional house price falls
  - highly parametric statistical models used to fill-in for limited data (e.g., multivariate Gaussian copula)
- Problems amplified for CDO-squared and by rating-at-the-edge

Sensitivity of CDO to default correlation



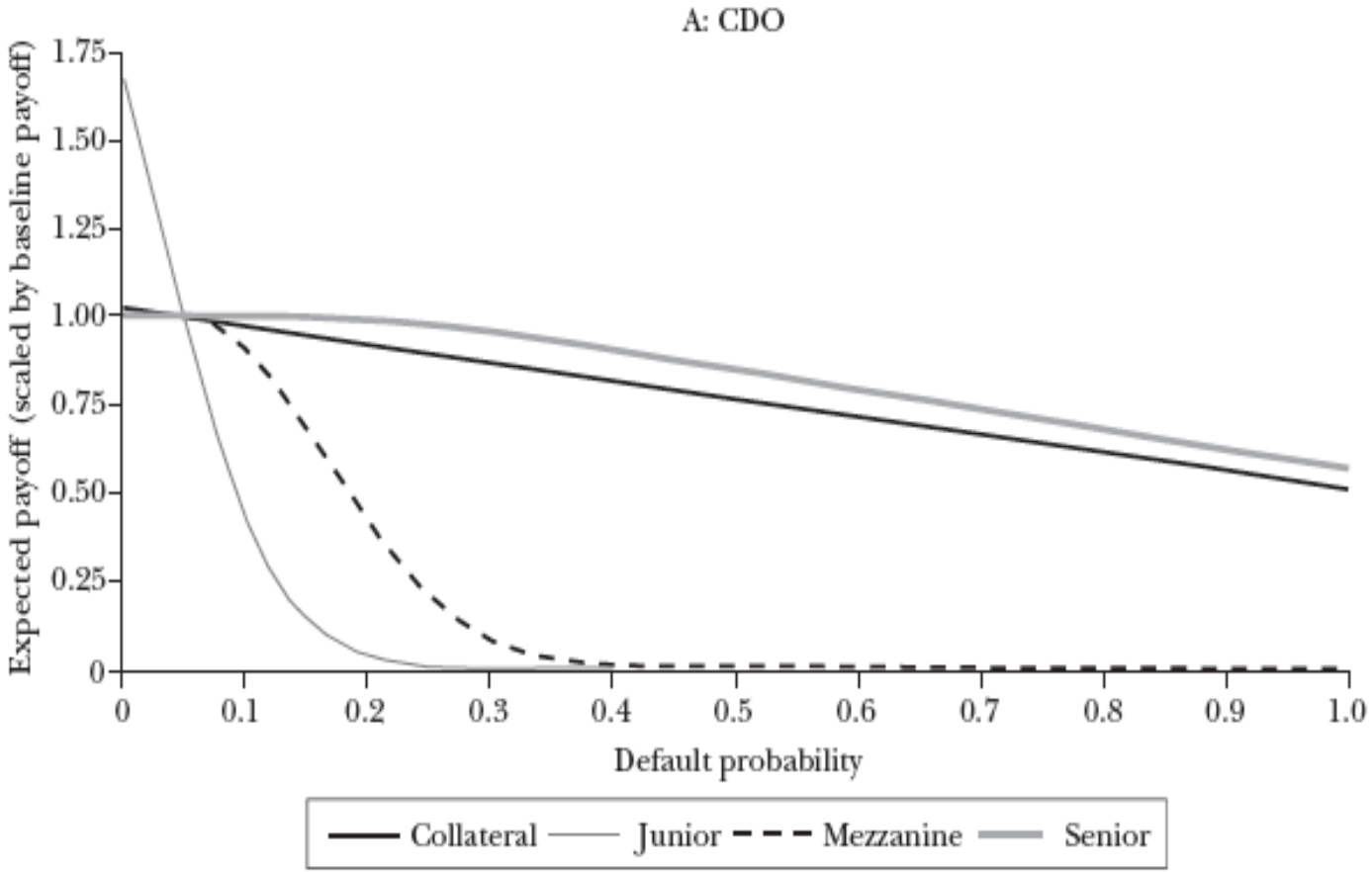
Normalised expected payoff as function of correlation *within* given pool for default probability of 0.05. As correlation increases, risk shifts from junior to senior tranche. Non-monotonic effect on mezzanine tranche, rises for high correlation as risk shifted to senior tranche. Source: Coval, Jurek and Stafford (2009).

Sensitivity of CDO^2 to default correlation



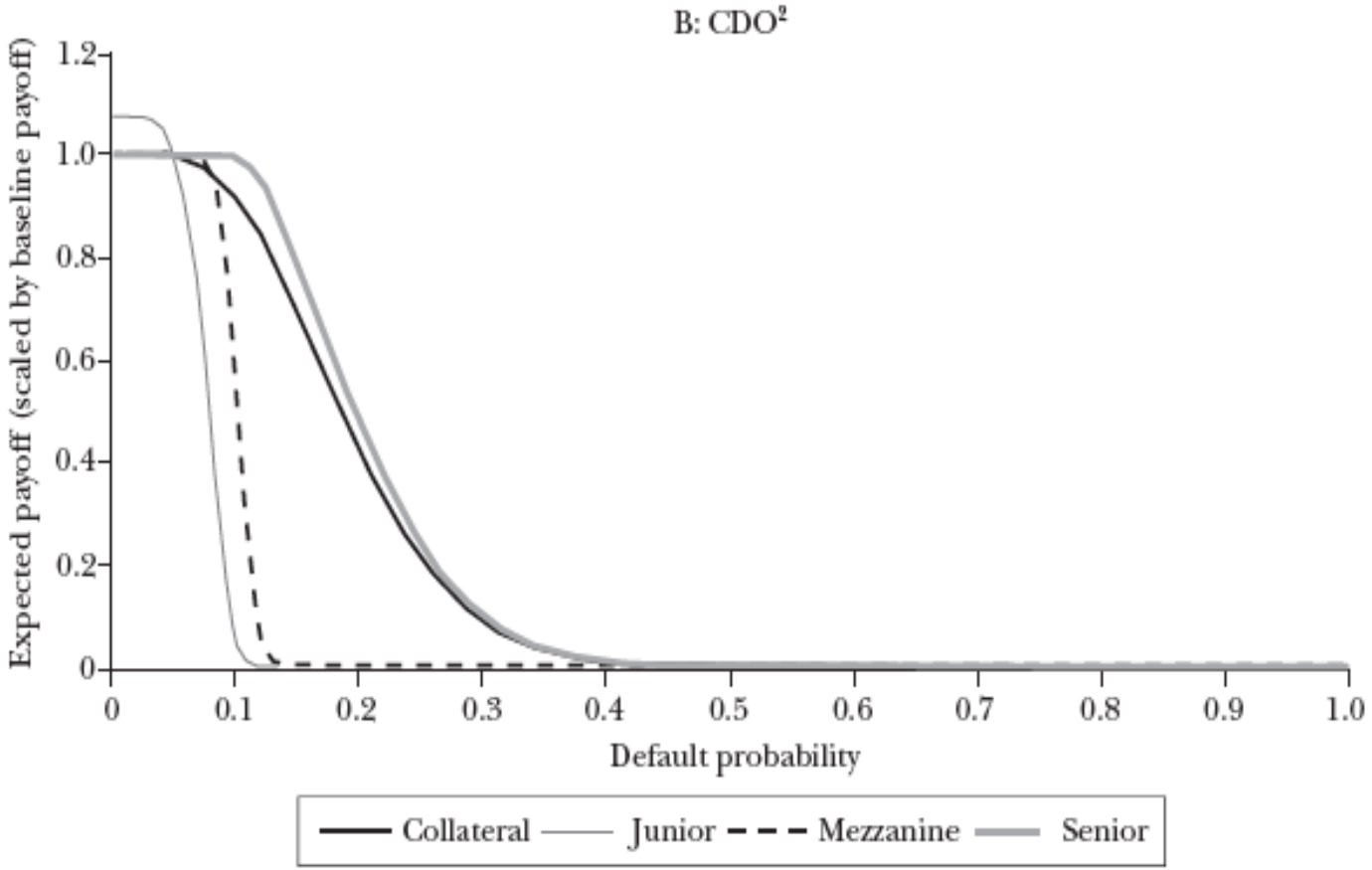
Amplification of sensitivity for CDO2. In practice, subprime exposure was in this form. CMOs re-securitised from subordinated tranches of subprime mortgage-backed securities. Source: Coval, Jurek and Stafford (2009).

Sensitivity of CDO to default probability



Normalised expected payoff as function of default probability for default correlation 0.20. Payoffs decline monotonically. Sensitivity highest for junior tranche. Source: Coval, Jurek and Stafford (2009).

Sensitivity of CDO^2 to default probability



Amplification of sensitivity for CDO2. Regions of extremely high sensitivity to small errors in estimated default probabilities. Source: Coval, Jurek and Stafford (2009).

Exposure to aggregate risk

- Rated on same scale as single-name products
  - two AAA products can have different exposures to aggregate risk
  - ratings only address *credit* risk per se, not whether that risk is likely to coincide with aggregate market risk/recession (cf., CAPM, expected excess return given by *covariance* with market)
- Structured products *concentrate* losses in states where all underlying assets are doing badly, i.e., in aggregate recession
- With a large enough pool of underlying assets, losses by structured product are *driven entirely by exposure to aggregate risk*

Next lecture

- Bank runs
  - ◇ Diamond and Dybvig "Bank runs, deposit insurance, and liquidity" *Journal of Political Economy*, 1983
  - ◇ Diamond "Banks and liquidity creation: a simple exposition of the Diamond-Dybvig model" FRB Richmond *Econ. Quarterly*, 2007
- Securitised banking and the run on repo
  - ◇ Gorton and Metrick "Securitized banking and the run on repo" NBER working paper, 2009

Readings available from the LMS