Lecture notes on risk management, public policy, and the financial system

Financial market impact of crises and policy responses

Allan M. Malz

Columbia University

Behavior of asset prices during crises

Anomalies in markets since the crisis

Behavior of asset prices during crises

- Shifts in asset prices
- Liquidity and credit risk in crises
- Extreme volatility
- Correlations

Anomalies in markets since the crisis

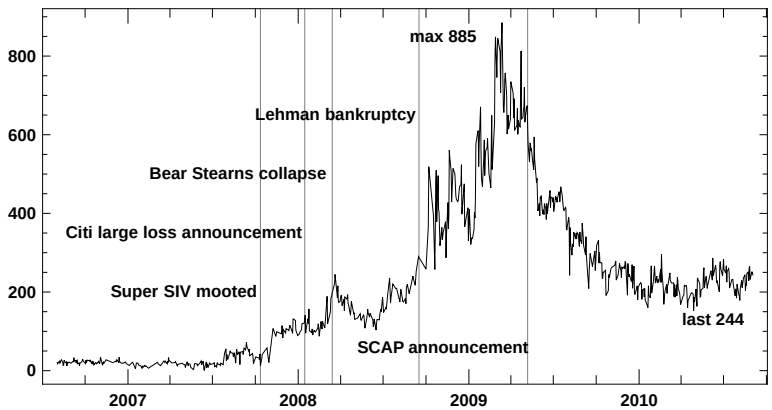
- Reduced size and growth of markets
- Market liquidity since the crisis
- Impact on wholesale funding and money markets

Decline in risky asset prices

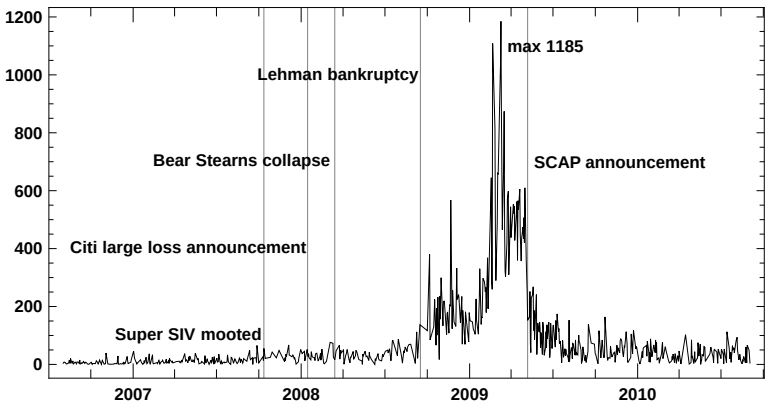
- Typical asset price behaviors during and in anticipation of "ordinary" recessions
  - Equity markets decline sharply
  - Credit spreads widen

Citigroup credit spreads 2006–2010

Senior unsecured bond spread



Senior-subordinated spread

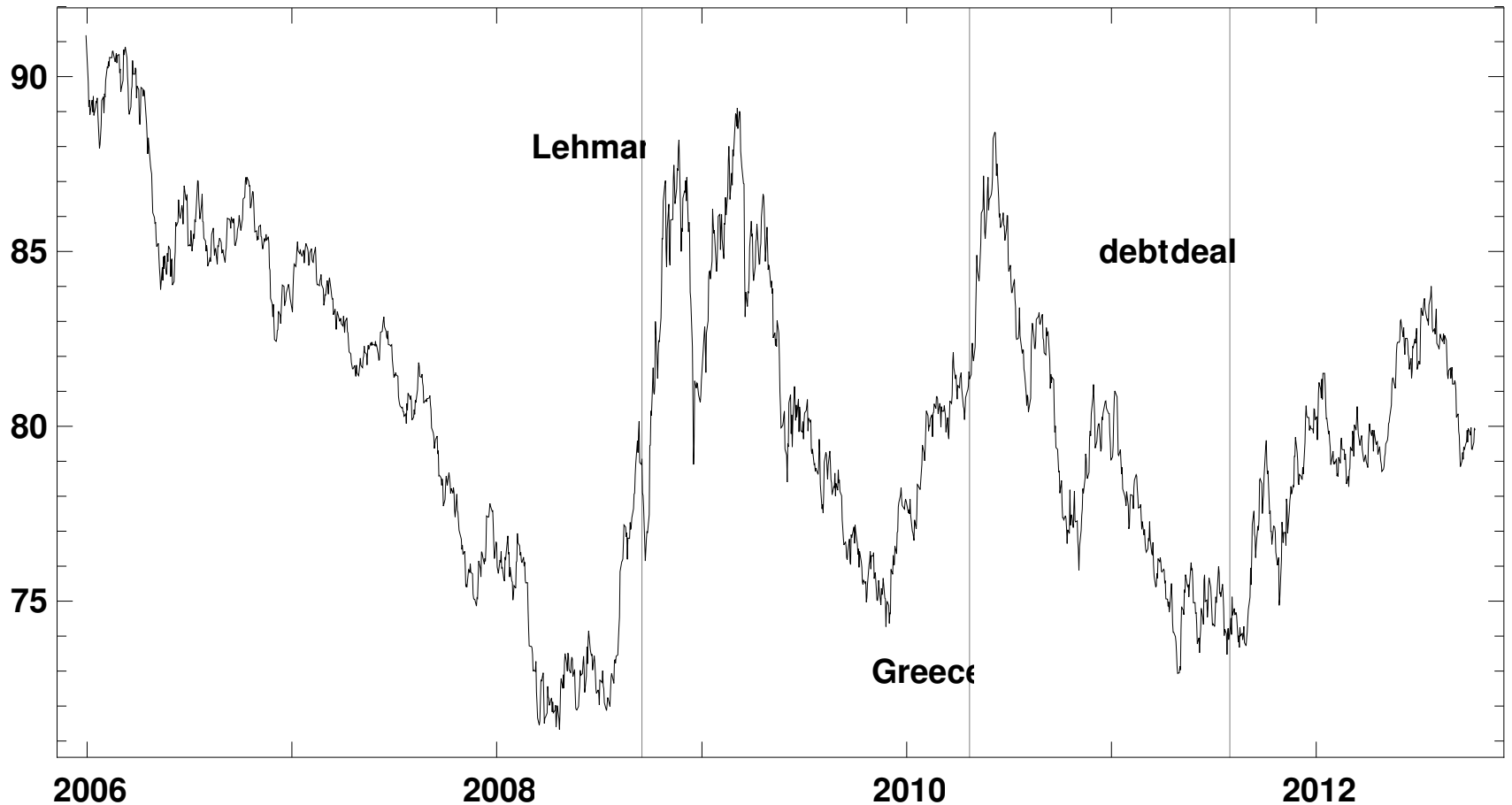


The senior bond spread over Libor (*z*-spread) is blended from spreads on the 4.7% maturing May 29, 2015 (CUSIP 172967CY5) and the 5.85% maturing August 2, 2016 (CUSIP 172967DQ1). The subordinated bond yields are for the 4.875% issue maturing May 7, 2015. *Source*: Bloomberg Financial L.P.

Rise in prices of safer assets

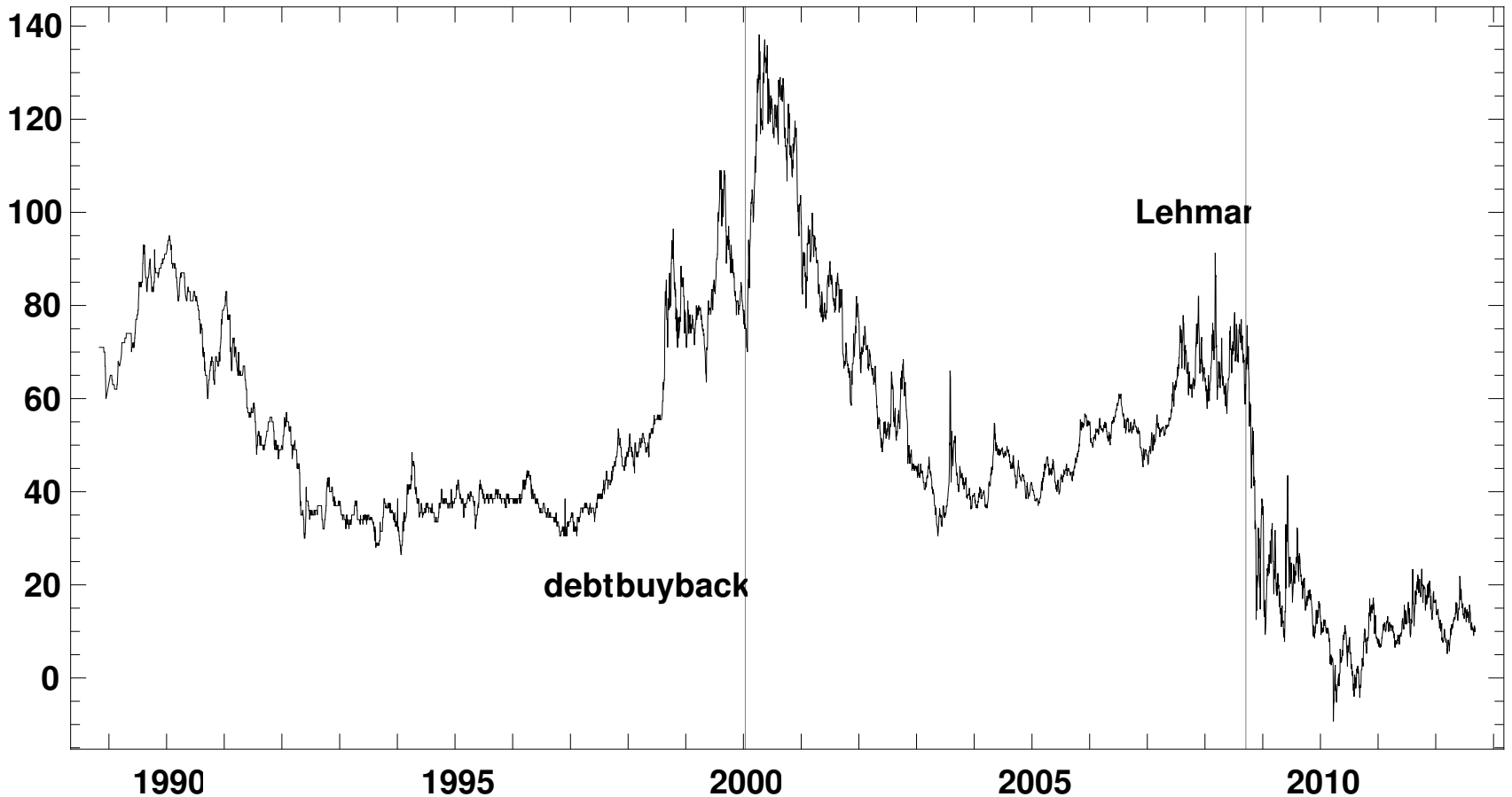
- U.S. dollar appreciation
- Compounding longer-term increase in demand for safe assets
- U.S. dollar-denominated interest-rate swaps since crisis
  - Negative spreads
  - Demand for duration
  - Markets need balance sheet to force a re-widening
- Credit discrimination becomes extreme in crisis: risk-free rates fall, increasing credit spreads

U.S. dollar index 2006–2012



Source: Bloomberg Financial L.P.

U.S. dollar swap spreads 1989–2012



Spread between fixed rate on 10-year plain vanilla interest-rate Libor swap and the yield to maturity of the on-the-run 10-year U.S. Treasury note, daily. *Source*: Bloomberg Financial L.P.

Solvency and liquidity

- **Solvency** refers to two conditions:
  - Ability to meet liabilities as they fall due: going-concern perspective
  - Having assets in excess of liabilities (**balance-sheet solvency**)
- Leverage and illiquidity both increase risk of insolvency
- Liquidity and solvency closely related, but not identical
  - Firm may be balance-sheet solvent but illiquid; **example:** bank experiencing run
  - Firm may be liquid but insolvent; **example:** underpriced insurance policies
- May be difficult to discern solvency, doubts of firm's insolvency can impair liquidity

Liquidity		Solvency
Reserves		Capital
Cash		Common equity
Mark-to-market loss	$\leftrightarrow$	Permanent/realized loss
Liquidity support		Resolution
Central bank		Finance ministry

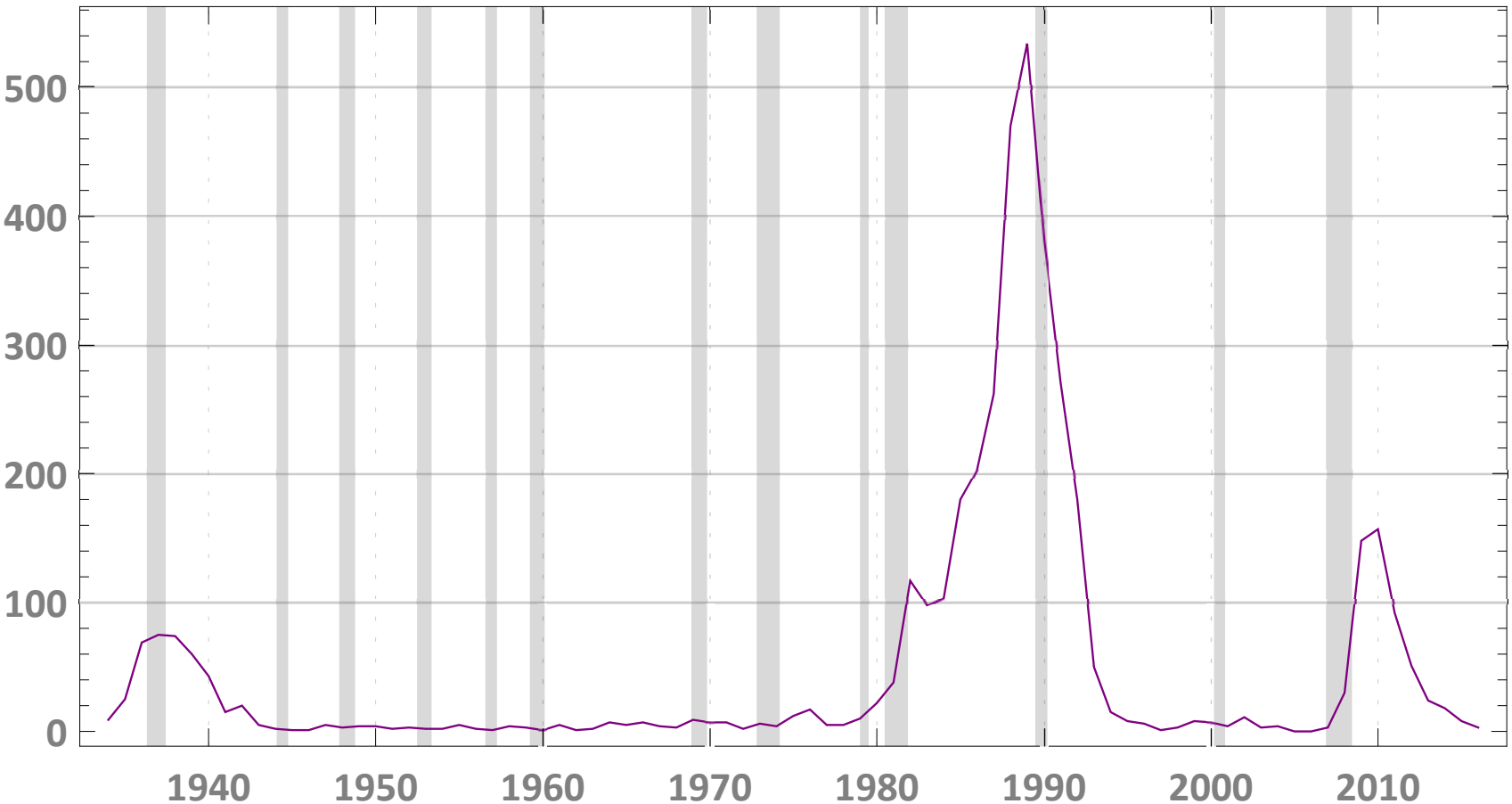
Liquidity contraction in financial crises

- Intense increase in liquidity preference
- Diminution of market liquidity for all but safest assets
- Diminution of funding liquidity→
  - Actual difficulty rolling over or extending term of short-term debt
  - Fear of difficulty rolling over short-term debt leads to **liquidity hoarding**: reluctance to lend and desire to extend term of own borrowing
- Liquidity as well as credit and counterparty risk affect money market spreads

Runs and panics

- Withdrawal of short-term funding from banks, more recently MMMFs, securitization funding vehicles
- "Daisy chains" of intermediary failure and "fire sales"
- Impairment of market functioning
- Classic runs: Mass withdrawal of retail bank deposits
- Contemporary runs: Mass withdrawal of wholesale short-term funding
  - Examples: Northern Rock 2007, Bear Stearns 2008
- Scarcity and devaluation of collateral (the "run on repo")
  - Amplified by rehypothecation fears: where's my collateral?
- **Prime brokers** face withdrawal of cash balalnces
  - Cash not held as collateral against shorts or OTC derivatives can be withdrawn on short notice
  - Held largely by hedge fund customers, but used to finance entire broker-dealer

U.S. bank failures 1934–2016



Number of commercial and savings banks, 2016 through mid-year. Vertically shaded intervals denote NBER recessions. *Source*: Federal Deposit Insurance Corporation (FDIC), Historical Statistics on Banking, Table BF02.

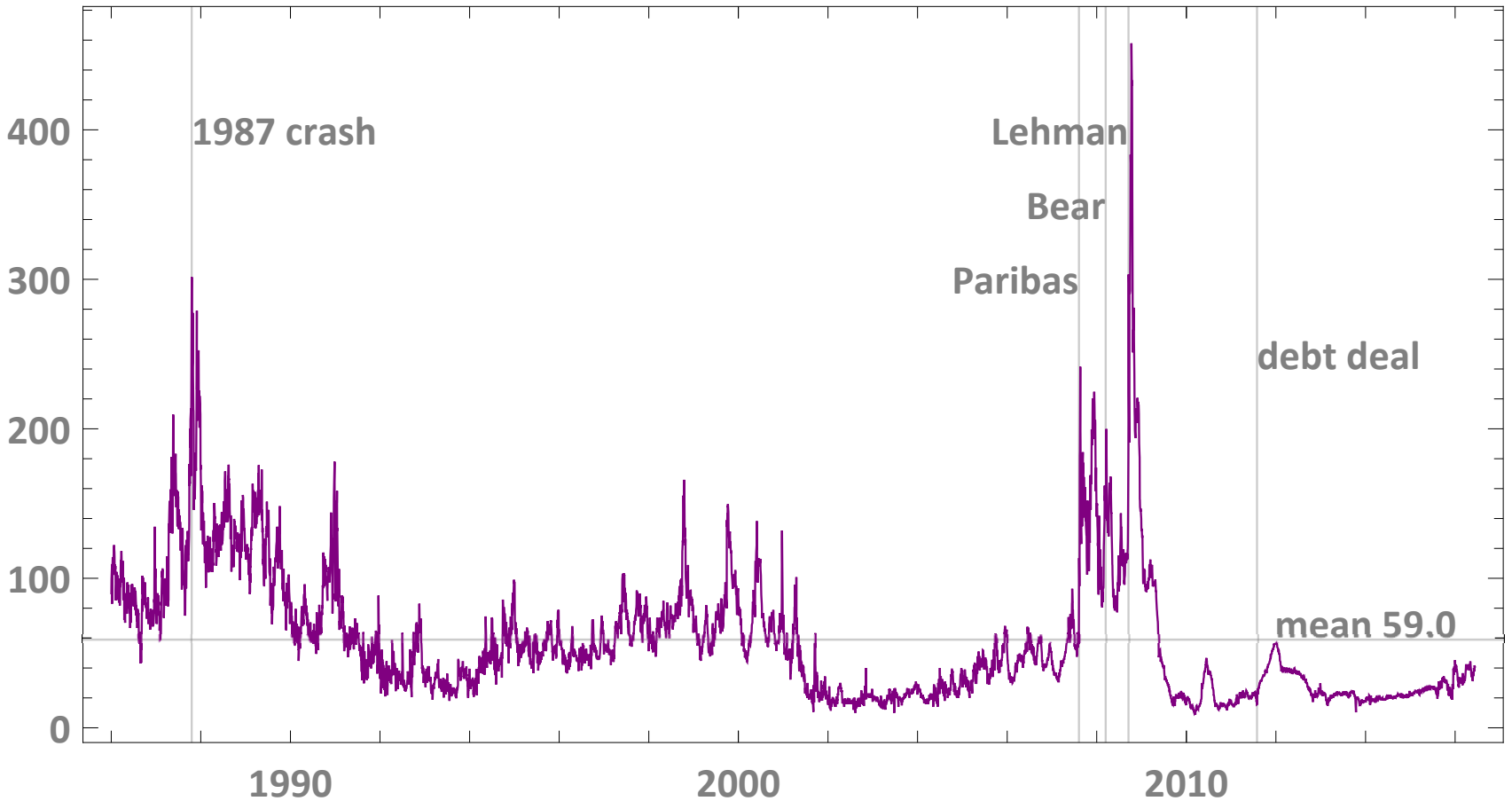
Illiquidity and insolvency in stress conditions

- Illiquidity: difficulty funding assets
- Insolvency: asset value falls below liabilities
  - In normal times, illiquidity of balance-sheet solvent firm often survivable
- Asymmetric information problem
  - Difficult to distinguish intermediary liquidity from solvency in real time under stress conditions
  - Asset values dropping rapidly, high volatility
  - Complexity and opacity of large intermediaries' balance sheets
  - Collective action problems in funding: no lender wants to step ahead of others, but no lender wants to see large-intermediary failure
- Illiquidity can become insolvency via market illiquidity
  - Vicious circle: Fear of insolvency→illiquidity→asset **"fire sales"** and runs
  - Higher likelihood of illiquidity tipping into insolvency with reliance on short-term wholesale funding

Money market spreads in the global financial crisis

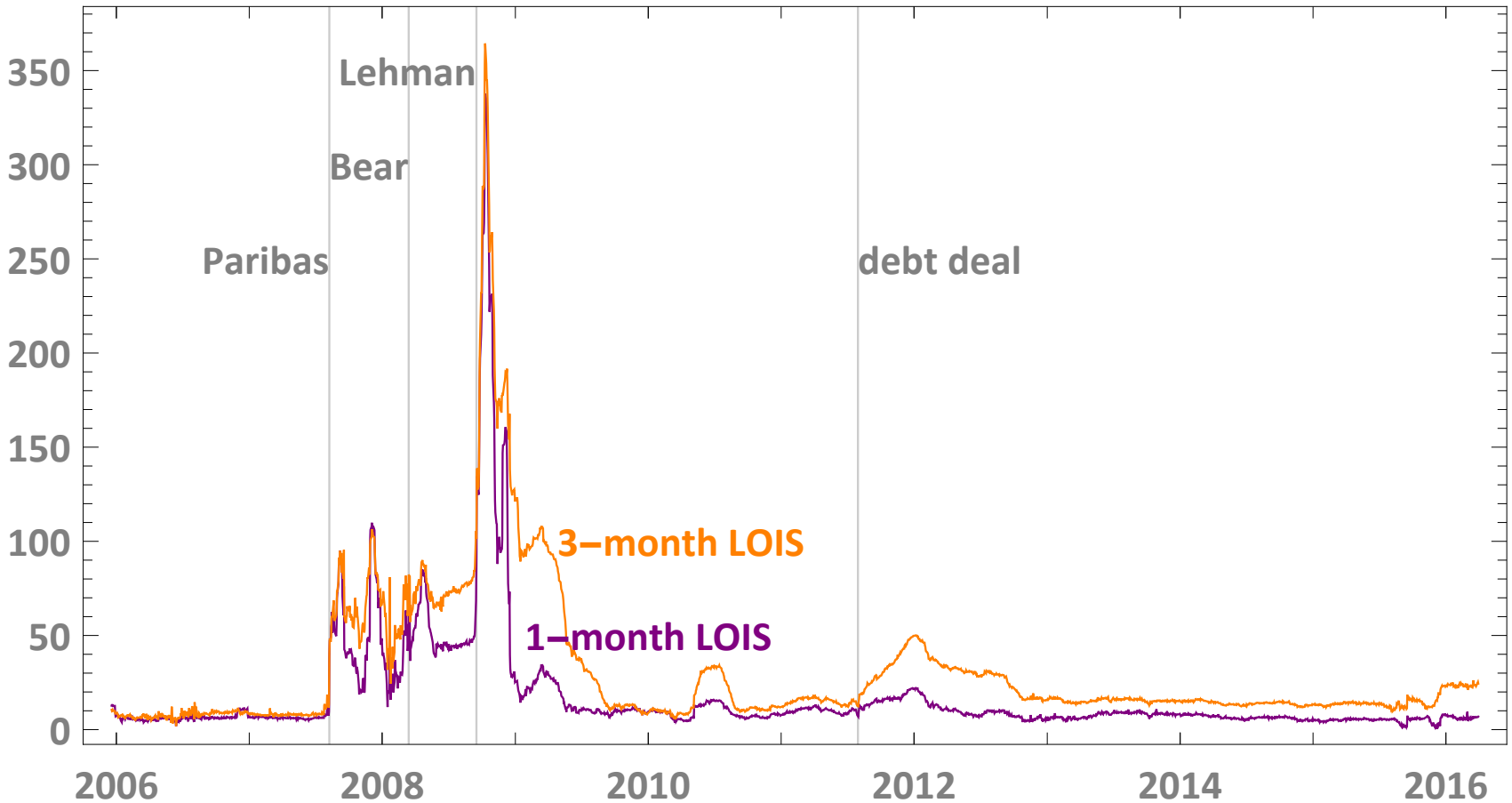
- Interpreting extremely sharp spread widening among money market rates after August 2007; may be due to
  Increased liquidity risk and liquidity hoarding
  Increased credit/counterparty risk →contagion
  Changes in term structure on economic fundamentals, interest-rate policy changes
- **TED spread:** Eurodollar or LIBOR rate minus rate on T-bills of same maturity
  - Interbank rates higher because of credit risk, T-bill rates lower on desire for safety
- **Libor-OIS** or **LOIS spread:**
  - OIS a relatively risk-free rate indicator of term structure expectations (but some counterparty risk)
  - Spread may be driven by liquidity premium or credit spread
- Compare Libor with other credit-risky rates, e.g. on wholesale-market **certificates of deposit** (CDs)
  - CD an Libor rates very close, suggestting credit/counterparty risk largely responsible for LOIS spread

TED spread 1986–2016



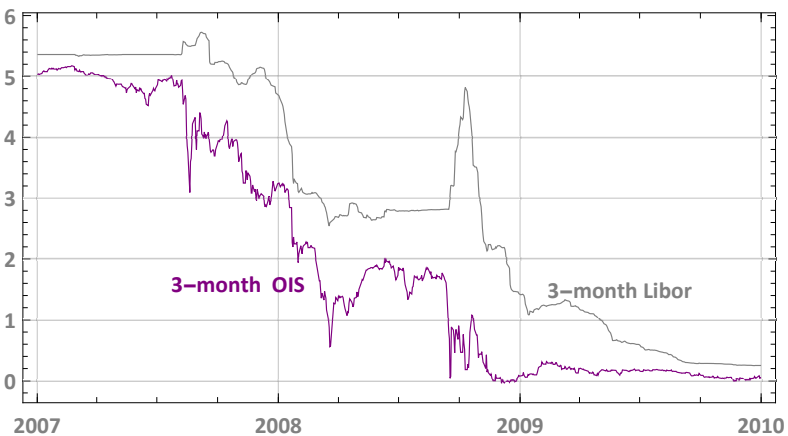
Three-month USD BBA Libor minus the 3-month Treasury bill yield, basis points, daily. *Source*: FRED.

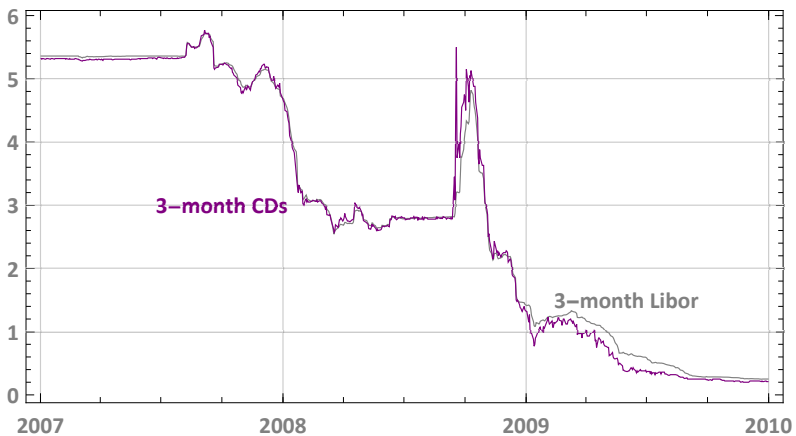
Libor-OIS spread 2006–2016



USD BBA Libor minus OIS of like maturity, basis points, daily. Purple plot: 1-month; orange plot: 3-month. *Source*: Bloomberg Financial L.P.

Libor and CD rates 2007–2009



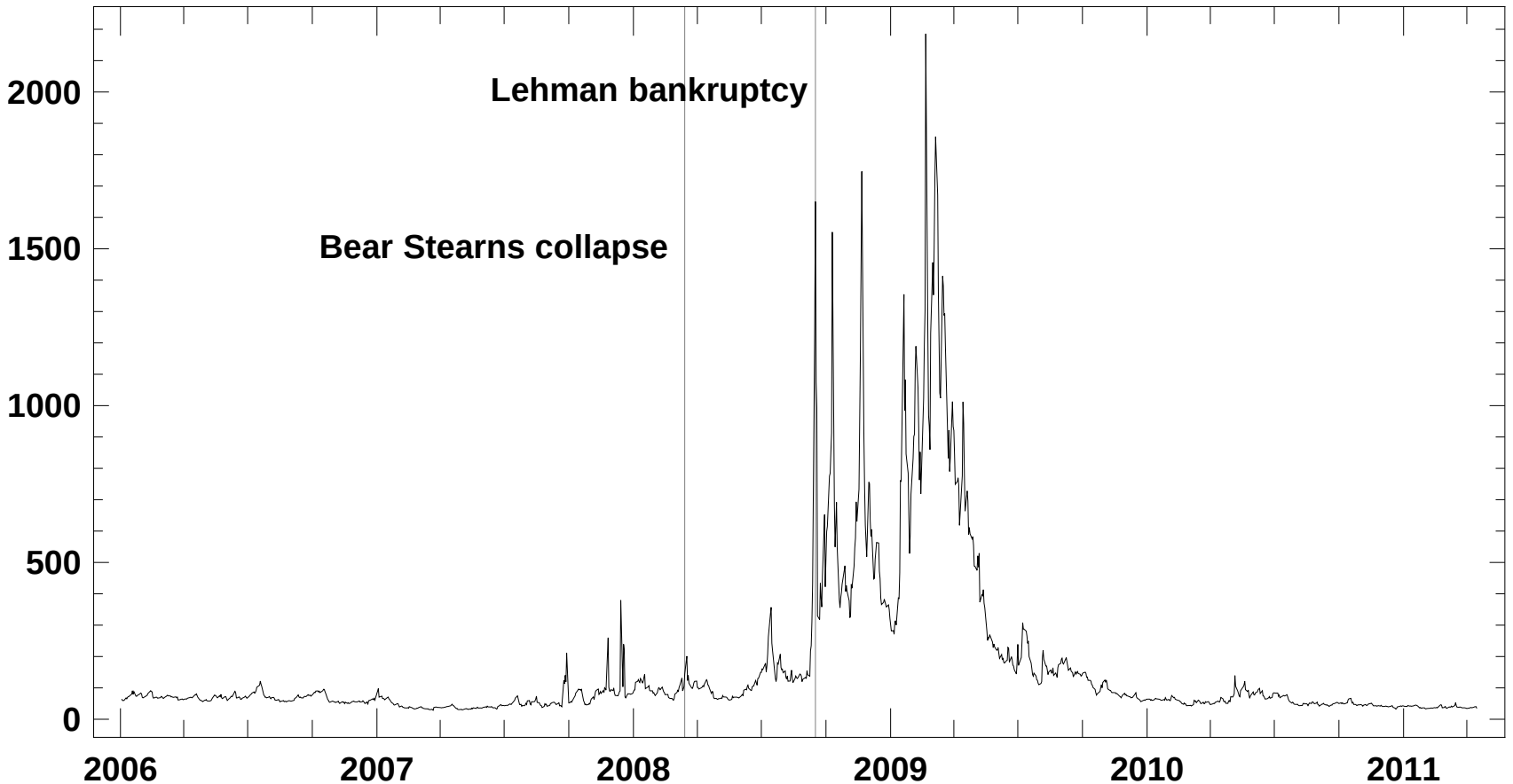


Left panel: 3-month USD BBA Libor (gray plot) and 3-month OIS (purple plot).
Right panel: 3-month USD BBA Libor (gray plot) and 3-month CD rate (purple plot).
All data in percent, daily. *Sources*: Bloomberg Financial L.P., FRED.

Typical volatility patterns

- Realized volatility
- Implied volatility
- Volatility of volatility
  - Market participants expect arrival of important news

S&P 500 volatility dispersion



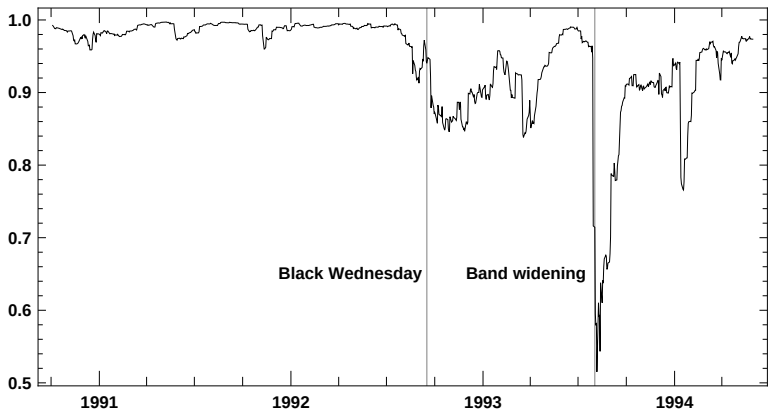
Cross-sectional variance of the implied volatilities of the largest S&P 500 constituents. *Data source*: Bloomberg Financial L.P.

Correlation observables

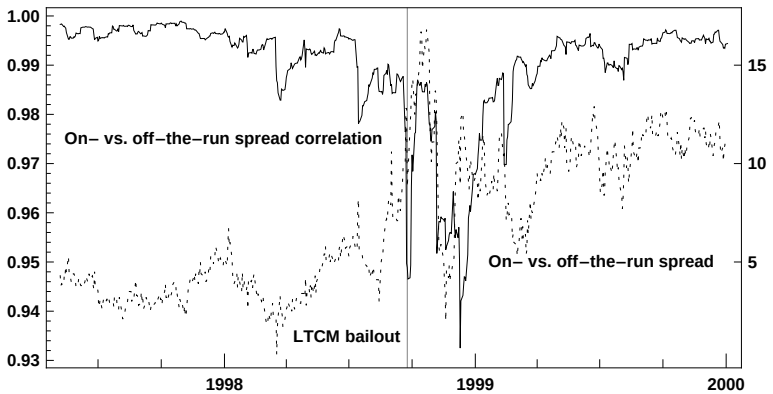
- Radicalization of historical correlations
  - Misleadingly summarized as "all correlations$\rightarrow 1$
  - Caution warranted: sampling during high-volatility periods
- Implied return correlations
  - Equity: derived from prices of index and single-stock options
  - Rates: derived from prices of options on different points on the term structure and on the term spread
- Default correlations
  - Derived from prices of standard tranches of credit default index swaps

Correlation breakdowns

European currency crisis 1992–1993

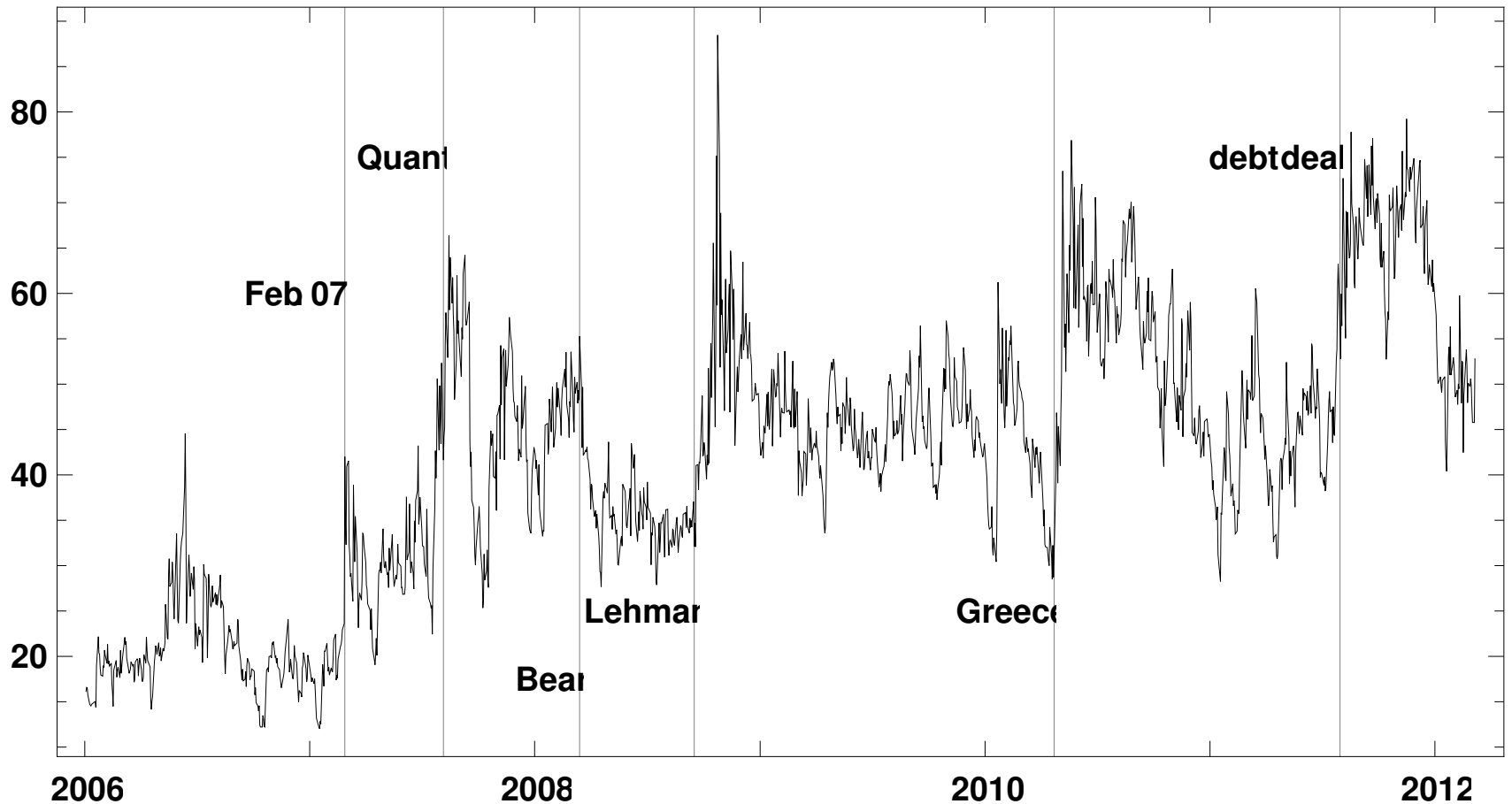


LTCManagement failure 1998



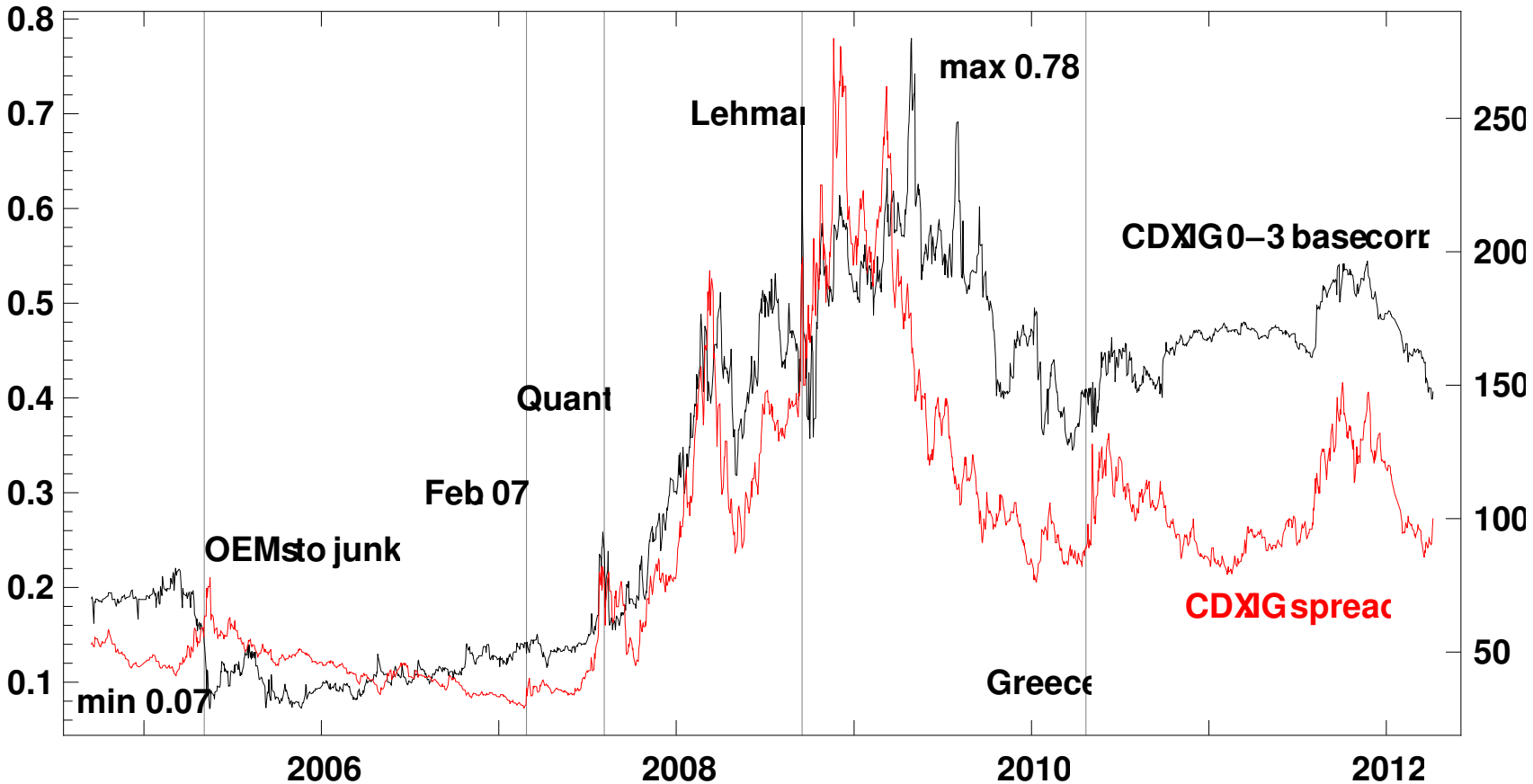
Left panel: daily correlation between logarithmic changes in the USD-DEM and USD-FRF exchange rates, computed using EWMA model with decay factor 0.94, October 5, 1990, to May 31, 1995. *Right panel*: correlation coefficient of daily changes in (solid line, left axis) and spread between (in basis points, dotted line, right axis) yields to maturity of the on-the-run and first off-the-run 30-year Treasury bond. Correlation computed using EWMA model with decay factor 0.94, May 7, 1995, to December 31, 1999. *Data source*: Bloomberg Financial L.P.

S&P 500 option-implied correlation 2006–2012



Percent. *Data source*: Bloomberg Financial L.P.

Base correlation 2004–2012



Black line (left axis) plots the equity base correlation. Red line (right axis) plots the 5-year IG CDX spread. *Source*: JPMorgan.

Behavior of asset prices during crises
- Shifts in asset prices
- Liquidity and credit risk in crises
- Extreme volatility
- Correlations

Anomalies in markets since the crisis
- Reduced size and growth of markets
- Market liquidity since the crisis
- Impact on wholesale funding and money markets

Policy changes and interest rates since the crisis

- Identification problem: specific changes in markets hard to trace back to specific policy change
- Two major categories of policy change
  - Monetary and debt management policies
  - Regulatory policies
- And acceleration of a pre-crisis trend
  - Low interest rates and demand for safe assets

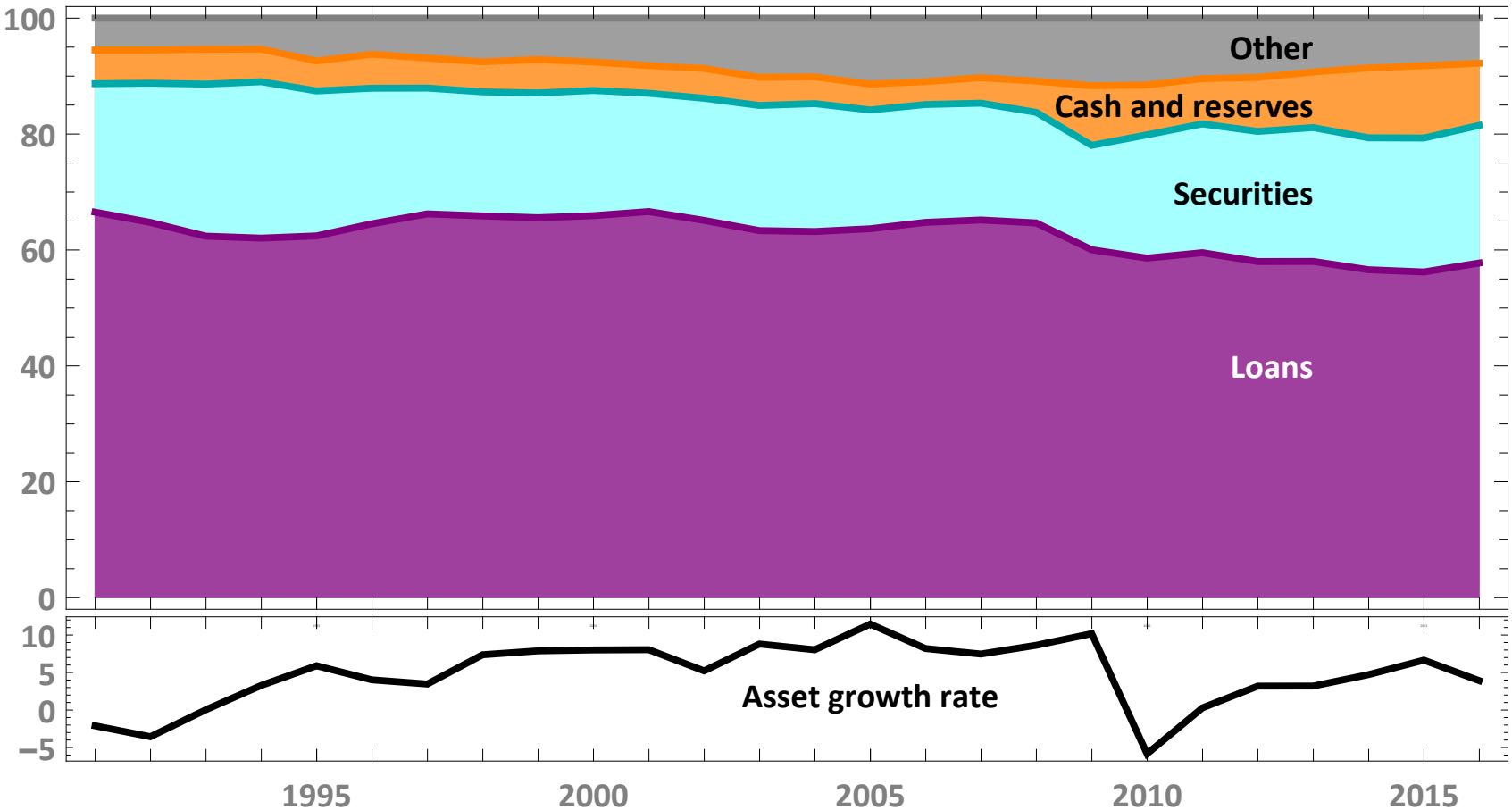
Arbitrage in normal times and after the crisis

- Slow arbitrage
  - Arbitrage never perfect, but unusually slow since crisis
- "Balance sheet"
  - Low return and low risk trades may require large positions
  - In turn requiring debt or equity funding

Slowing growth of U.S. commercial banks

- Overall growth in financial assets lower than pre-crisis
- Reduction in net interest margin (NIM)
  - Below 3 percent for first time since recovery from long-term interest rate control policies imposed during Second World War
- Reduction in lending activity
- Increase in share of cash and reserves
  - Composed in large part of excess reserves, counterpart of liability on Federal Reserve balance sheet

Commercial bank financial assets 1990–2015



Top panel: share of each asset type in total financial assets of U.S.-chartered depository institutions. Lower panel: annual growth rate of financial assets. Annual data. *Source*: Federal Reserve Board, Financial Accounts of the United States (Z.1), Table L.111.

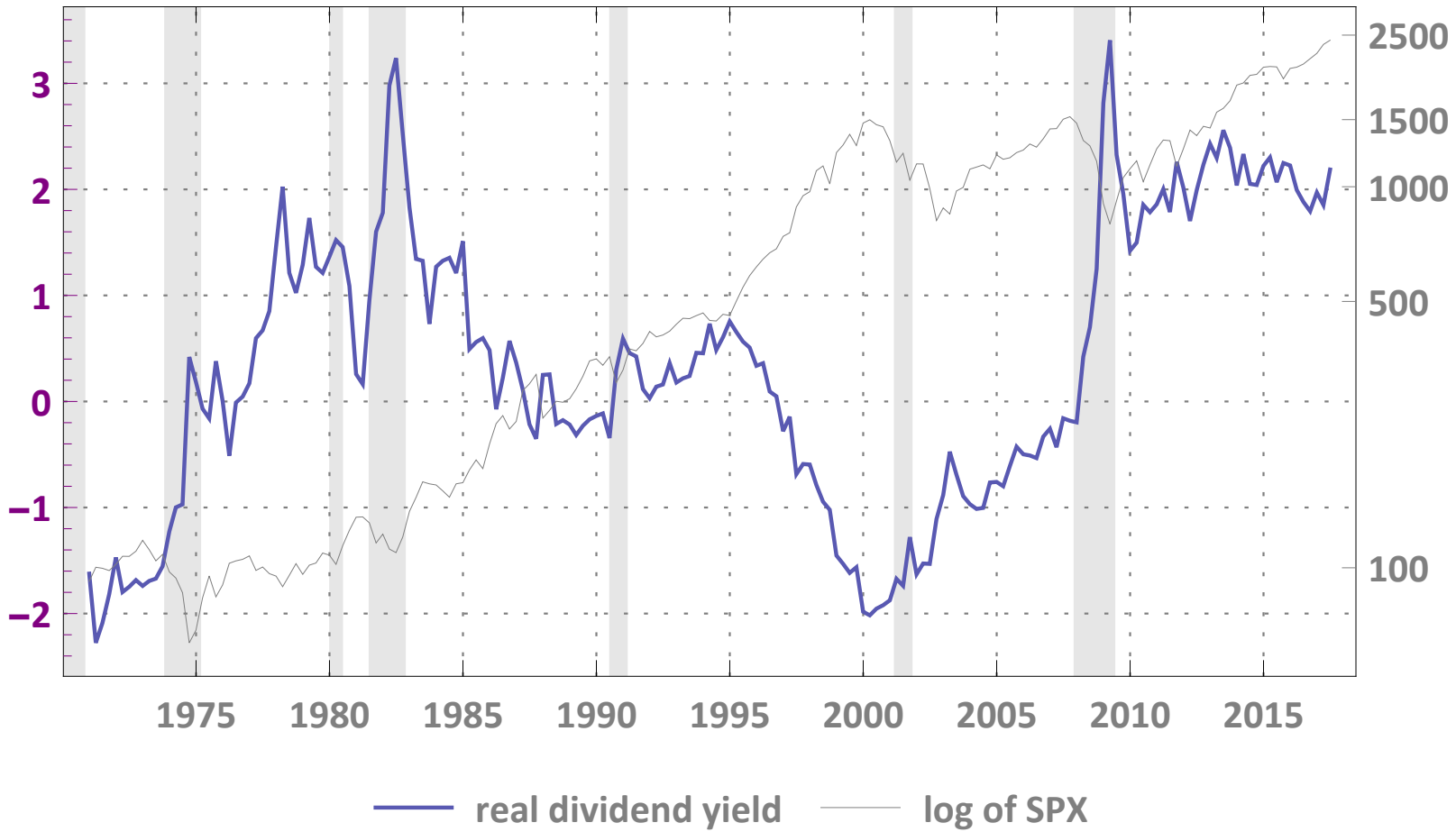
Low real interest rates

- Real rates down $\approx$ 200 basis points since crisis
- Potential explanations indicate risk aversion
  - Demand for safe assets
  - Low prospective returns
- Fed keeping real rate artificially low?
  - Rising asset prices an intended element of monetary policy transmission
  - Fed placing market rate near natural rate or market rate below natural rate?
  - But low capital spending and bank lending in spite of low rates
- Are yields low/prices high due to low risk-seeking?
  - High real dividend yields
  - Credit spreads wider than before crisis

Credit spreads and equity prices

- Are yields low/prices high due to low risk-seeking?
  - High real dividend yields
- Equity prices by some measures not that high *given low interest rates*
  - Shiller CAPE is currently 31, highest since 2000-01 decline
  - But dividend yield at record high relative to real interest rates
- Credit spreads are not at pre-crisis lows
  - U.S. lows in 1997 and 2005
  - Euro lows in 2005 and 2007; Bloomberg Barclays Agg now 3 times wider

Dividend-real rate yield spread 1970–2017

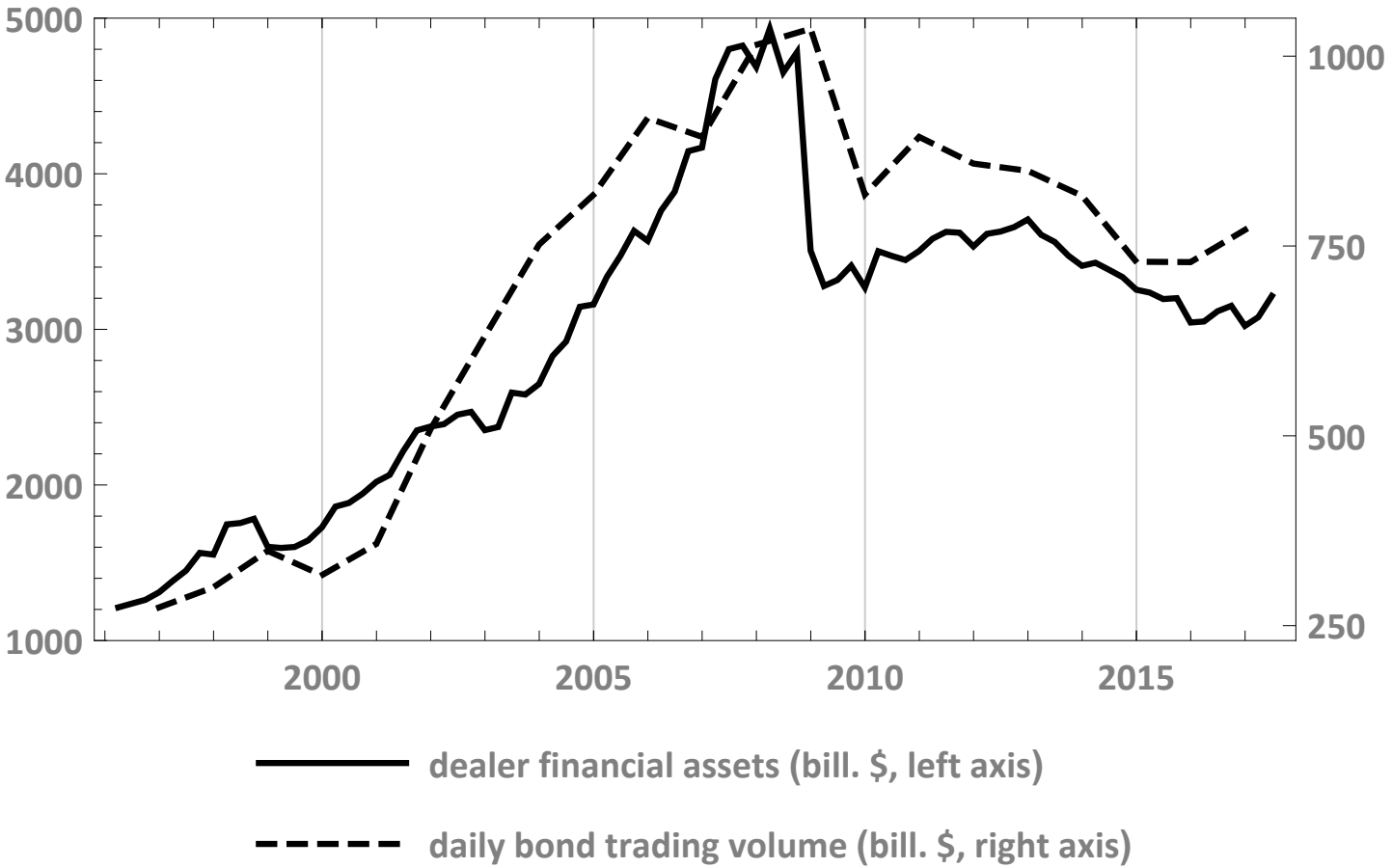


12-month trailing dividend yield of the S&P 500 index (*source*: Bloomberg LP) minus Laubach-Williams estimate of the short-term natural rate, percent, Q4 1970–Q2 2017.

Trading costs steady but flexibility impaired?

- Focus on U.S. corporate bond market
- Bid-ask spreads appear steady
- But dealers withdrawing, trading volumes down
- Leads to deterioration in
  - Ability to trade in size
  - Speed of executing desired trades
- "Tantrums"
- Liquidity evaporates for issues of troubled firms

Dealer assets and bond trading volume 1996–2017



Total financial assets of security brokers and dealers, $bill. *Source*: Federal Reserve Board, Financial Accounts of the United States (Z.1), Table L.130. Average daily trading volume of U.S. bonds, $bill. *Source*: Securities Industry and Financial Markets Association (SIFMA).

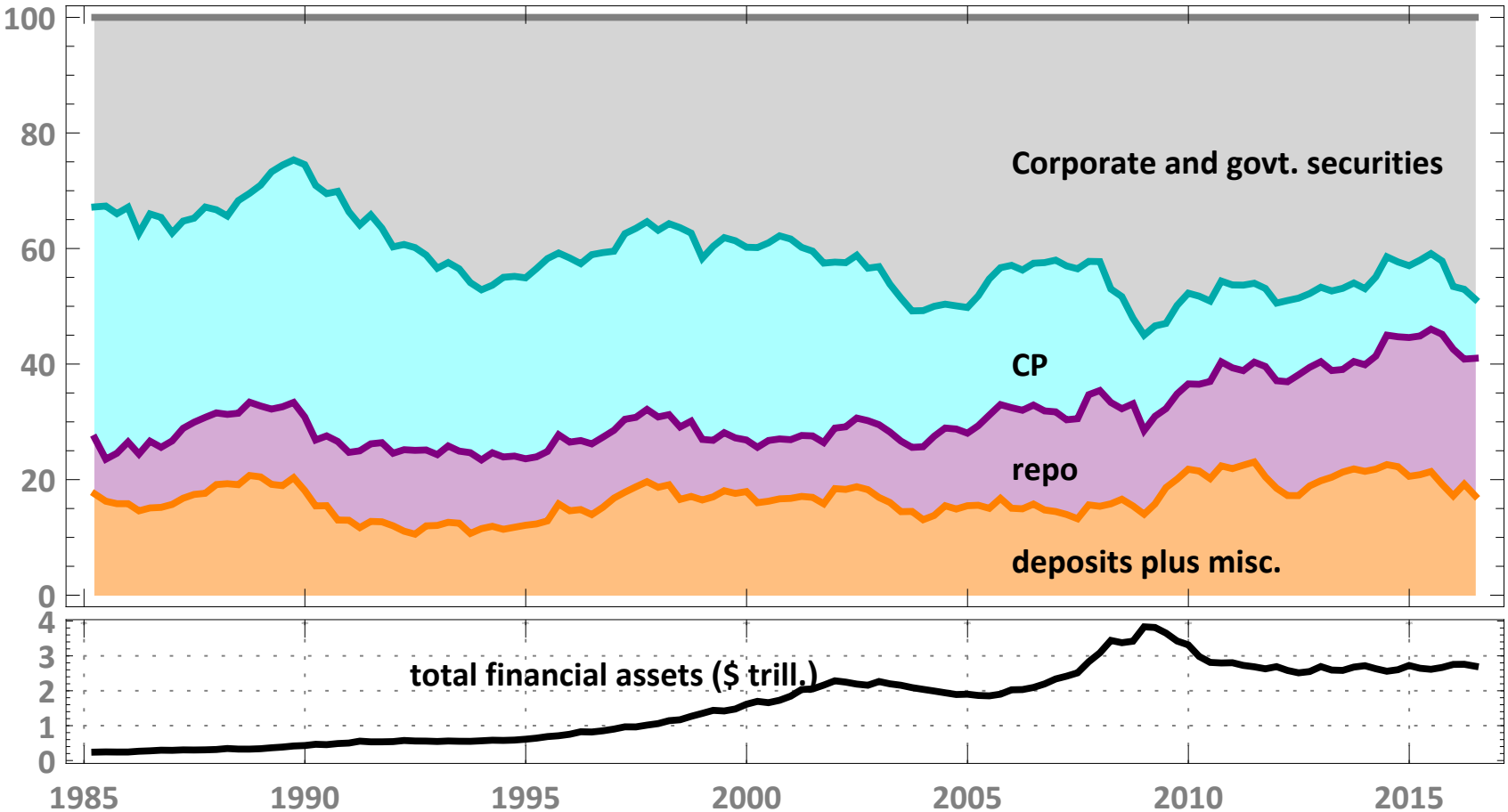
The shrunken money market: overview

- **Short-term wholesale funding** markets grew dramatically up to crisis
- Trading and issuance volumes much lower since crisis
- Yet money markets awash in liquidity
- Declining integration: different money market rates track each other less closely
  - E.g. lower correlation of daily changes
  - Largely, but not completely, integrated→incomplete "arbitrage"
  - Integration crucial for transmission of policy rates to market rates
- Profound regulatory changes post-crisis
- Shifts in market participants
  - Greater MMMF role in short-term intermediation, e.g. eurodollars
  - Declining and "broken model" of broker-dealer role
  - Short-term borrowing less attractive to banks
- New tools introduced by Federal Reserve

Decline in money fund assets

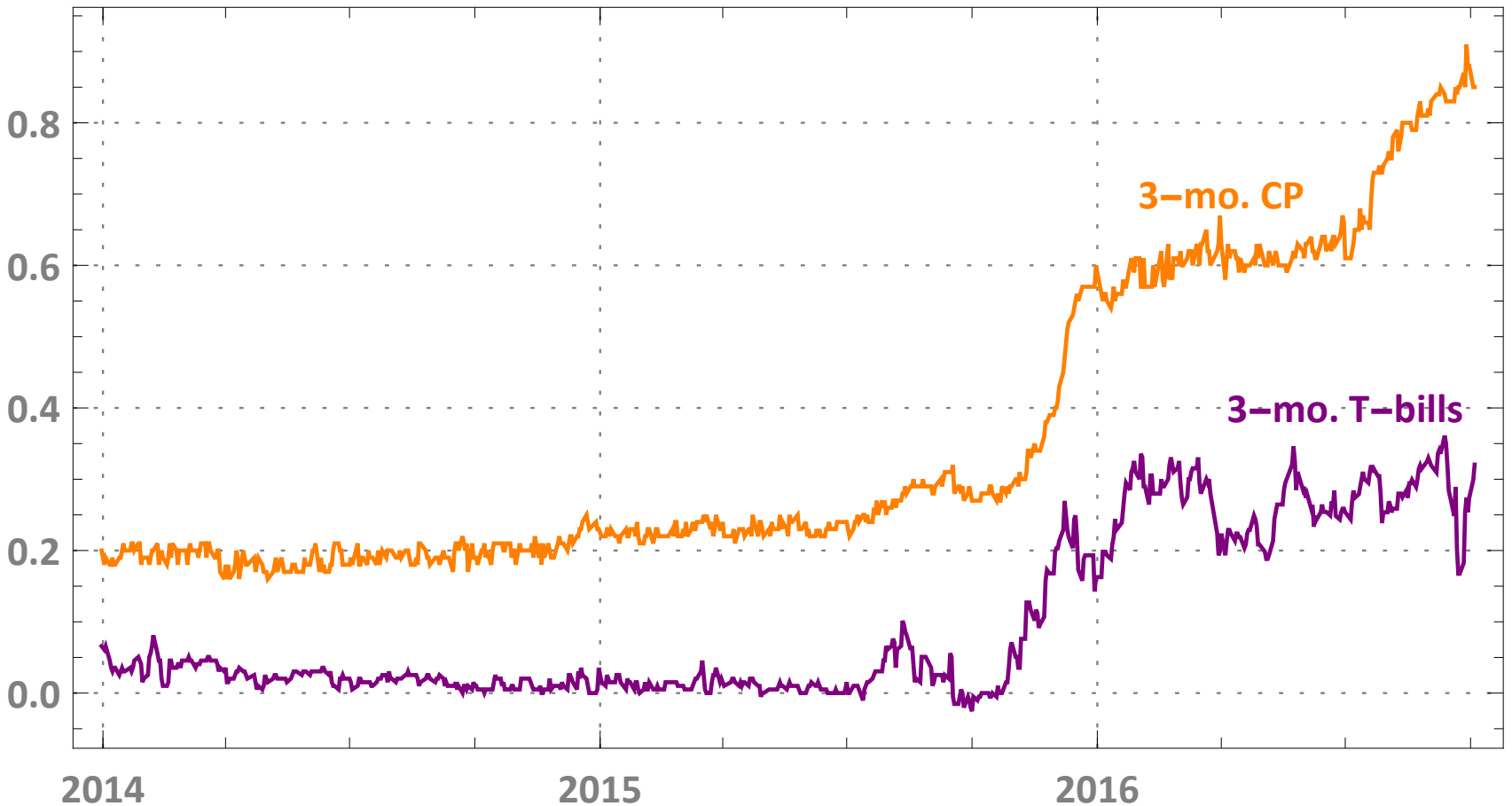
- Reduction in total MMMF assets of about 25 percent from pre-crisis peak
- Shift from commercial paper to repos in asset mix
- As compliance deadline for money fund reforms approaches
  - Shift from prime to government-only funds

Money market fund assets 1985–2016



Top panel: share of each asset type in total financial assets of U.S. money market mutual funds. Lower panel: total financial assets of money market mutual funds, $ trillions. Quarterly data, Q1 1985 to Q2 2016. *Source*: Federal Reserve Board, Financial Accounts of the United States (Z.1), Table L.121.

Three-month U.S. money market rates 2014–2016



Secondary market rates on highly-rated three-month commercial paper and on U.S. Treasury bills, daily, percent. *Source*: Bloomberg LP.

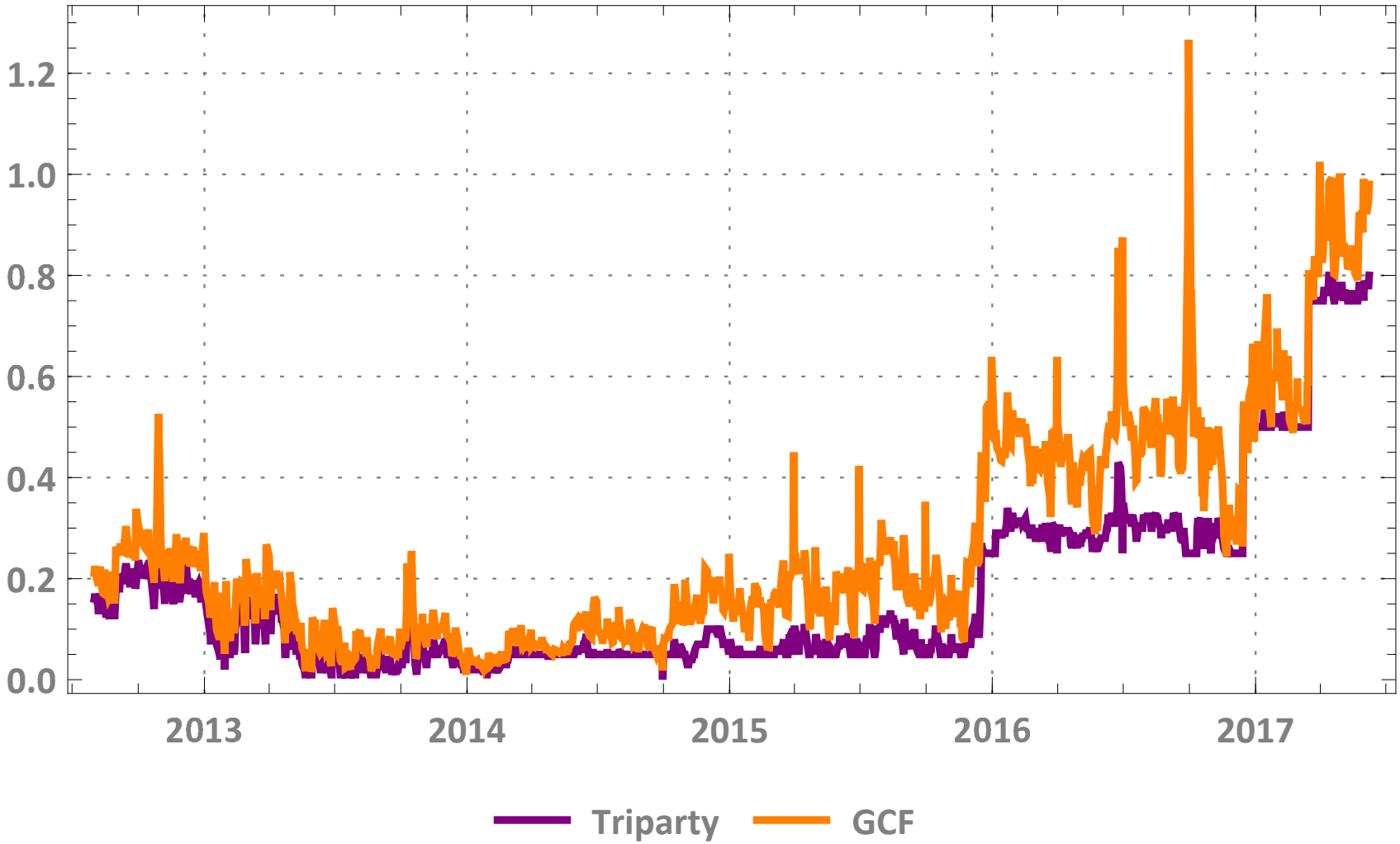
Repo markets

- Higher capital and new liquidity standards decrease profitability of repo dealing
  - Repo dealing has low profit margin, low risk
  - Leverage ratio—if binding—disincentivizes use of **"balance-sheet capacity"**
  - Liquidity standards: Liquidity Coverage Ratio (LCR)→less attractive to supply high-quality liquid assets (HQLA) as collateral
    - Treasury repo has zero run-off assumption
- Impact on repo markets
  - During the crisis, desire for safety dominant: need for collateral, safe assets→Repo rates falling well below funds rate
  - Although secured, dealer-intermediated GC repo higher than unsecured fed funds rate
  - Increase in incidence of **fails**, failure to deliever collateral at conclusion of repo transaction
- Implications for→exit from extraordinary accommodation: changes in market functioning, transmission mechanism

Incomplete arbitrage in money markets

- Fed funds below comparable money market rates
  - Trades lower than repo, a secured rate
  - IOER has not acted as floor for funds rate, becomes ceiling during normalization
- Repo "bid-ask spread" wide and volatile
- GCF repo: dealer-to-dealer, dealers to hedge funds
  - Matched books
- Triparty repo: dealers source cash and securities
  - Provided by MMMFs, institutional investors

Triparty and GCF repo rates 2012–2017

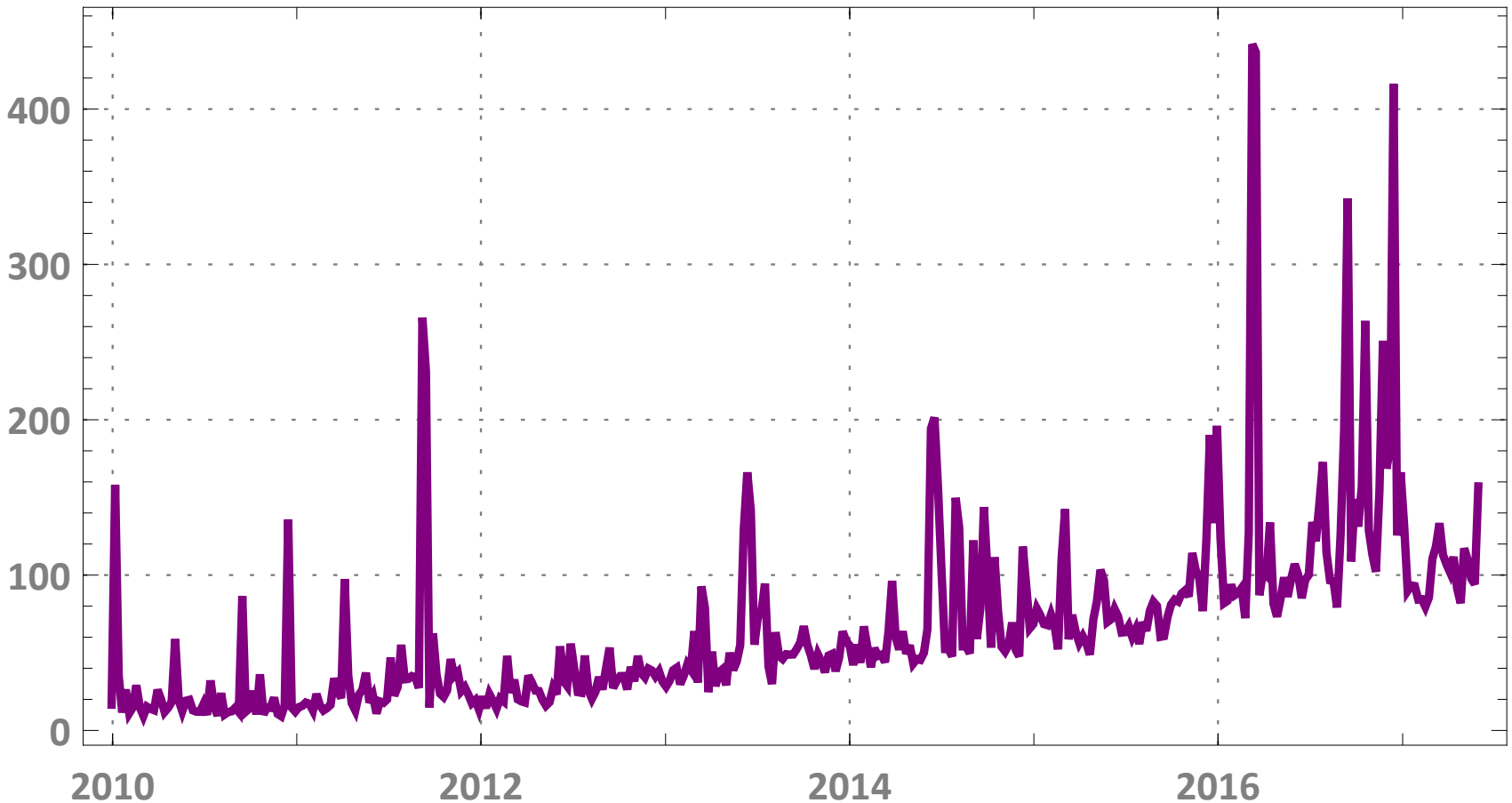


Triparty: BNY Mellon Treasury Tri-Party Repo Index; GCF: DTCC GCF Repo Index for Treasury, percent. *Data source*: Bloomberg LP, Bank of New York Mellon.

Regulatory changes and collateral shortage

- Regulatory changes
  - Clearing mandates (but clearing→increase in netting, possible offset)
  - Basel liquidity ratio
  - **Financial repression**: reduction in yield resuling from increased demand imposed by regulation
- Responses include **collateral swaps**, swap lower- for higher-quality collateral for a fee
- Restraints on rehypothecation leads to ↓supply of collateral
- For European banks in particular, additional pressure from **encumbrance** of assets
  - Assets pledged or otherwise committed→subordination of remaining debt
  - **Covered bonds**: bonds secured by specific assets, usually mortgage loans
  - **Long Term Refinancing Operations** (LTROs): European Central bank program provides 3-year loans against eligible collateral

Treasury fails 2010–2016

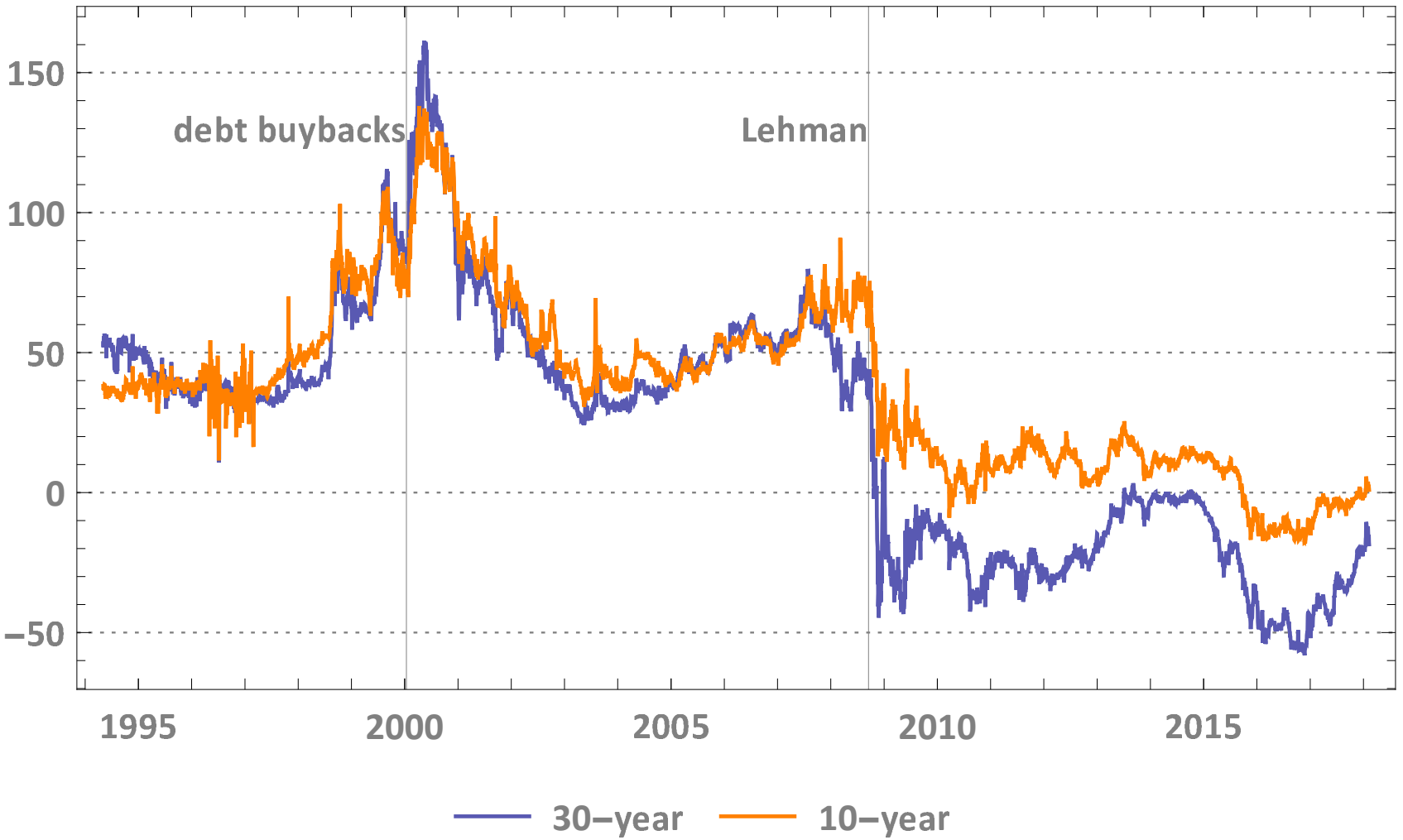


Count of fails to receive and to deliver, 1000's. *Source*: Bloomberg LP. Average of Bloomberg tickers FAILTRED Index and FAILTRER Index, divided by 1000.

Impact of post-crisis regulation on swap markets

- Normal relationship: swaps somewhat higher than Treasuries
  - Swaps have some credit/counterparty risk
  - Risk of financing component: floating short-term rate
- Occasionally very wide: shortage of Treasuries on budget surplus, termination of 30-year issuance
- Clearing mandates diminish credit risk component
- Negative swap spreads: swap rates below Treasury yield
  - Unprecedented prior to global financial crisis
  - 30-year swap spread negative since 2008
  - 10-year swap spread negative since 2015
- Repo market changes$\rightarrow$higher cost to keeping Treasuries on balance sheet

Swap spreads 1994–2018



Spread of plain-vanilla interest-rate swaps over yield of Treasury of like maturity, basis points, daily, 05May1994–09Feb2018. *Source*: Bloomberg LP.