Lecture notes on money, finance, risk management, and public policy

Financial imbalances and financial crises

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The long history of crises

- Very old phenomenon, dates back at least to late medieval era, origins of deposit banking
- Disparate phenomenon, different features central in different crises
- Some major crises before the Great Depression:

1343 Collapse of several Florentine banks on failure of England to repay war-finance debt

1763 Widespread failures of Dutch, German banks following end of Seven Years War and war boom

1825 Bank of England suffers gold drain, widespread bank failures, stock and bond declines following credit expansion

1837 Widespread suspension of specie payments by, failures of U.S. banks, sharp recession

1873 Failure of Jay Cooke bank, followed by widespread bank failures, stock crashes in many countries, "Long Depression"

1907 Exposure of losses by some banks leads to widespread runs and stock market declines

Typical features of financial crises

Credit contraction: sudden pervasive withdrawal of credit

International dimension: crisis affects a number of countries, abrupt changes in exchange rates or capital flows, transmitted via trade and finance

Bankruptcies in private and public sector, financial firm failures

Liquidity contraction: Sudden increase in demand for, narrowing of palette of liquid assets

Runs and panics: investors demand instant return of short-term capital from financial firms, **flight to quality** or **safety**

Impairment of market functioning and contraction of markets

Economic activity falls rapidly, recessions/depression generally unusually long and severe

Asset prices display extreme volatility; **market crashes**, other unusual behavior

Types of financial crises

- Each a unique historical event→quantitative treatment of financial crises difficult
  - Including systematic identification and dating (onset and end of crisis), classification
- Typical classification, based on triggering events and focal point of impact:

  Banking crises: widespread bank failures, triggered by market or other event igniting fears of loan losses
  - Banking panics less frequent since advent of (→)deposit insurance

  Debt crises: event or fear of large or widespread default

  External debt crises: debt vis-à-vis foreign residents, more frequent since end of fixed exchange-rate regime

  Sovereign debt or **fiscal crises:** default on public debt

  Currency crises: large devaluation of local currency, often following failure of peg

Financial crises are rarely purely of one type

- Increasing frequency of crises in postwar era
- Banking crises often associated with sovereign debt crises
  - Governments frequently explicit or implicit guarantors of banks via deposit insurance, bailouts
  - ($\rightarrow$)**Doom loop:** banks large holders of sovereign debt, mutual exposure of banks and sovereigns
  - International exposure if external sovereign
- Crises often currency/balance of payments focused
  - Currency crises generally associated with other major financial and economic disturbances
- Many crises combine all types

Major postwar financial crises

Collapse of Bretton Woods 1968–1971, beginning of 1970's stagflation

1987 stock market crash 20 percent 1-day decline but little lasting effect

Japan crisis in 1989 preceded by rapid rise in stock, land prices, followed by protracted recession

European Monetary System of 1992–1993, largest speculative attack on fixed exchange rates

S&L crisis of early 1980's, gambling for resurrection

Mexico default 1994–95, fixed exchange rates, short-term foreign exchange borrowing

Asian crisis 1997–98, fixed exchange rates, short-term foreign exchange borrowing

Global financial crisis 2008-2011 (?), extreme leverage, liquidity crunch

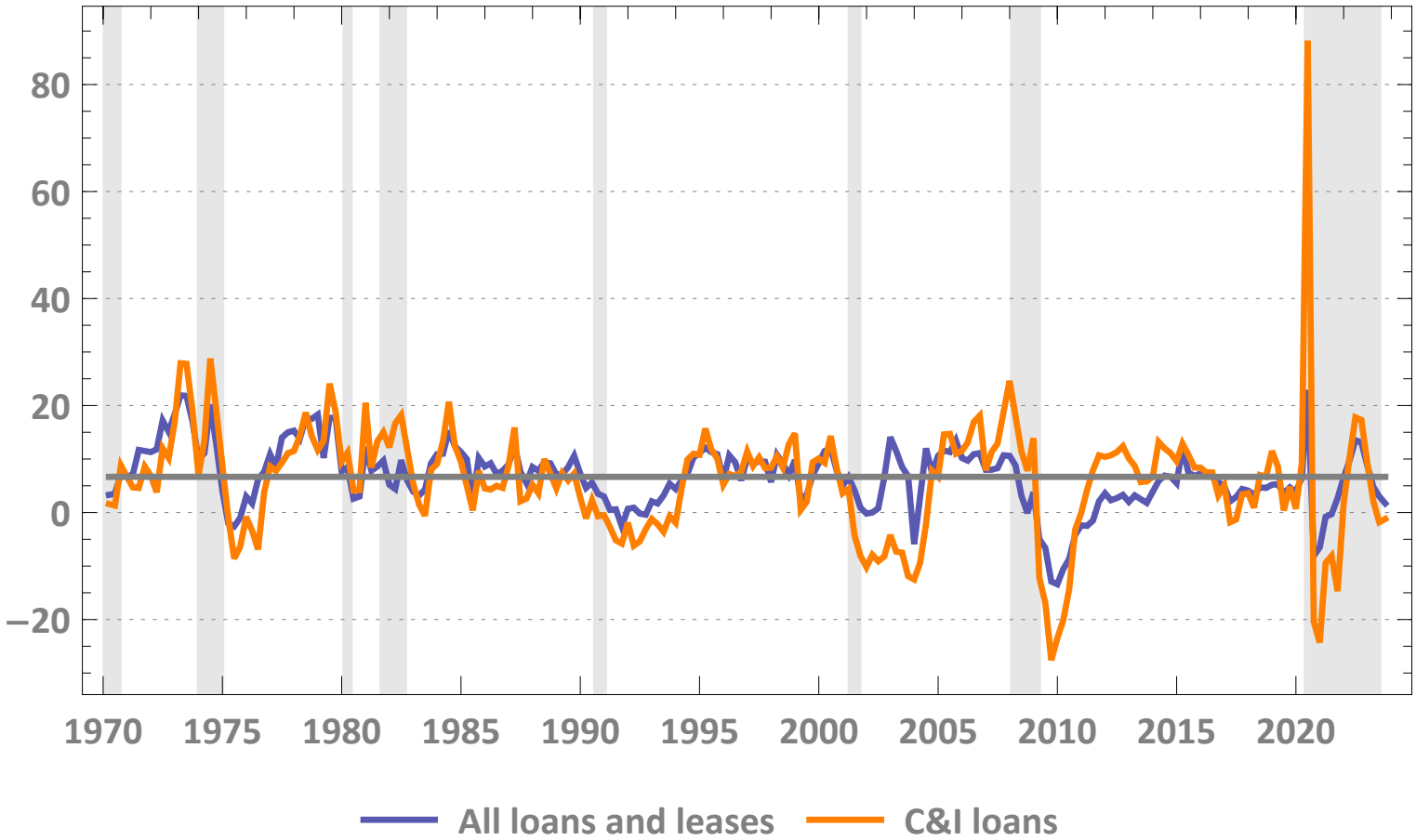
Eurozone crisis 2009–14 (?), sovereign debt, regional divergence

Covid-19 pandemic 2020–22, extreme supply and demand shock, liquidity crunch, inflation

Credit contraction in financial crises

- Credit *growth* during expansions generally gradual; credit *contractions* are quite abrupt
  - $\rightarrow$ "Credit crunch": **lending** or **credit transmission channel** of financial crises to real economy
- Non-price balance-sheet constraints: intermediaries can't fund, or seek to deleverage and preserve capital ("capital crunch")
- Often also reduction in broader money supply aggregates/velocity, even if central bank keeps monetary base steady
- Contraction of securities markets
- $\rightarrow$Debt overhang

Growth rate of U.S. bank lending 1970–2023



Annualized growth rate of all loans and leases in bank credit and of commercial and industrial (C&I) loans, by all US commercial banks, seasonally adjusted, percent, quarterly, Q1 1970 to Q3 2023. The horizontal grid line represents the mean growth rate of all loans over the period. Vertically shaded intervals denote NBER recessions. *Source*: Federal Reserve Board, H.8 data release.

Debt overhang in crises

- Bad consequences of high leverage once crisis hits
- Leverage reduces incentives by firm owners to invest, since returns raise value of debt→deepens recession
- →Banks with high leverage can't/reluctant to raise new equity capital
  - Banks continued dividend payments in spite of losses mid-2007 to mid-2008

Zombie lending

- Unforeseen consequence of sustained low-interest rate policy
  - Particularly Japan from early 1990s, Europe after 2010
  - Views low rates as "stealth recapitalization" of banks
- Banks continue lending to heavily-indebted but insolvent/impaired firms
  - At low rates relative to comparable borrowers
- Banks motivated by risk-shifting
  - Defer booking losses, increasing equity funding
  - Avoid regulatory scrutiny
- Consequences
  - Misallocation of resources, reduced productivity, weak recovery
  - Competitive distortions

Monetary policy and crises

- Unevenly distributed across countries
  - Evidence of causal role poor/politically-driven regulatory environment
- Too-high monetary/credit expansion, too-low interest rates→unsustainable growth
  - Inflation, balance of payments deficits
- Traditional approach: monetary and fiscal policy, business cycles
- Limited scope for finance in contemporary macroeconomic theories
- Goals/objective function: growth/employment vs. price stability

Background of the crisis: competing narratives

- Low real interest rates
- Low inflation deceptive? Inflation targeting
- Why were interest rates so low?
  - Feeding a boom, rates below natural
  - Global savings glut: current account deficit and the "conundrum"
- Leverage
  - Excessive dependence on short-term debt
  - How encouraged by public policy? E.g. keeping MMMF yields positive to avert runs, maintain market for bank paper

How do low interest rates manifest themselves?

- Rising credit aggregates
- Unsustainable debt relative to income
- Rising asset prices
- Credit spreads, implied and realized volatility, and other evidence of risk premiums low
- Reaching for yield: institutional investors, return hurdles
- May occur during periods of stable prices and employment
- Imbalances then put an end to period of stable prices and employment
- $\rightarrow$International dimension

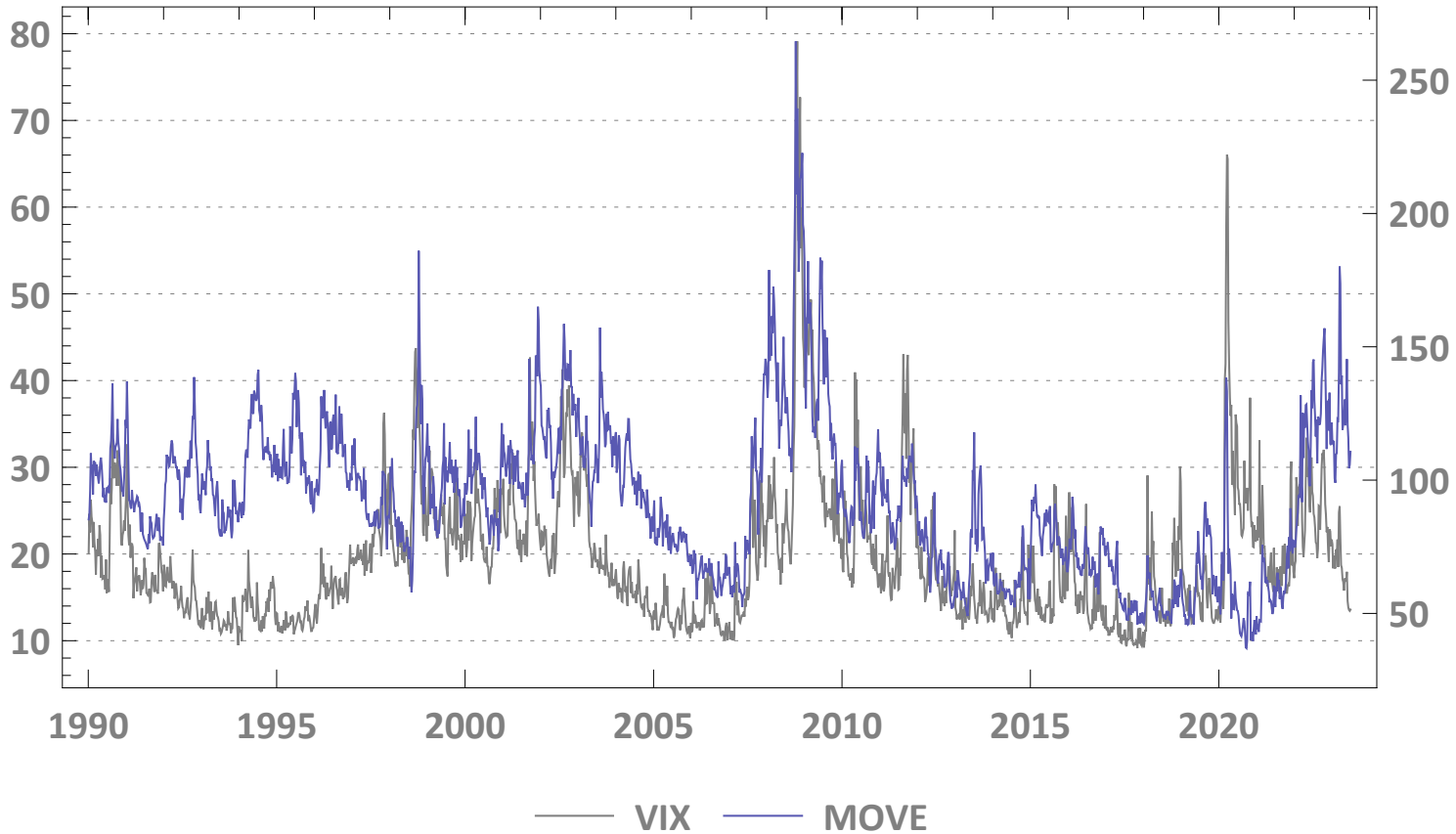
Paradox of volatility

- Volatility low when risk-taking high
  - Low volatility *encourages* risk-taking, boom phase of boom-bust cycle
  - $\rightarrow$Current monetary policy: market volatility a substitute for Fed policy normalization
- Thus volatility low when financial imbalances building
- $\rightarrow$Unusually low volatility a warning signal financial imbalances may be building
- Policy can encourage build ups
  - Low rates cited as cause of reaching for yield, as paradox of volatility suggests

Implied volatility and variance premium

- Implied and realized asset return volatility extremely low
- Variance risk premium:
  - Difference between implied volatility and expected volatility
  - Reward to supplying protection against volatility
- Variance premium also at low level:
  - Jan. 1990 to onset of crisis end-Feb. 2007: about 4.25 percent
  - Late Sep. 2011 to date: about 2.75 percentage

Equity and swaption implied volatility 1989–2020



CBOE Volatility Index (VIX): weighted average of prices of options on the S&P 500 Index with approximately 1 month to expiry and with a range of strike prices, daily, 02Jan1990 to 31Aug2020. Merrill Lynch Option Volatility Estimate (MOVE) Index: index of implied normal volatilities of at-the-money options with approximately 1 month to expiry on U.S. Treasury notes and bonds, daily, 04Apr1988 to 28Aug2020. *Source*: Bloomberg LP.

Reaching for yield and the Great Moderation

- Rajan (2006) thesis: intermediary/manager behavior when interest rates low
  - Aggressive allocation shifts to riskier bonds and alternatives rather than leverage
  - Variable asset returns, but fixed liabilities
  - Make up risk-free rate shortfall via expected return and premium on market (especially duration) and credit risks
  - Riskier assets rather than leverage
  - Imperfect discernment of risk by standard measurement techniques
- Hard to define, even harder to identify
- Market conditions
  - Low absolute level of yields
  - Spread compression, curve flattening
  - Low volatility, stable→**paradox of volatility**

Reaching for yield behaviors: examples

- Higher-yielding securities with given credit rating
- Add duration risk
- Lower credit rating/quality
- Higher-risk asset class, e.g. whole loans, structured products, equity, alternatives
- Non price features, e.g. cov-lite
- Closely related: discerning between authentic alpha and priced factors (e.g. liquid alternatives)
- Rewarded by market through asset flows?
- **Example:** insurance companies
  - Invest premiums to generate income to fund future claims
  - Add duration risk, lower credit rating/quality, allocate to private equity

Reaching for yield and intermediary type

- Focus on unlevered, esp. institutional investors
- Banks also suffering from net interest margin compression
  - Endeavoring to shift to fee income, but regulatory and competitive pressures
- Insurance companies
  - Need net income, annuities/fixed-rate with obligations
- Pension/retirement plans
  - Pension liabilities
  - Asset returns may not match
  - Public-sector (but not private): vast underfunding problem
- Bond mutual funds: higher yielding bonds than benchmarks
- Institutional prime MMMFs: wholesale funding, flows highly sensitive to relative performance

Reaching for yield behaviors: examples

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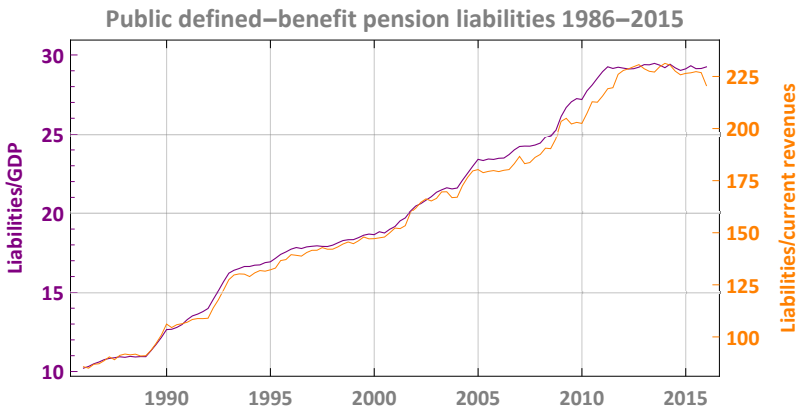
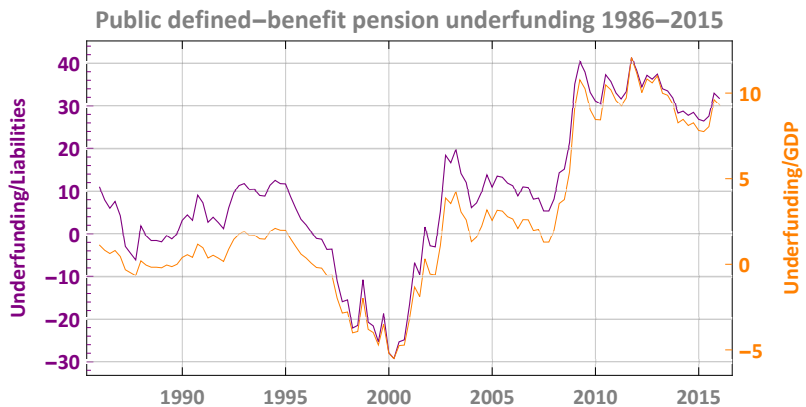
UK liability-driven investment crisis

- **Liability-driven investment** (LDI) strategy
  - Receive fixed in interest rate swaps
  - Use part of assets as collateral
  - Swap cash flows hedge pension liabilities
  - Remaining assets earn excess over return required to fund liabilities
- Employed by private UK defined benefit pension plans
- Vulnerable to margin calls
- 23Sep2023 presentation of UK mini-Budget→sharp rise in gilt yields
- UK pension plans forced to sell gilts to meet calls, amplifying gilt price decline

Public pension plan underfunding 1986–2015



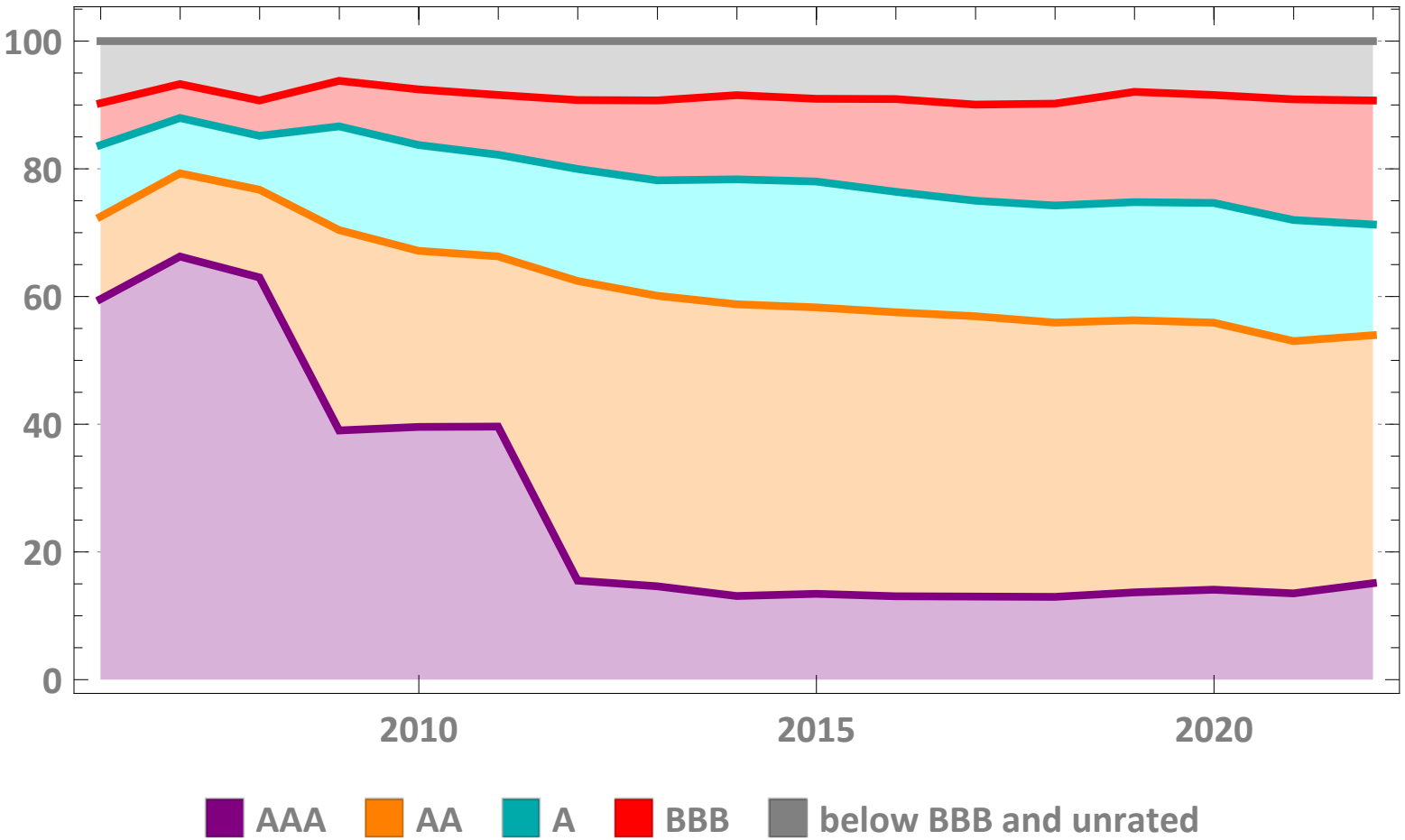


Left panel: Ratio of accrued state and local government defined benefit pension entitlements to GDP (Purple plot, left axis), and to state and local government current receipts (orange plot, right axis). Right panel: Ratio of defined benefit pension plan entitlements unfunded by assets to total entitlements (Purple plot, left axis), and to GDP (orange plot, right axis). Percent, quarterly, Q4 1984 through Q3 2013. Negative values indicate overfunding. *Source*: Federal Reserve Board, Financial Accounts of the United States (Z.1), Table L.120.b, lines 16 and 18, Table F.107, line 1, Table F.2, line 1.

Incentive and regulatory causes

- Corporate governance issues on the buy side
- Do institutional investors take too much risk, and, if so, what incentivizes them to do so?
- Agency problems: buy-side managers don't bear tail risks
  - Analogous to conflict of interest between equity owners and creditors
  - Capital Decimation Partners (Lo)
- Problem not unique to reach for yield: "we have to put our money to work"
  - An unsolved crisis mystery: why the demand for AAA subprime?
  - Institutional investor demand, not issuer pays the source of high ratings
- Capital standards for insurance: NAIC, Solvency II
  - High capital charges for common stock, little differentiation of common vs. alternatives

U.S. insurance company credit allocation 2005–2022



Credit rating shares (percent of par) of fixed-income investments of U.S. property-casualty insurance companies, annual. *Source*: New England Asset Management.

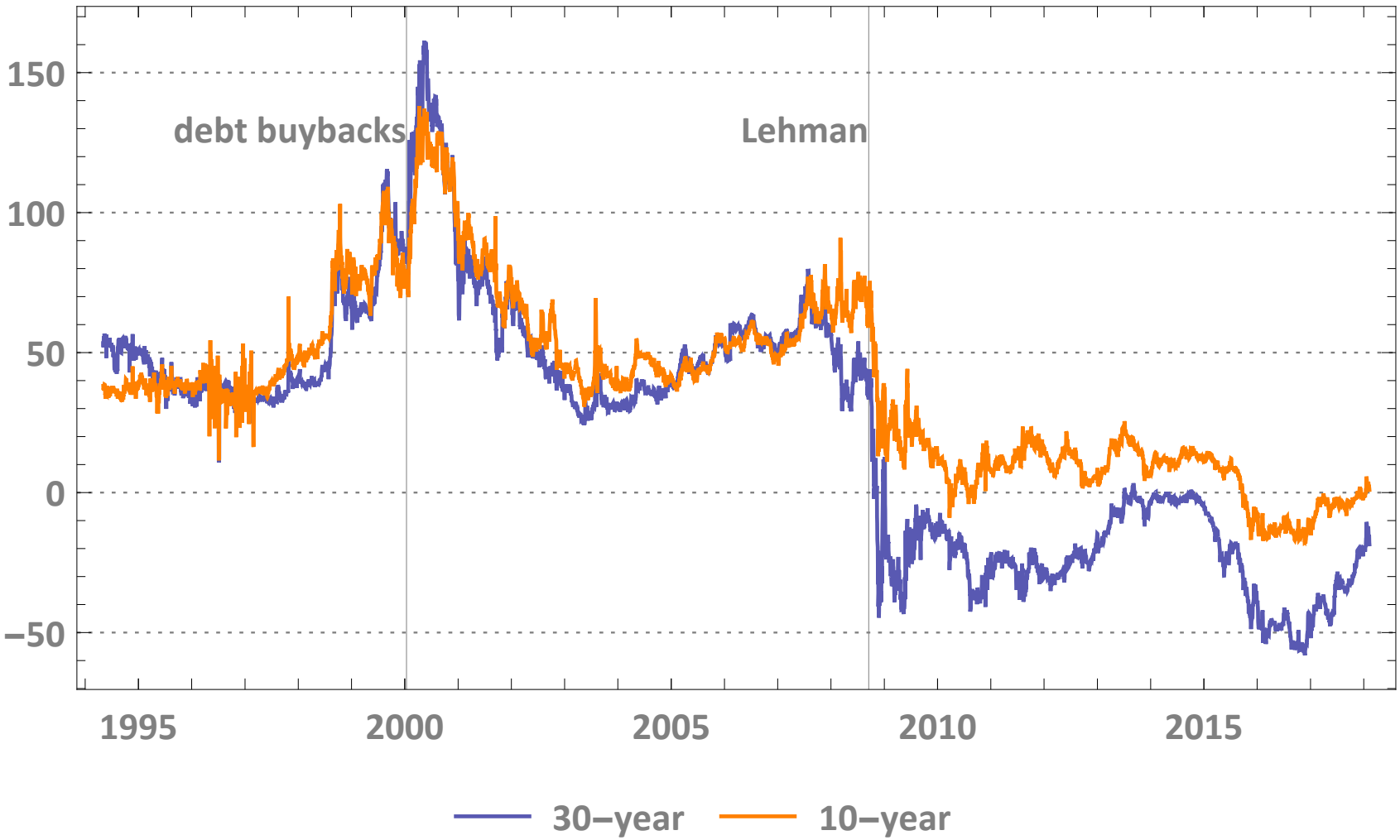
Resolving the paradoxes seems risky

- How will the tension between reaching for yield and risk aversion be resolved?
  - Contradictory evidence is disturbing: resolved smoothly or disruptively?
  - Low liquidity, but not much demanded or needed right now
- An eerie parallel: the dots plot
  - Market estimates of future interest rates persistently and quite drastically lower than Federal Reserve's
- Market doesn't appear able to withstand large shocks
- Potential sources
  - Policy normalization
  - Problems in a number of specific large countries
  - Conflict risks

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.

Why are crises so severe?

- Understanding severity and speed with which crises develop
- Crisis-related recessions/depressions more severe than typical business-cycle troughs
- One framework of analysis: distinction between **triggers** and **propagation mechanisms** of crises
- Are crisis triggers large or small events?
  - If relatively small and initial impact not widespread, focus on propagation mechanisms to explain severity→**contagion**
  - If triggers relatively large or widespread, focus on sources of **common shocks**
  - "Popcorn" vs. "domino" approach (E. Lazear)—and perhaps "asteroids" as well

Common shocks and propagation of crises

- **Common shocks** hit intermediaries/countries
- **Examples:**
  - Widespread bad underwriting or sudden declines in prices of widely-held assets
  - Impact of sudden tightening of credit constraints/rationing
  - A controversial example: was not bailing out Lehman a policy error? Was uncertainty regarding policy a common shock?

Endogeneity

- **Endogeneity:** focus on internal amplification, self-reinforcing mechanisms
  - Internal forces as well as external shocks important
  - Loops: Market prices determined not only by fundamentals, but by reactions of market participants to price levels/changes
  - Amplification via leverage, market institutions
- **Multiple equilibria** and **sunspots:** redemption decisions taken individually but with a collective outcome
- **Externalities:** one firm's actions imposes costs on others
- Self-propagating mechanisms, build-up of financial imbalances
- Synchronous/homogenous investor behavior rather than offsetting randomness
- Related concept: **procyclicality** of the financial system
  - Tendency for financial variables to vary with real variables so as to increase amplitude of business cycle

Contagion and interconnectedness

Interconnectedness: "dominoes" metaphor of propagation

- Motivation for Dodd-Frank OTC derivatives **clearing mandate**
- Two types of interconnectedness:

  Asset interconnectedness: lenders harmed by loan and counterparty losses, default in turn to their lenders

  Liability interconnectedness: rapid unwinds by borrowers forced into →**fire sales**

Contagion: sudden shifts in beliefs, fear of problems at *other* market participants

- **Information-insensitive** liabilities become **information-sensitive**
- The Tylenol effect: where are the toxic assets?→reluctance to lend, runs and run-like behaviors
- Where is my rehypothecated collateral?
- Who is too dependent of short-term financing?
- My suddenly information-sensitive short-term assets make it impossible to sell, use them as collateral, so I can no longer fund myself→run on me

Self-reinforcing mechanisms in crises

Balance sheet mechanisms: diminution of capital, "involuntary" increase in leverage

Collateral devaluation: margin calls, reduced range of acceptable collateral

- Tylenol effect: collateral pool supporting securitizations contain toxic assets
- Leads to fire sales as market participants can't maintain positions→**"run on repo"**

Risk triggers include

Option hedging: sellers of puts hedge price declines by increasing short positions

Stop-loss orders activated on price declines

VaR limits: increase in volatility induces unwinding to remain within limits, exacerbated by similarity of models (→capital standards)

Accounting triggers: mark-to-market (MTM) accounting rules said to exacerbate crises

Yen carry trade unwind of August 2024

- Sharp asset price changes early August 2024:
  - Increase in VIX
  - Decline US, Japanese stock indexes
  - Appreciation of ¥vis-à-vis USD
- Possible triggers: Bank of Japan tightening, weak US economic data
- Deleveraging across markets

Net worth and asset price declines

- Impact of market and credit losses
  - Prior to crisis: diminution of equity increases moral hazard, incentives to "gambling for resurrection," e.g. U.S. savings and loan crisis
  - At onset of crisis: fire sales
- Impact of market-driven changes in leverage
  - During the upturn: increases in asset values→strengthening of balance sheet→increased risk taking
  - During the downturn: inverse behavior, amplified by desire to preserve credit ratings
- Minimum capital and credit rating requirements drive leverage impact

Mark-to-market accounting and financial crises

- The putative mechanism: MTM for banks induces loss, reduction of book and regulatory capital ($\rightarrow$procyclicality)
- Fire sales further reduce MTM values, become contagion mechanism to other banks
  - But bank may sell assets with gains to shore up capital
- Impact of MTM for banks' regulatory capital limited
  - Most assets in banking book (held to maturity), only permanent impairments enter capital
  - Losses on available for sale securities enter OTTI, but not capital
- Not marking to market exacerbates asymmetric information problem
  - Tradeoff of value of transparency vs. harm of procyclicality
- Can be addressed through higher and anticyclical capital
- Empirical evidence difficult to interpret (causality, incremental impact of MTM) and mixed

Are crises inevitable?

- **Post-Keynesians:** crises inherent and inevitable in market economy
- Modern macroeconomics, e.g. Keynesian fine-tuning, monetarist critique of 1929 Fed: crises avoidable, occur due to policy errors

Minsky model or **Financial Instability Hypothesis:** three stages of the financial cycle or firm financing models

- Crises and instability inherent in capitalist system
- Stability leads to complacency and increased debt, risk-taking ($\rightarrow$paradox of volatility)

Hedge finance: debt can be repaid out of the cash flows of the borrower

- Debt does not need to rolled over or refinanced

Speculative finance: firm can pay interest but not principal out of cash flows

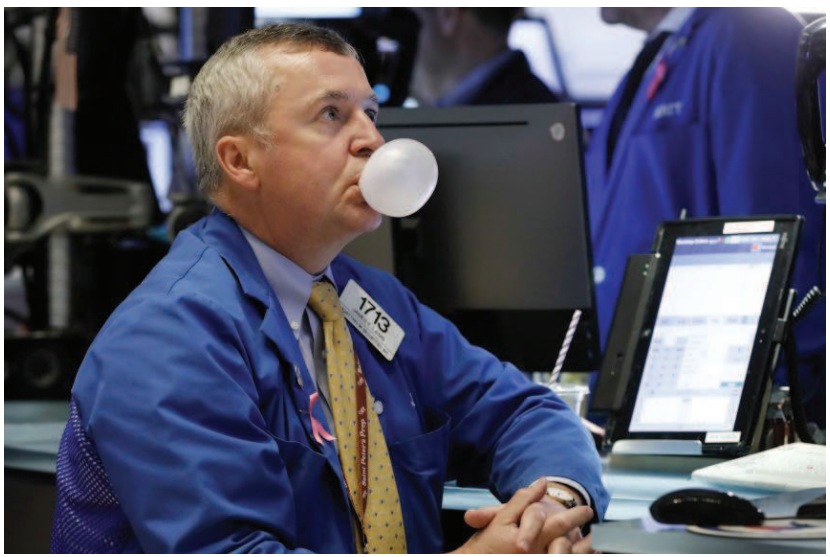
- Firm must refinance or sell investment at a higher price to remain solvent

Ponzi finance: even interest cannot be paid out of cash flows

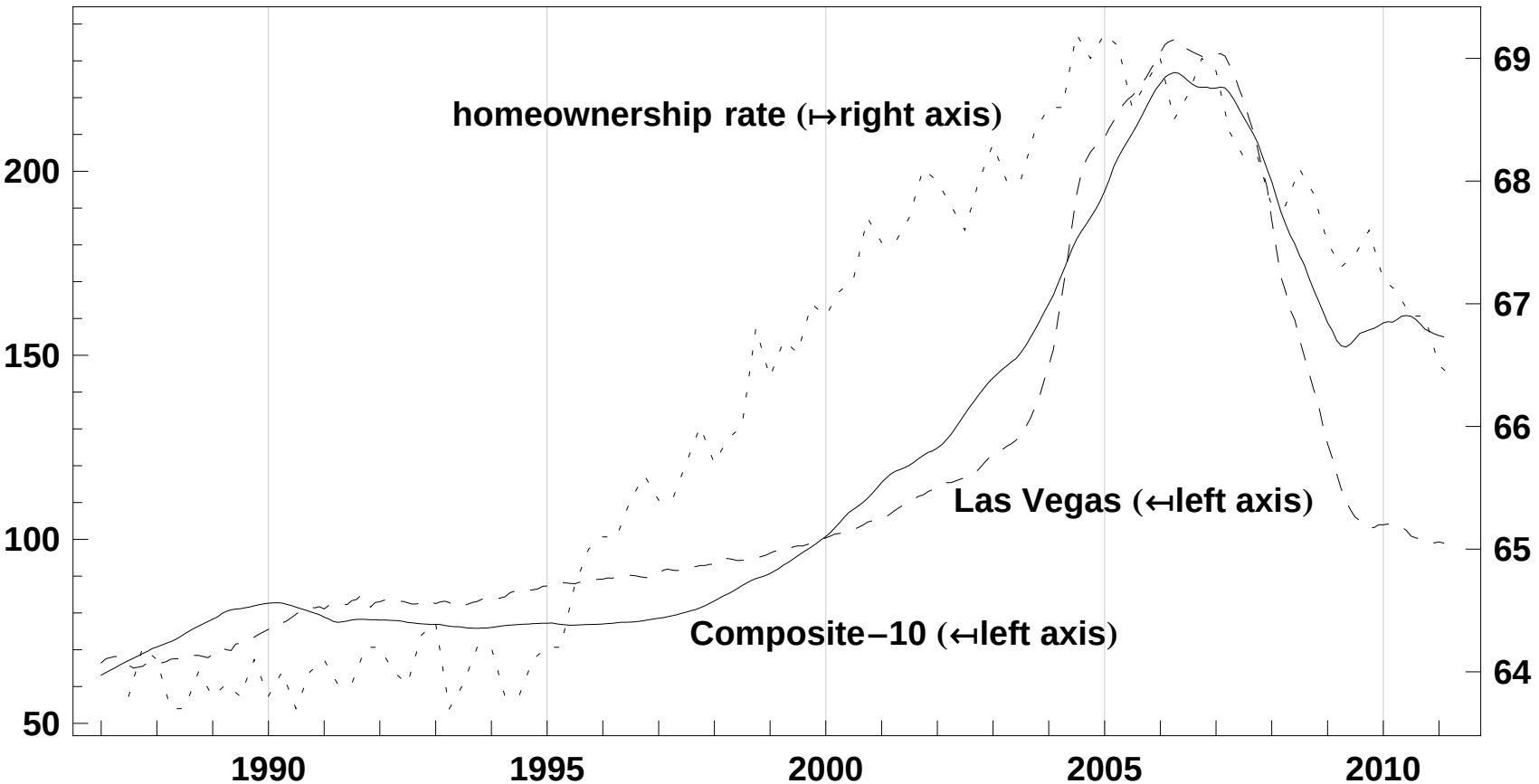
- Further borrowing needed to service existing debt($\rightarrow$bubbles)

Bubbles

- Asset prices become detached from fundamentals and trade on expected future capital gains
- Controversies:
  - Can/do bubbles exist? Compatibility with rational maximizing behavior
  - Identification
  - Policy vis-à-vis bubbles$\rightarrow$"lean or clean"
- Models of rational bubbles$\rightarrow$multiple equilibria



U.S. house prices and homeownership 1987–2011

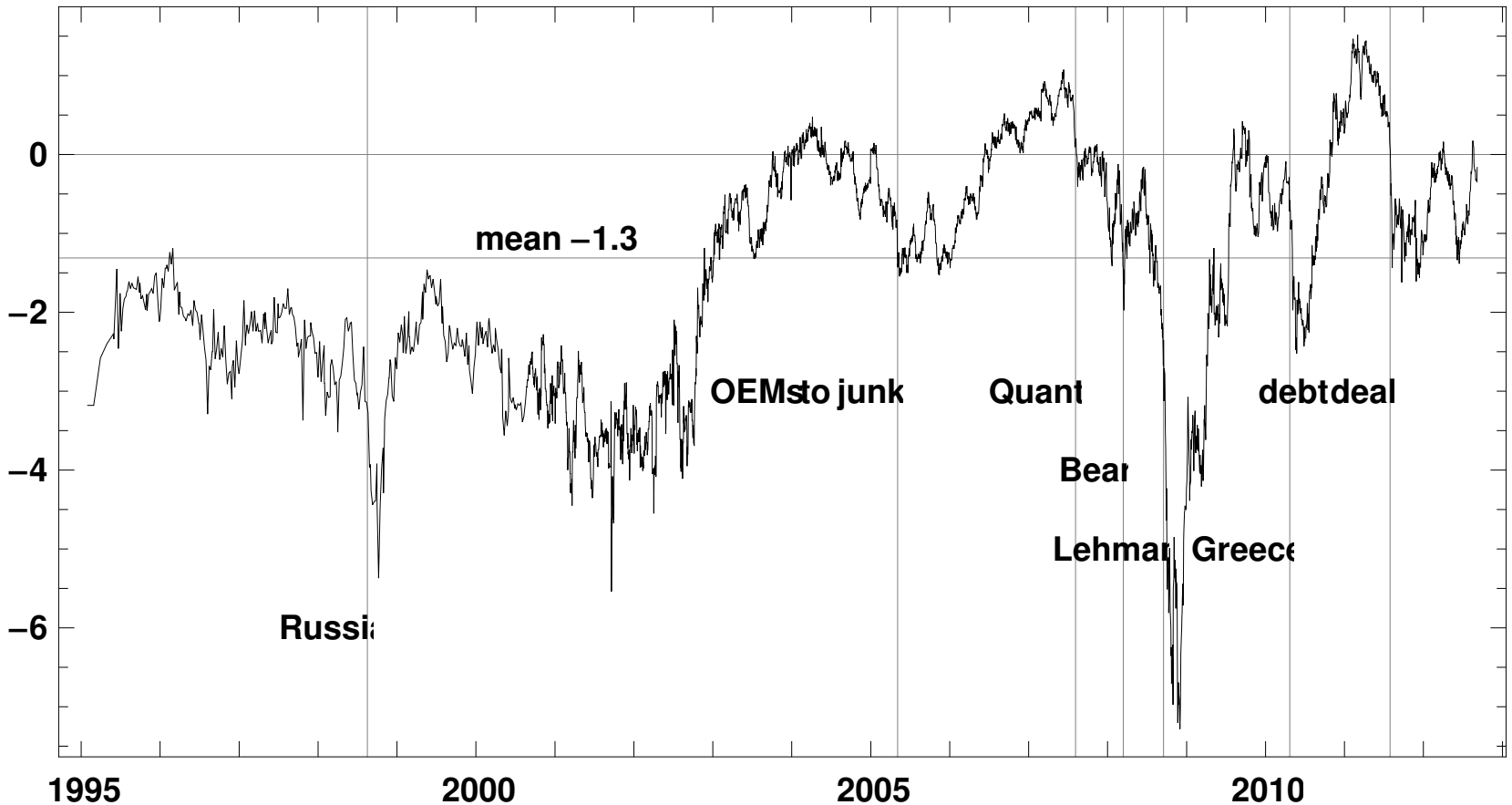


Solid line: S&P/Case-Shiller 10-City Composite Home Price Index. Dotted line: S&P/Case-Shiller Home Price Index for Las Vegas. Dashed line (right axis): U.S. Census Bureau estimate of U.S. homeownership rates. House price data monthly, Jan. 1987–Feb. 2011; homeownership rates quarterly 1987–Q1 2011.

Liquidity risk and fragility of the financial system

- Interactions between funding and market liquidity
- Can be distinguished analytically but not in practice
- Lack of funding liquidity→forced sales, lack of a two-way market, redeemable capital
- Lack of market liquidity→margin calls, reluctance to fund
- Example: convertible bonds
  - Strategy of buying converts and hedging option→ long gamma returns
  - Embedded option generally cheap, but requires leverage (economies of scale)
  - Tail risk: converts cheapen sharply on withdrawal of leverage and capital redemption

Convertible bond cheapness 1995–2011

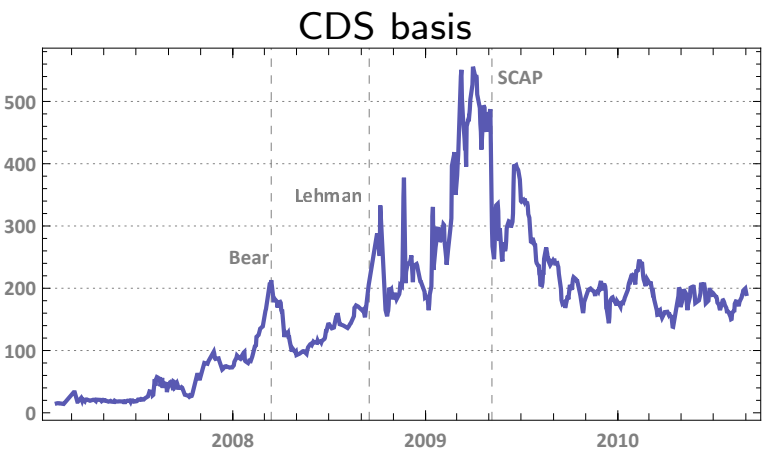


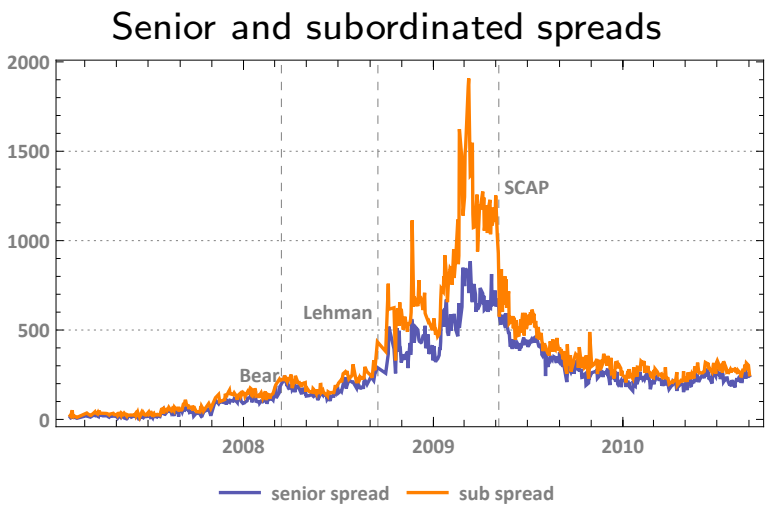
Difference between theoretical and market prices of convertible bonds, weekly through 1997 and daily through 06Sep2012, in percent. The theoretical price is the value of the replicating portfolio, taking the credit, risk-free rates, and the embedded option into account. *Sources*: Bank of America, Barclays Bank.

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 2007–2010





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. CDS basis is measured as the spread between the 5-year on-the-run CDS and senior bond spreads. Daily, 01Feb2007 to 02Sep2010. *Source*: Bloomberg.

Rise in prices of safe assets

- Demand for and prices of safe assets rise during stress periods
- U.S. dollar frequently—but not invariably—appreciates
- **Examples:**
  - 2008: onset of global financial crisis
  - 2010–11: European debt crisis—until U.S. debt ceiling impasse
  - 2020: onset of Covid pandemic
- **Counterexamples:**
  - Negative spreads
  - Demand for duration
  - 2025: U.S. tariff imposition
- Credit discrimination becomes extreme in crisis: risk-free rates fall, increasing credit spreads

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

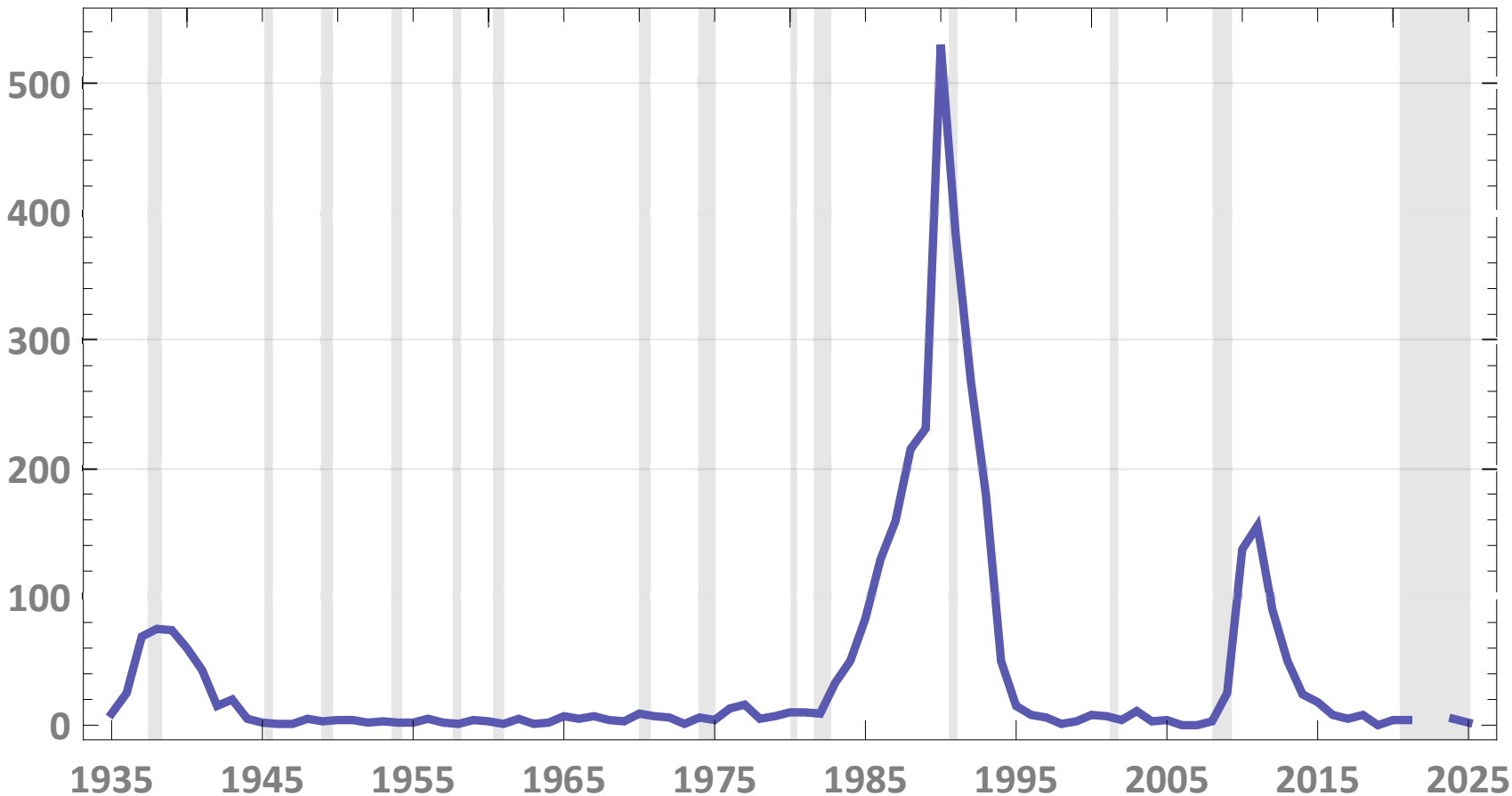
Liquidity contraction in financial crises

- 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 balances
  - 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 1934–2024



Number of commercial and savings banks. Vertically shaded intervals denote NBER recessions. *Source*: Federal Deposit Insurance Corporation (FDIC), via FRED, series BKFTTLA641N.

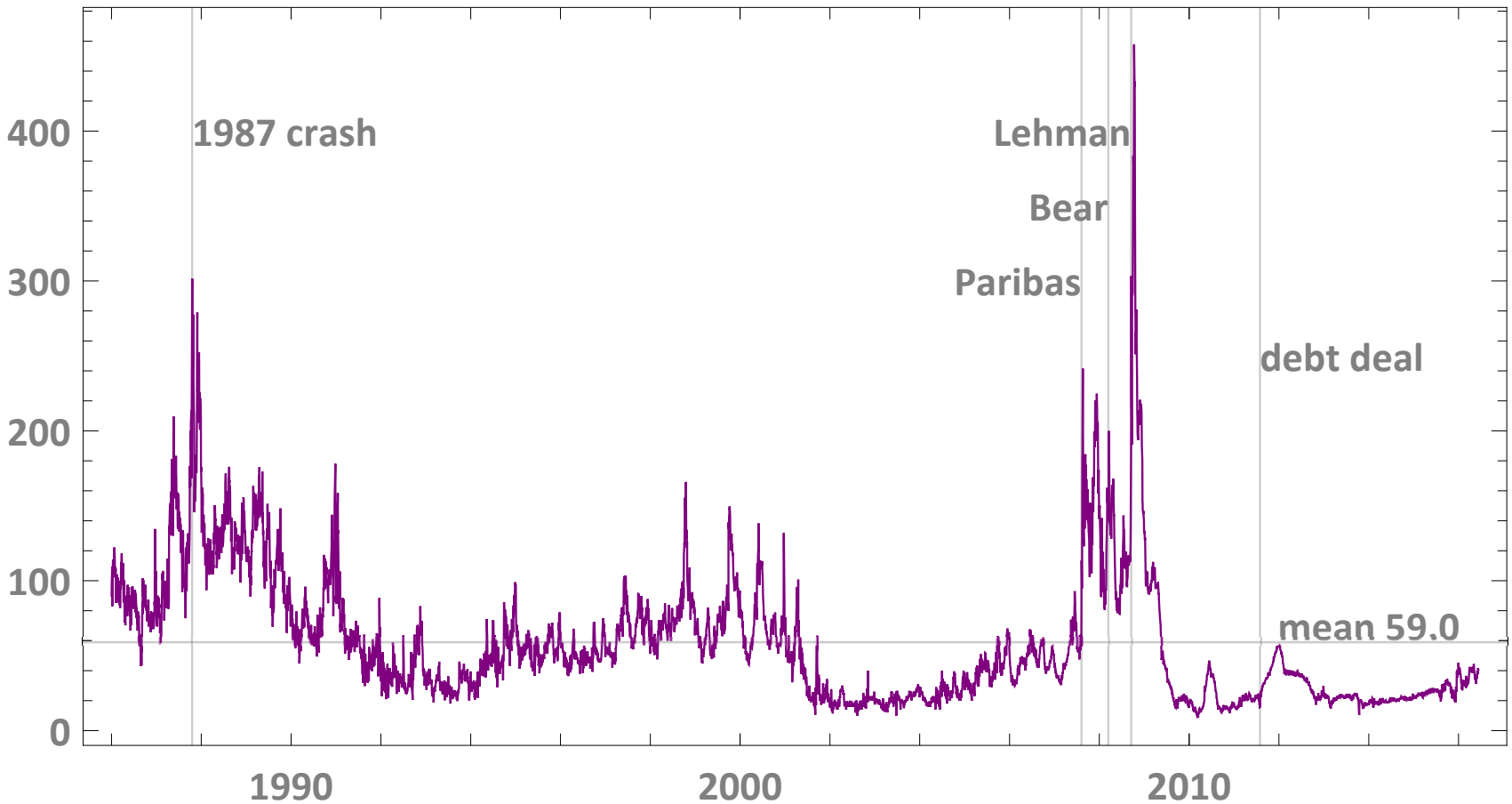
Illiquidity and insolvency in stress conditions

- 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

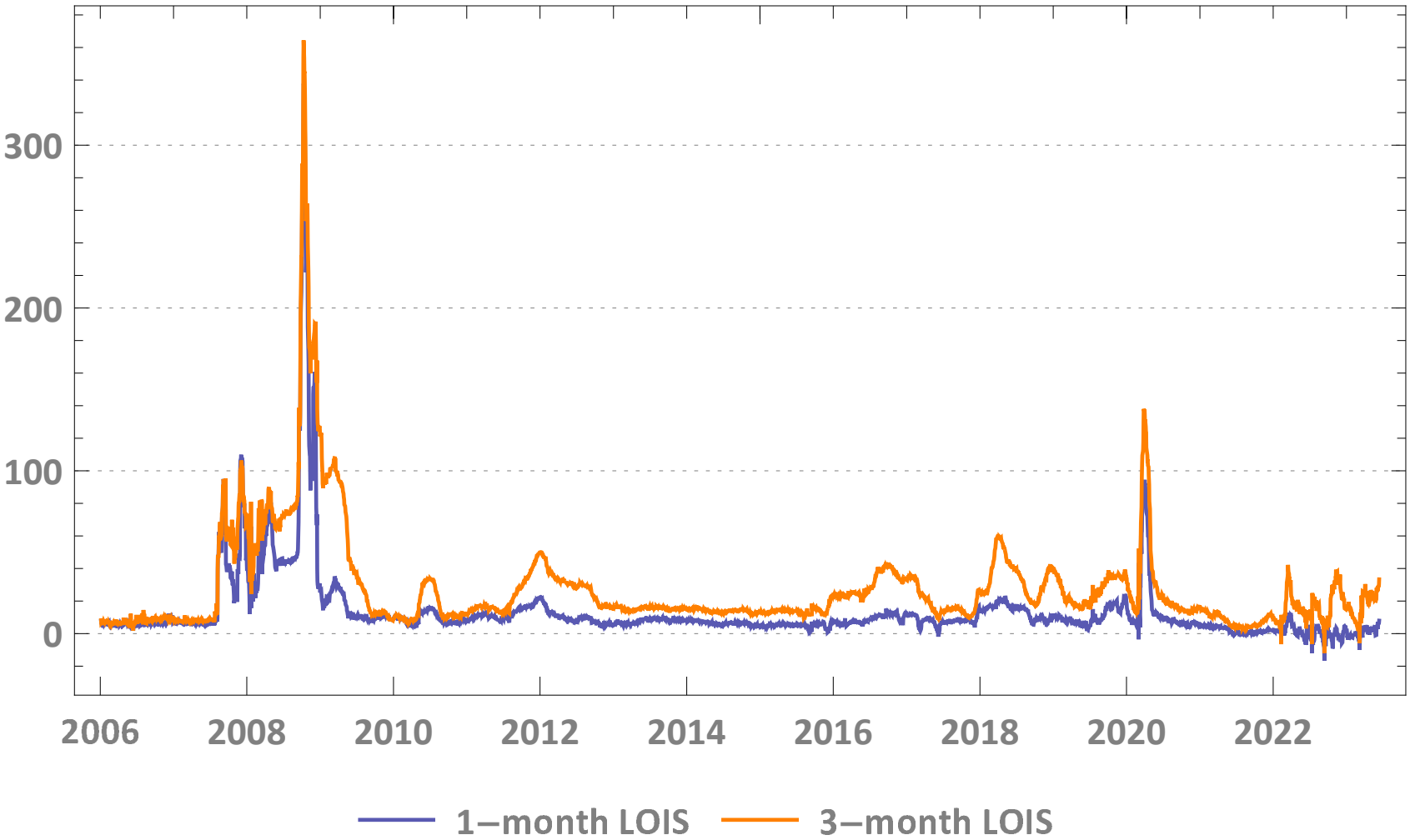
- Interpreting extremely sharp spread widening among money market rates after August 2007; may be due to
  Increased liquidity risk and liquidity hoarding
  Increased credit/counterparty risk →contagion
  Changes in term structure on economic fundamentals,
  interest-rate policy changes
- **TED spread:** 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



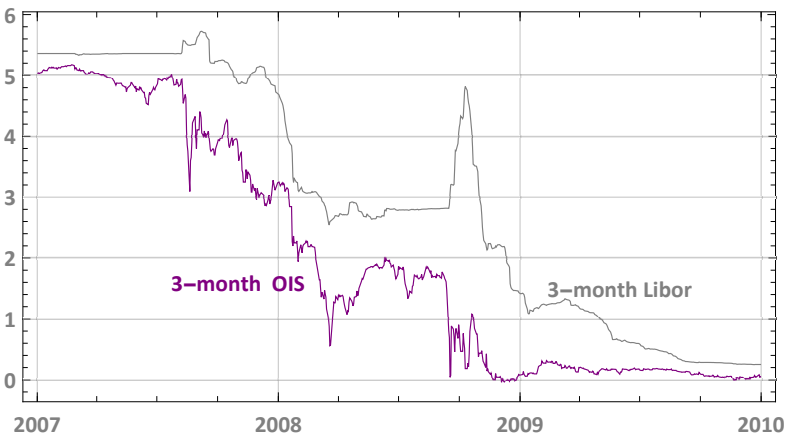
Three-month USD BBA Libor minus the 3-month Treasury bill yield, basis points, daily. *Source*: FRED.

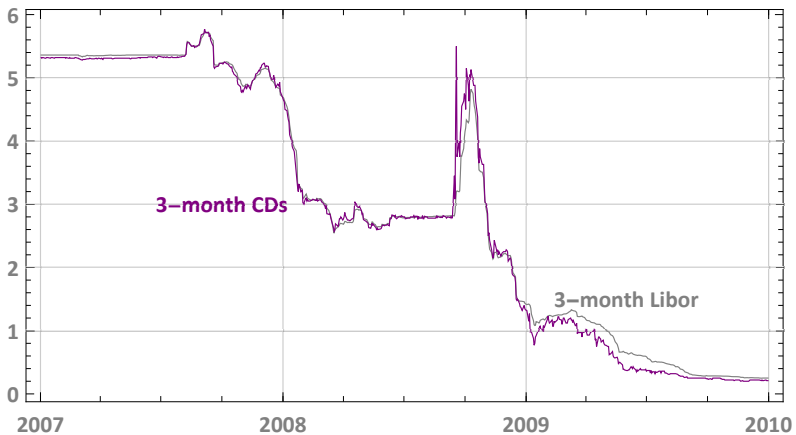
Libor-OIS spread 2006–2016



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

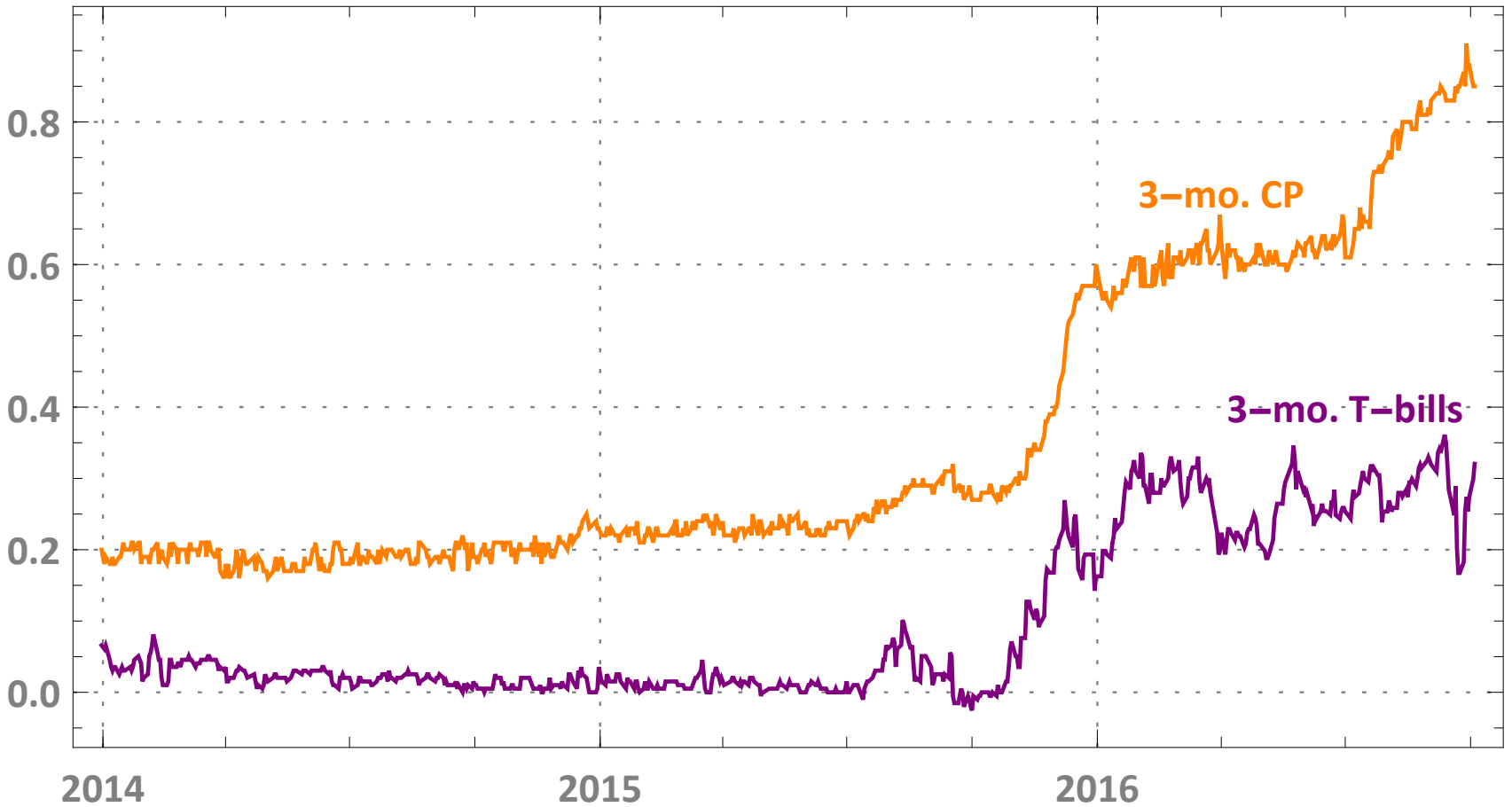
Libor and CD rates 2007–2009





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.

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

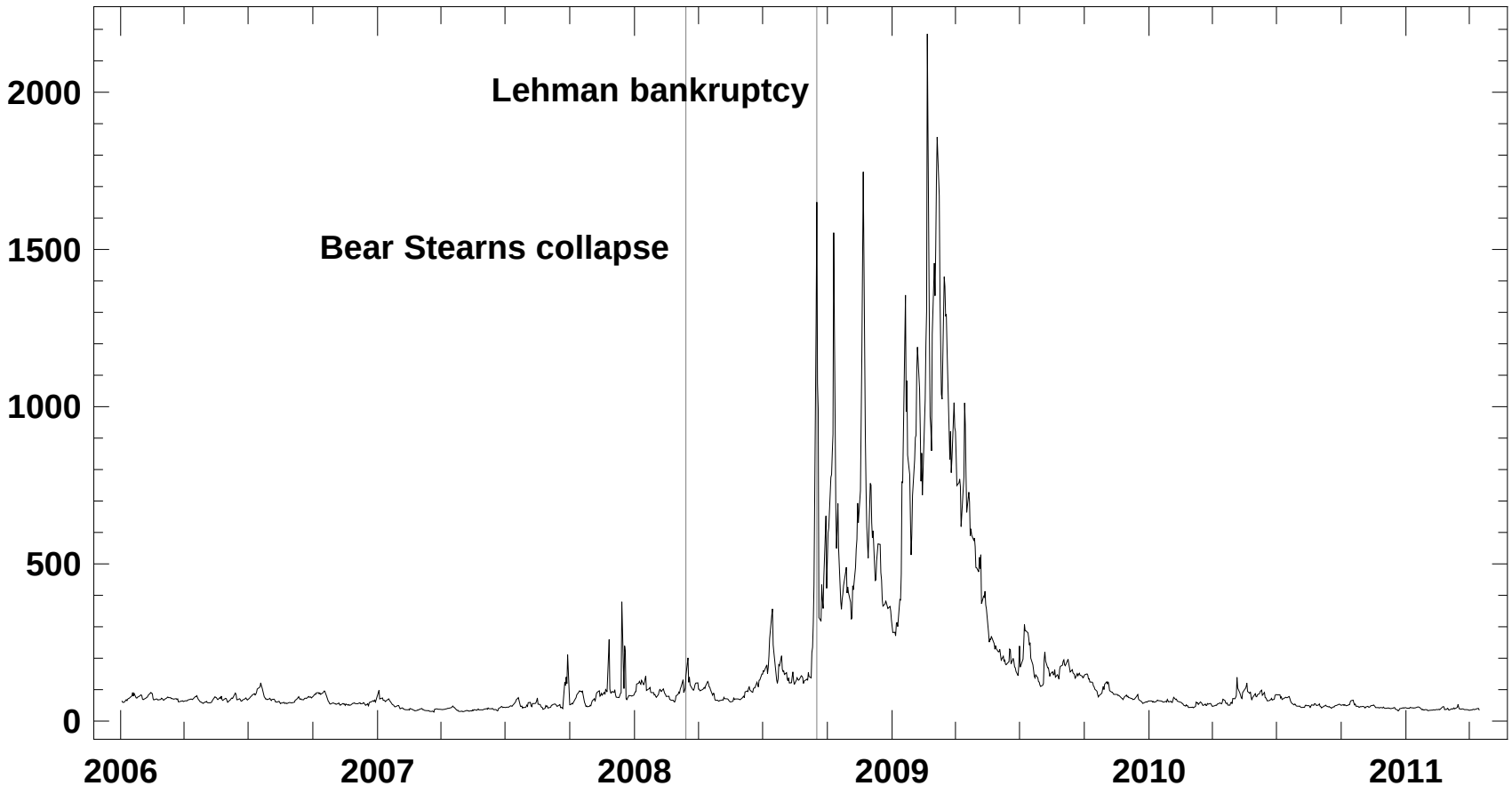


Secondary market rates on highly-rated three-month commercial paper and on U.S. Treasury bills, daily, percent. *Source*: Bloomberg LP.

Typical volatility patterns

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

S&P 500 volatility dispersion



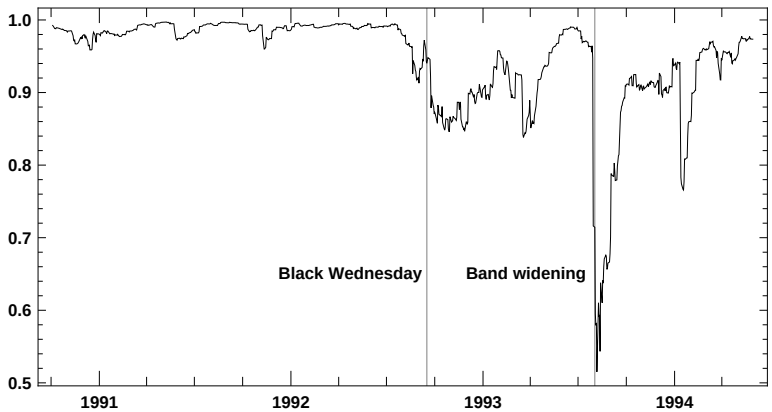
Cross-sectional variance of the implied volatilities of the largest S&P 500 constituents. *Data source*: Bloomberg Financial L.P.

Correlation observables

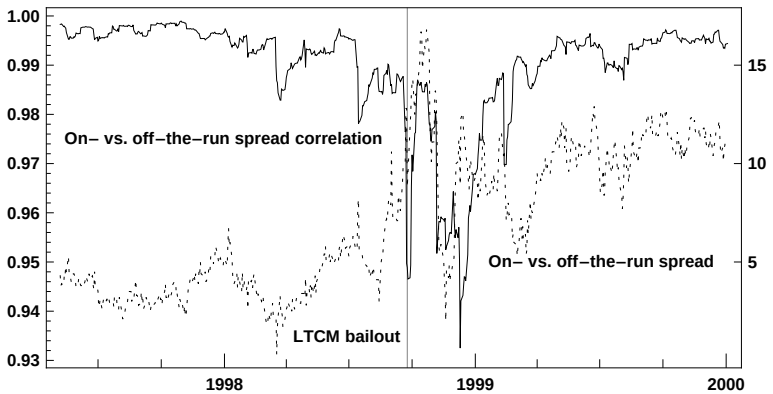
- Radicalization of historical correlations
  - Misleadingly summarized as "all correlations$\rightarrow 1$
  - Caution warranted: sampling during high-volatility periods
- Implied return correlations
  - Equity: derived from prices of index and single-stock options
  - Rates: derived from prices of 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

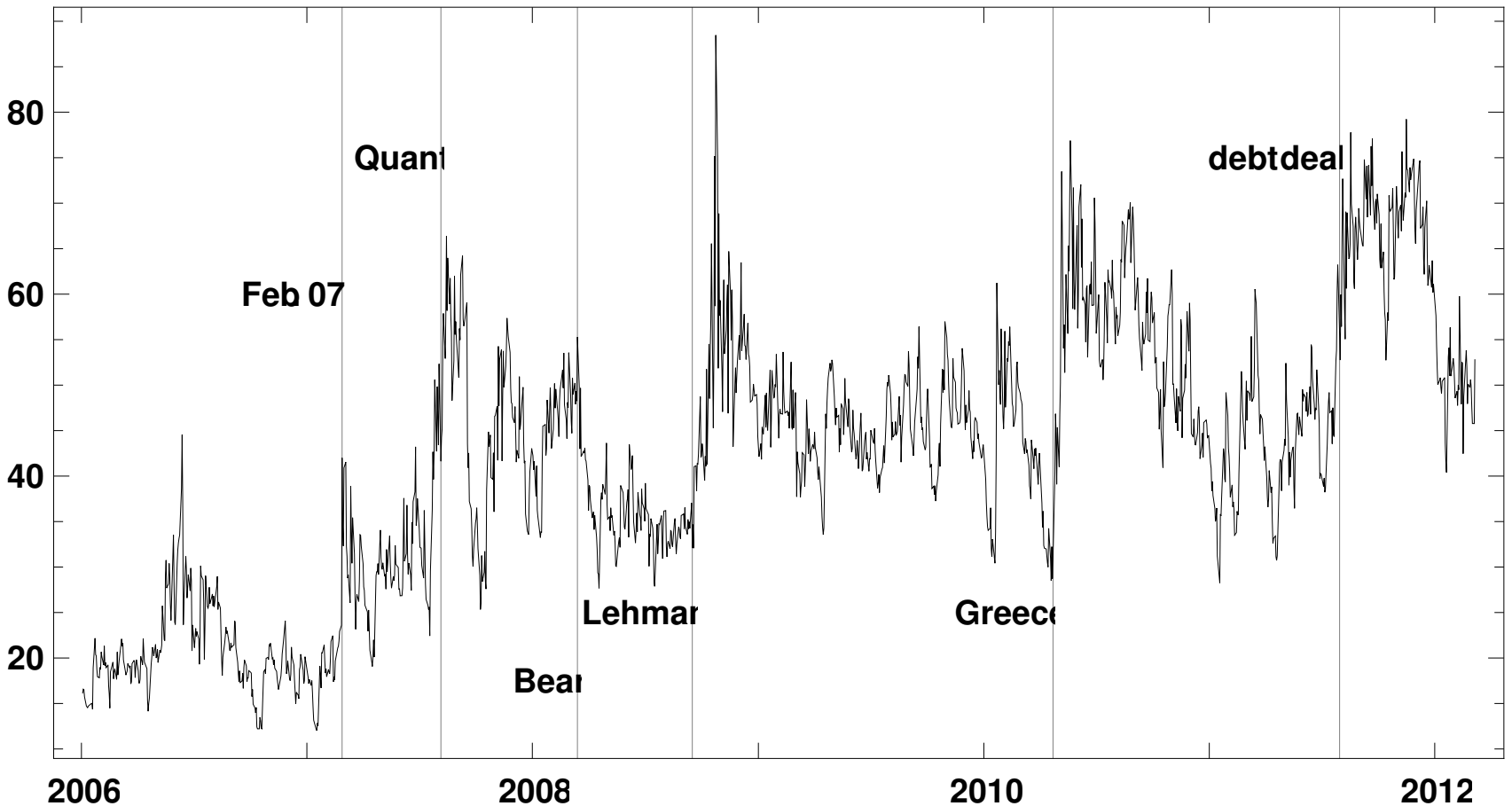


LTCManagement failure 1998



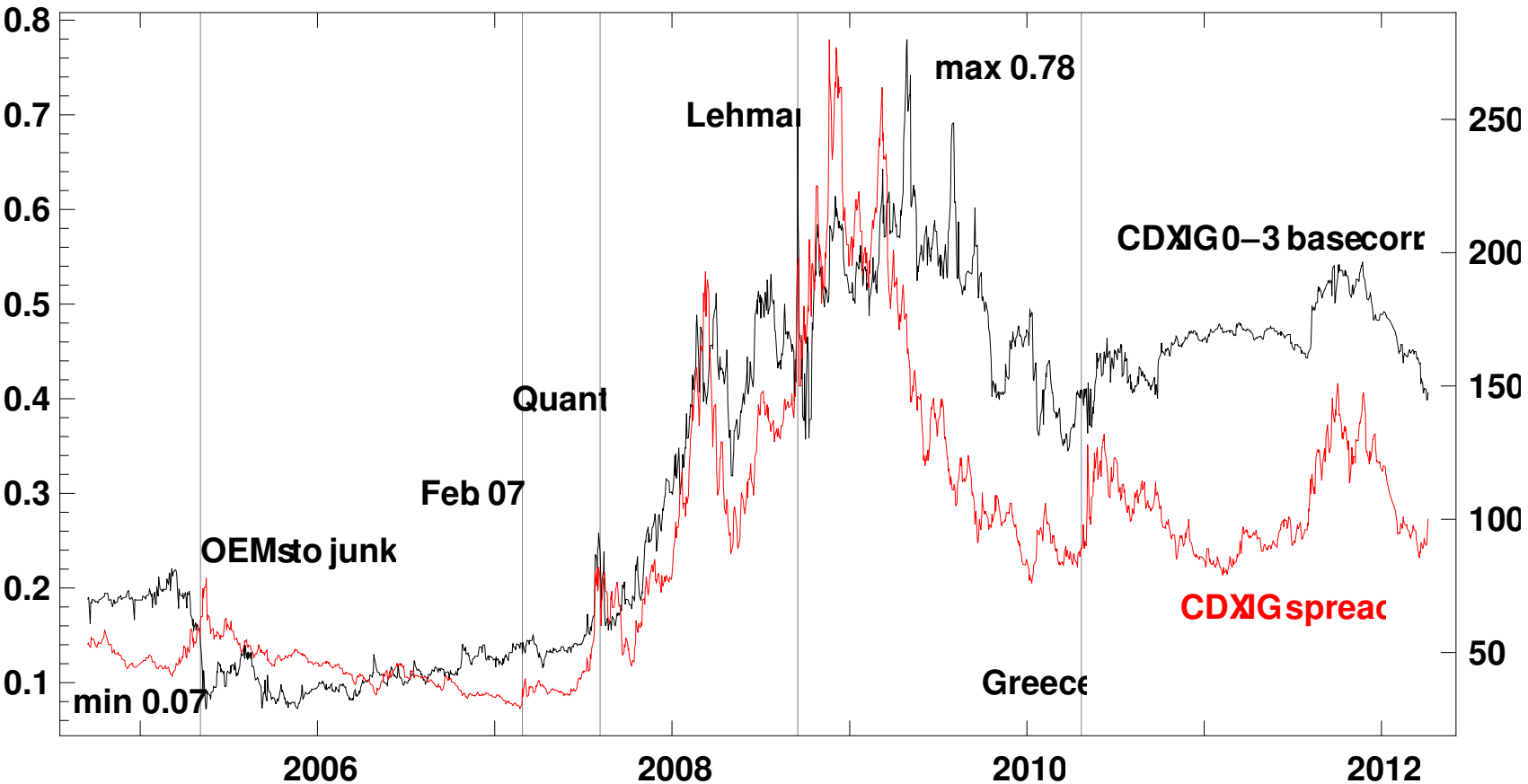
Left panel: daily correlation between logarithmic changes in the USD-DEM and USD-FRF exchange rates, computed using EWMA model with decay factor 0.94, October 5, 1990, to May 31, 1995. *Right panel*: correlation coefficient of daily changes in (solid line, left axis) and spread between (in basis points, 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.

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

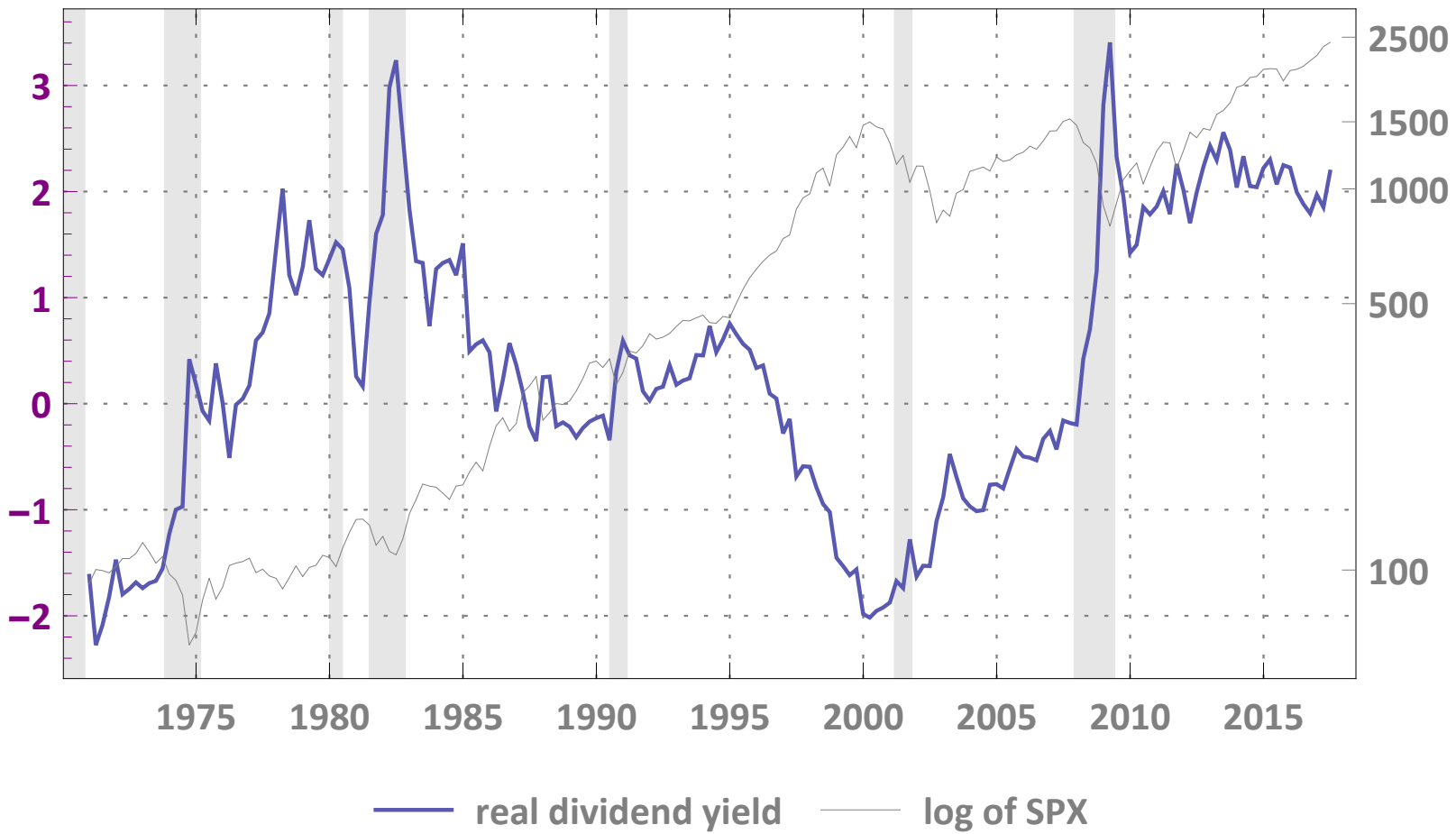
Low real interest rates

- 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

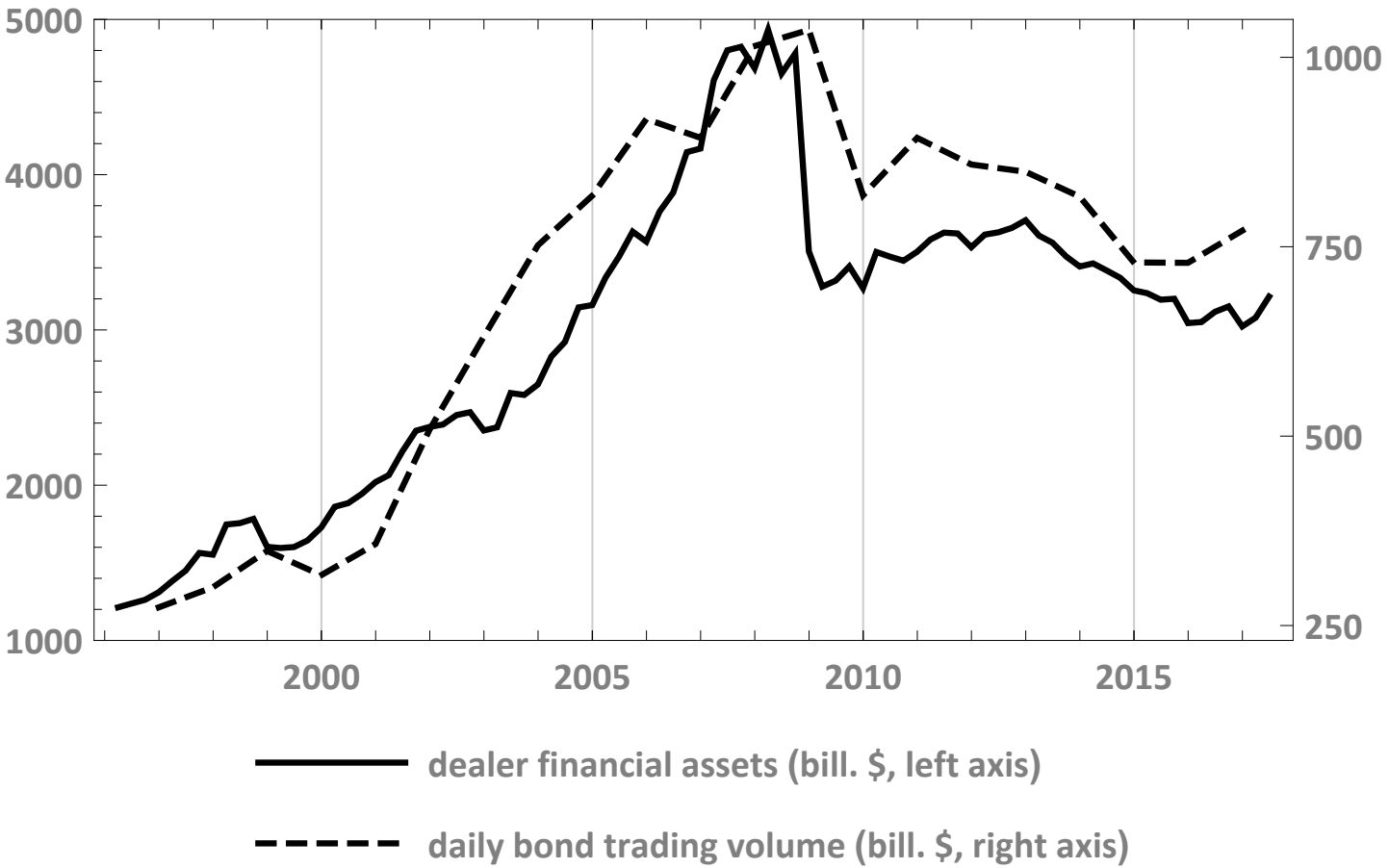


12-month trailing dividend yield of the S&P 500 index (*source*: Bloomberg LP) minus Laubach-Williams estimate of the short-term natural rate, percent, Q4 1970–Q2 2017.

Trading costs steady but flexibility impaired?

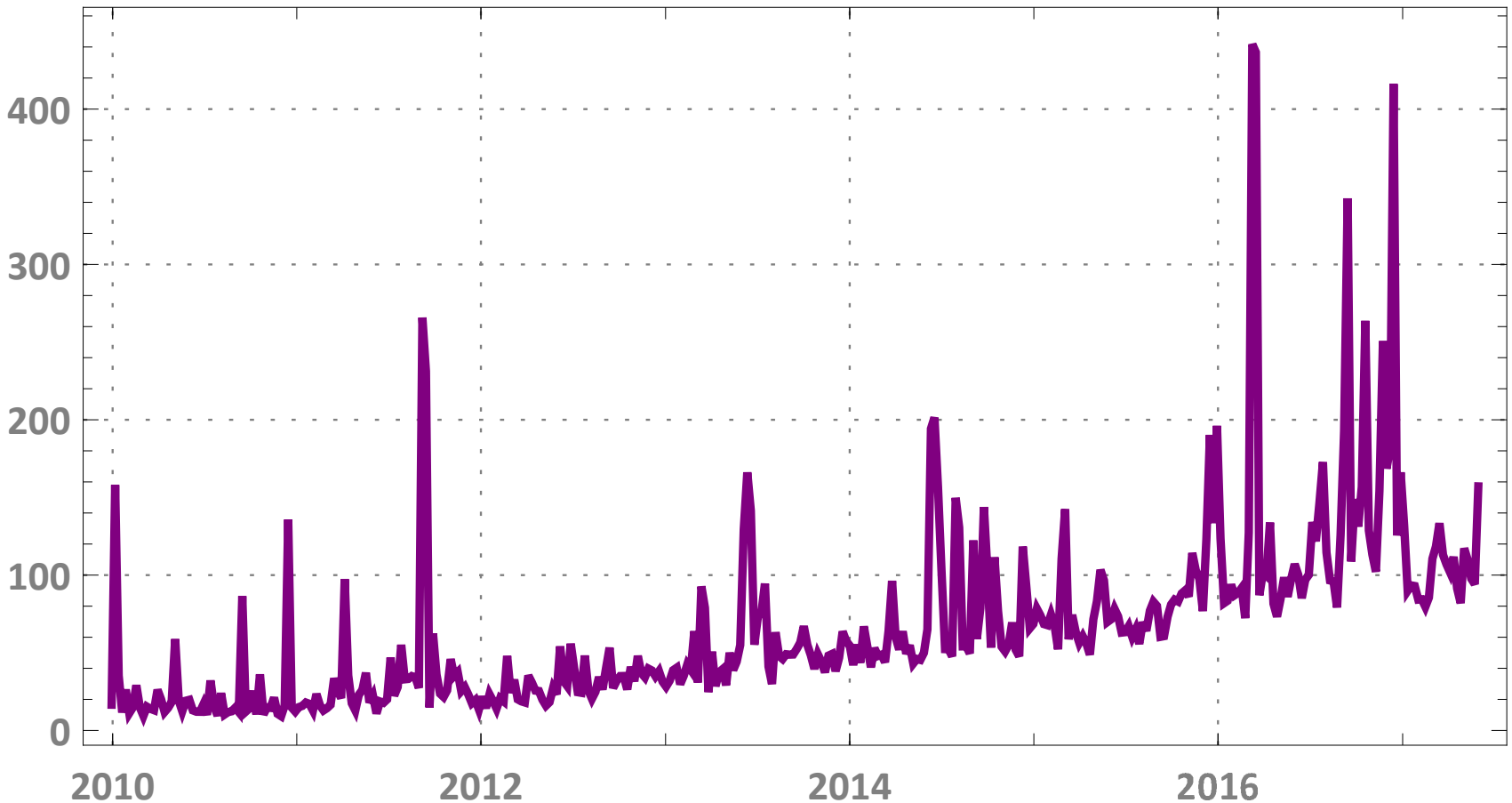
- Focus on U.S. corporate bond market
- Bid-ask spreads appear steady
- But dealers withdrawing, trading volumes down
- Leads to deterioration in
  - Ability to trade in size
  - Speed of executing desired trades
- "Tantrums"
- Liquidity evaporates for issues of troubled firms

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).

Treasury fails 2010–2016

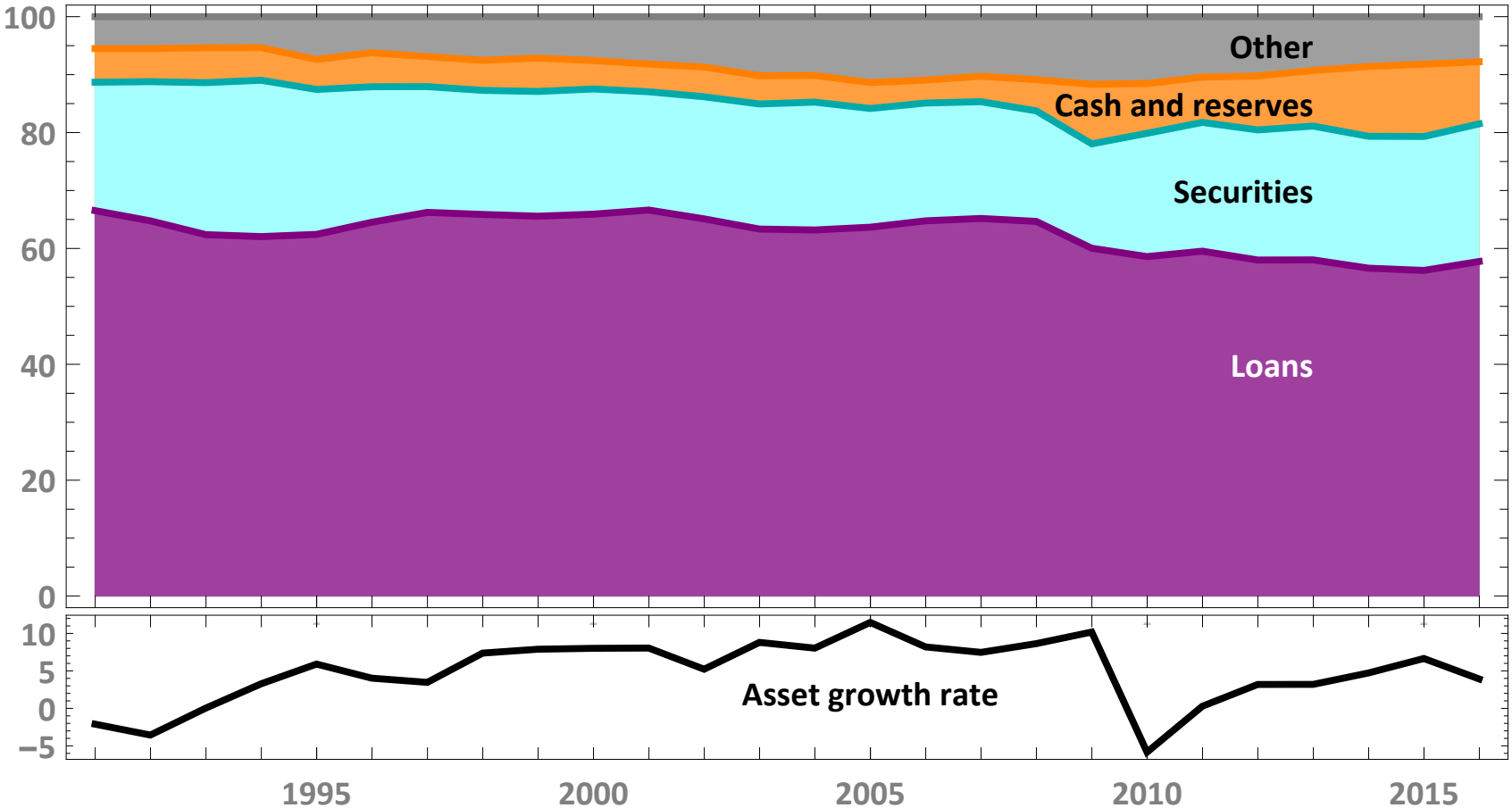


Count of fails to receive and to deliver, 1000's. *Source*: Bloomberg LP. Average of Bloomberg tickers FAILTRED Index and FAILTRER Index, divided by 1000.

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

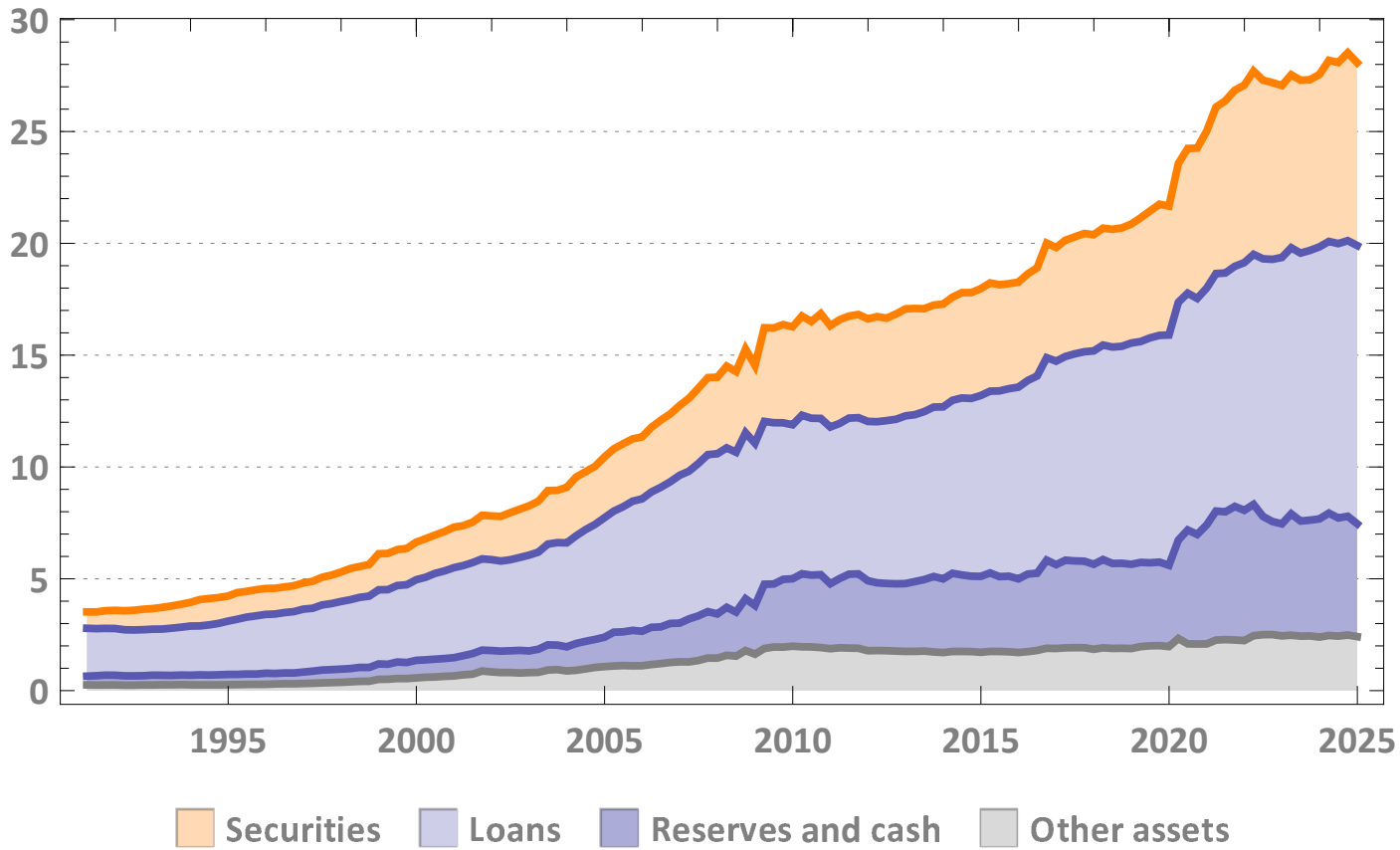


Top panel: share of each asset type in total financial assets of U.S.-chartered depository institutions. Lower panel: annual growth rate of financial assets. Annual data. *Source*: Federal Reserve Board, Financial Accounts of the United States (Z.1), Table L.111.

Changes in bank asset and funding risks

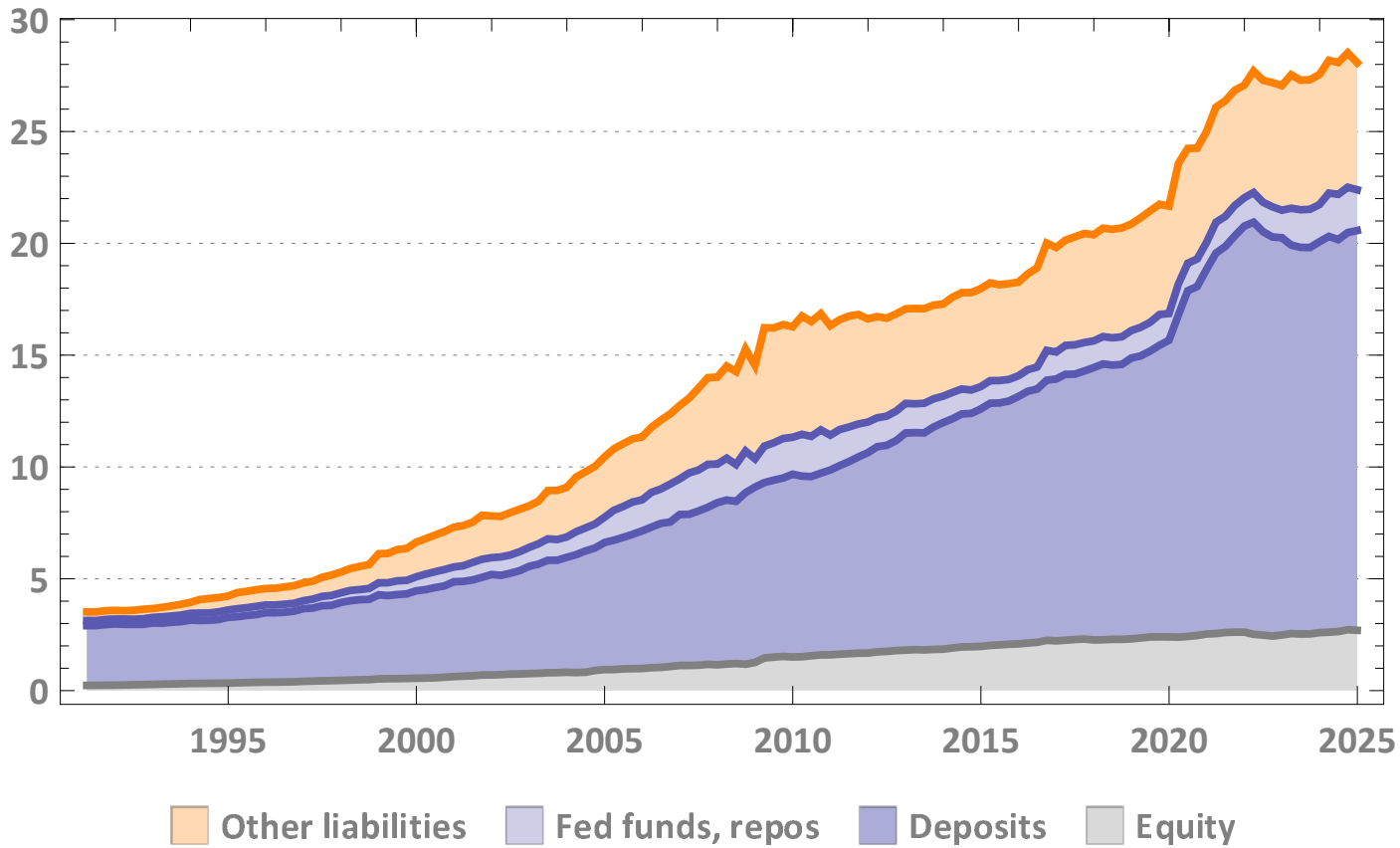
- Asset risk
  - Historically: loan credit risk primary asset risk
  - Recent trend: securities a growing share of banks' interest-earning assets
  - Marketable as well as illiquid securities
- Funding sources
  - Historically: primarily deposits
  - Recent trend: higher issuance of debt securities
  - Deposits remain the mainstay

U.S. commercial banking assets 1991–2024



Securities includes available for sale (AFS), held to maturity (HTM), and trading assets. Data based on call reports and other filings of U.S. commercial banks and BHCs, including nonbank subsidiaries of BHCs and not including assets and liabilities of foreign bank organizations (FBOs). USD trillions, quarterly Q1 1991 to Q4 2024. *Source*: Federal Reserve Bank of New York, Quarterly Trends for Consolidated US Banking Organizations, Table 1: Balance Sheet Composition.

U.S. commercial banking liabilities 1991–2024



Other liabilities consist largely of debt securities issued by banks and bank holding companies (BHCs). Data based on call reports and other filings of U.S. commercial banks and BHCs, including nonbank subsidiaries of BHCs and not including assets and liabilities of foreign bank organizations (FBOs). USD trillions, quarterly Q1 1991 to Q4 2024. *Source*: Federal Reserve Bank of New York, Quarterly Trends for Consolidated US Banking Organizations, Table 1: Balance Sheet Composition.