Dynamic Dependence in Corporate Credit

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Research Questions

- Industry reports suggest that diversification benefits in corporate credit markets have gone down.
  - How do we model dynamic dependence in credit markets?
  - How do we measure diversification benefits?
- Do credit spreads, volatility and correlation have separate dynamics?
- Which economic variables drive credit and equity correlations?

Credit Default Swaps (Markit)

- Hedging
  - CDS allow capital or credit exposure constrained businesses (banks for example) to free up capacity.
  - CDS can be a short credit positioning vehicle. It is easier to buy credit protection than short bonds.
  - CDS may allow users to avoid triggering tax/accounting implications that arise from sale of assets
- Investing
  - Investors take a view on deterioration or improvement of credit quality of a reference credit
  - CDS offer the opportunity to take a view purely on credit
  - CDS offer access to hard to find credit (limited supply of bonds syndicate)
  - Investors can tailor their credit exposure to maturity requirements, as well as desired seniority in the capital structure
  - CDS require little cash outlay and therefore creates leverage

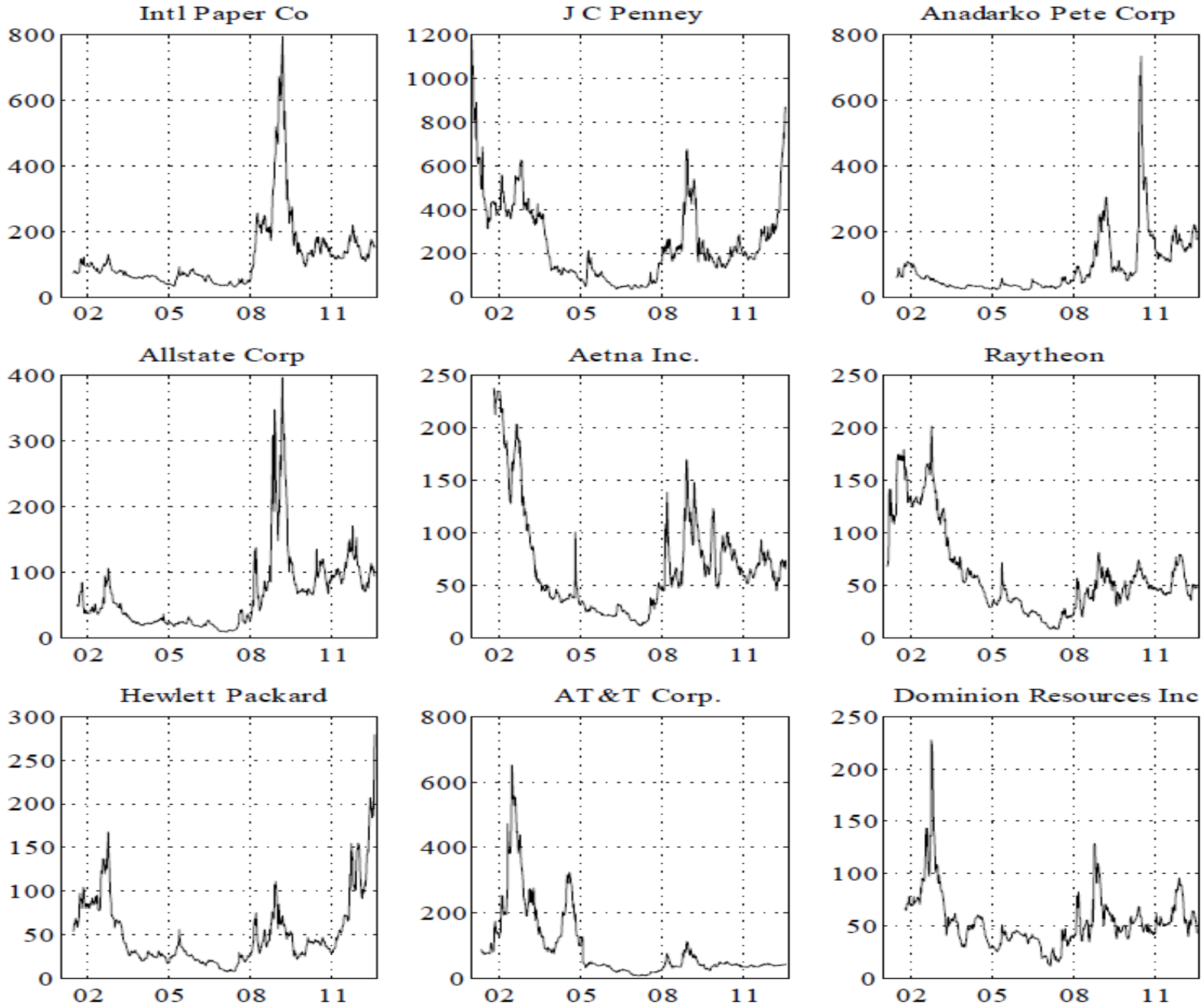
Overview

1. Data
2. Volatility Models
3. Copula Models
4. Credit Diversification Benefits
5. Economic Drivers of Copula Correlations

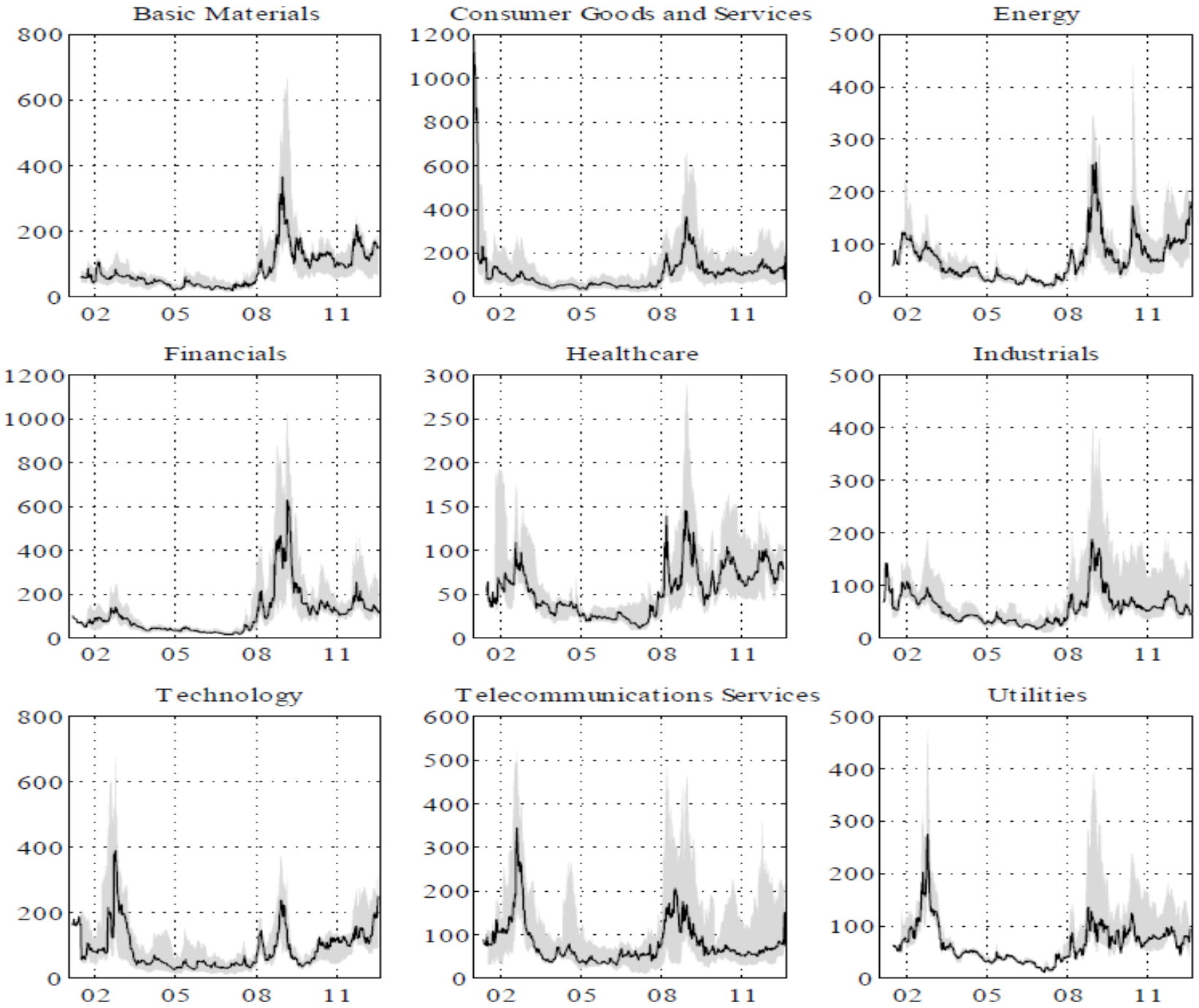
1. Data

- 5-year-CDS quotes each Wednesday.
- From Markit: 226 individual firms included in the first 18 series of the CDX North American investment grade index.
- Data range: from 10/01/2001 to 22/08/2012.
- Exclude 3 firms with fewer than 52 consecutive weeks in our sample.
- Construct time series of default intensities from CDS premia using constant default intensity model.

CDS Spreads for 9 Sample Firms

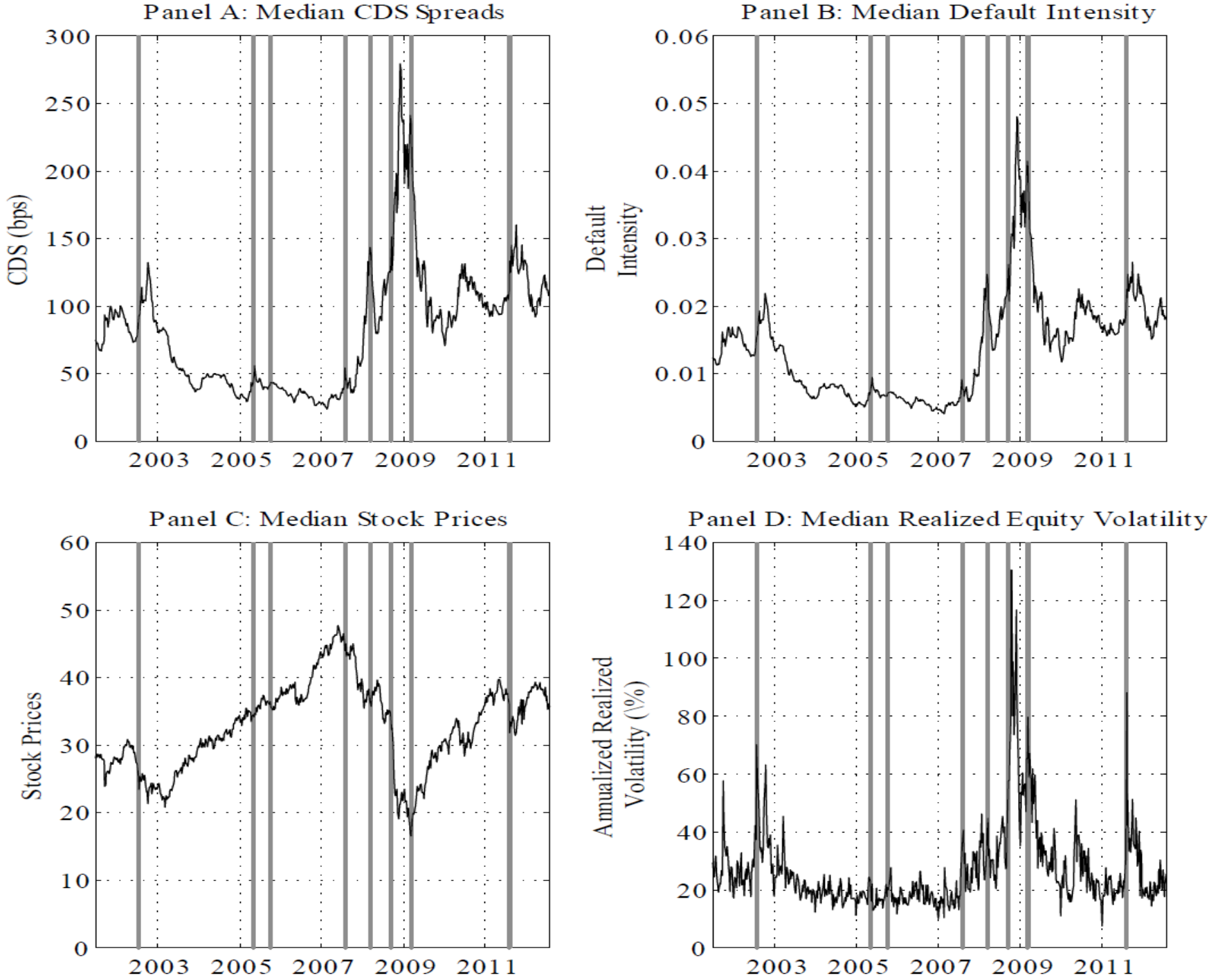


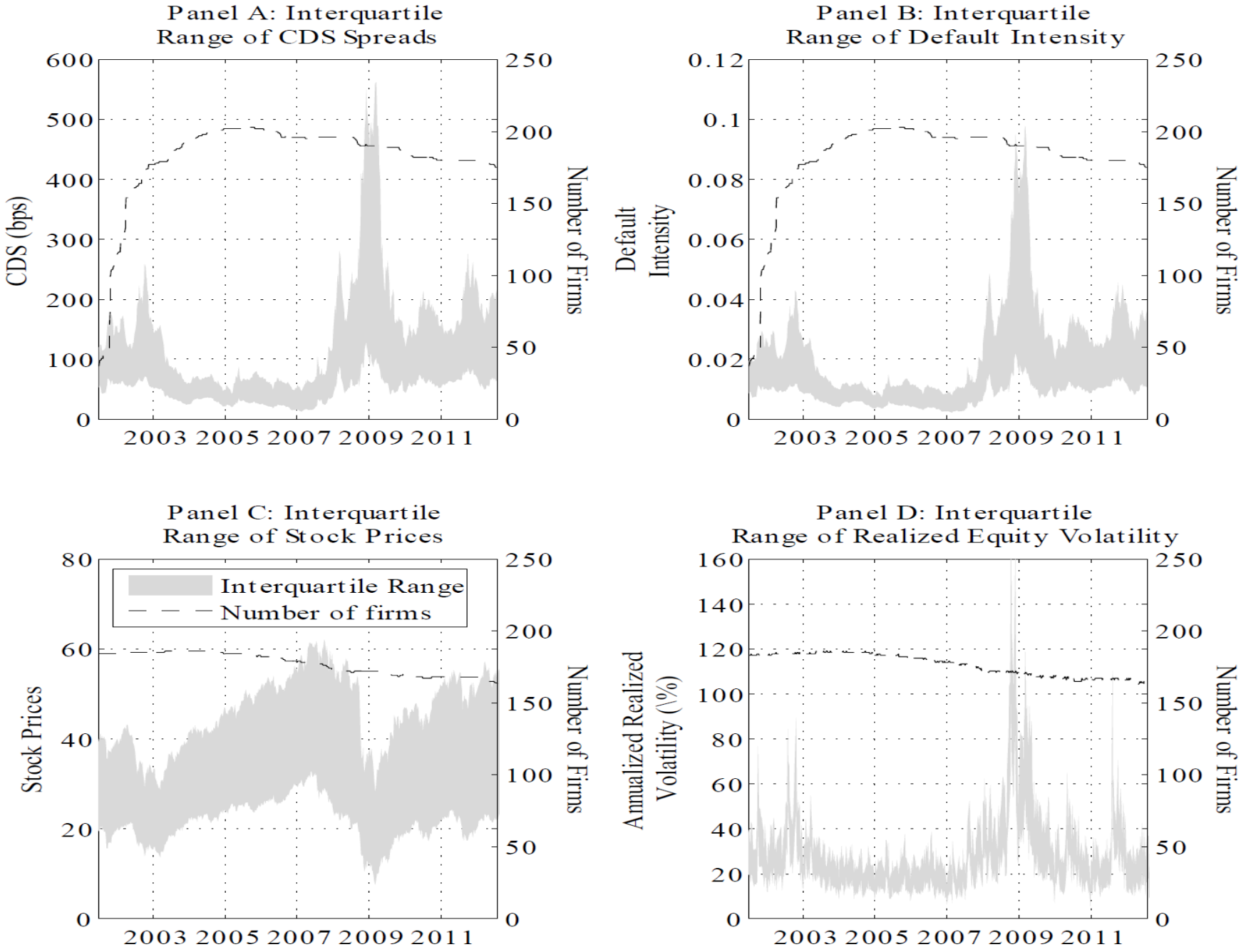
CDS Spreads for 9 Industries:
Industry Median and Industry IQR



Some Market Events in our Sample

- 19/07/2002 WorldCom Bankruptcy
- 05/05/2005 Ford and GM Downgrade to Junk
- 08/10/2005 Delphi Bankruptcy
- 06/08/2007 Quant Meltdown
- 16/03/2008 Bear Stearns Bankruptcy
- 15/09/2008 Lehman Bankruptcy
- 10/03/2009 Stock Market Trough
- 05/08/2011 US Sovereign Debt Downgrade


Panel A: Median CDS Spreads
CDS (bps)
300
250
200
150
100
50
0
2003
2005
2007
2009
2011
Panel B: Median Default Intensity
Default Intensity
0.06
0.05
0.04
0.03
0.02
0.01
0
2003
2005
2007
2009
2011
Panel C: Median Stock Prices
Stock Prices
60
50
40
30
20
10
0
2003
2005
2007
2009
2011
Panel D: Median Realized Equity Volatility
Annualized Realized Volatility (%)
140
120
100
80
60
40
20
0
2003
2005
2007
2009
2011


Panel A: Interquartile Range of CDS Spreads
CDS (bps)
Number of Firms
Panel B: Interquartile Range of Default Intensity
Default Intensity
Number of Firms
Panel C: Interquartile Range of Stock Prices
Interquartile Range
Number of firms
Stock Prices
Number of Firms
Panel D: Interquartile Range of Realized Equity Volatility
Annualized Realized Volatility (%)
Number of Firms
2003 2005 2007 2009 2011

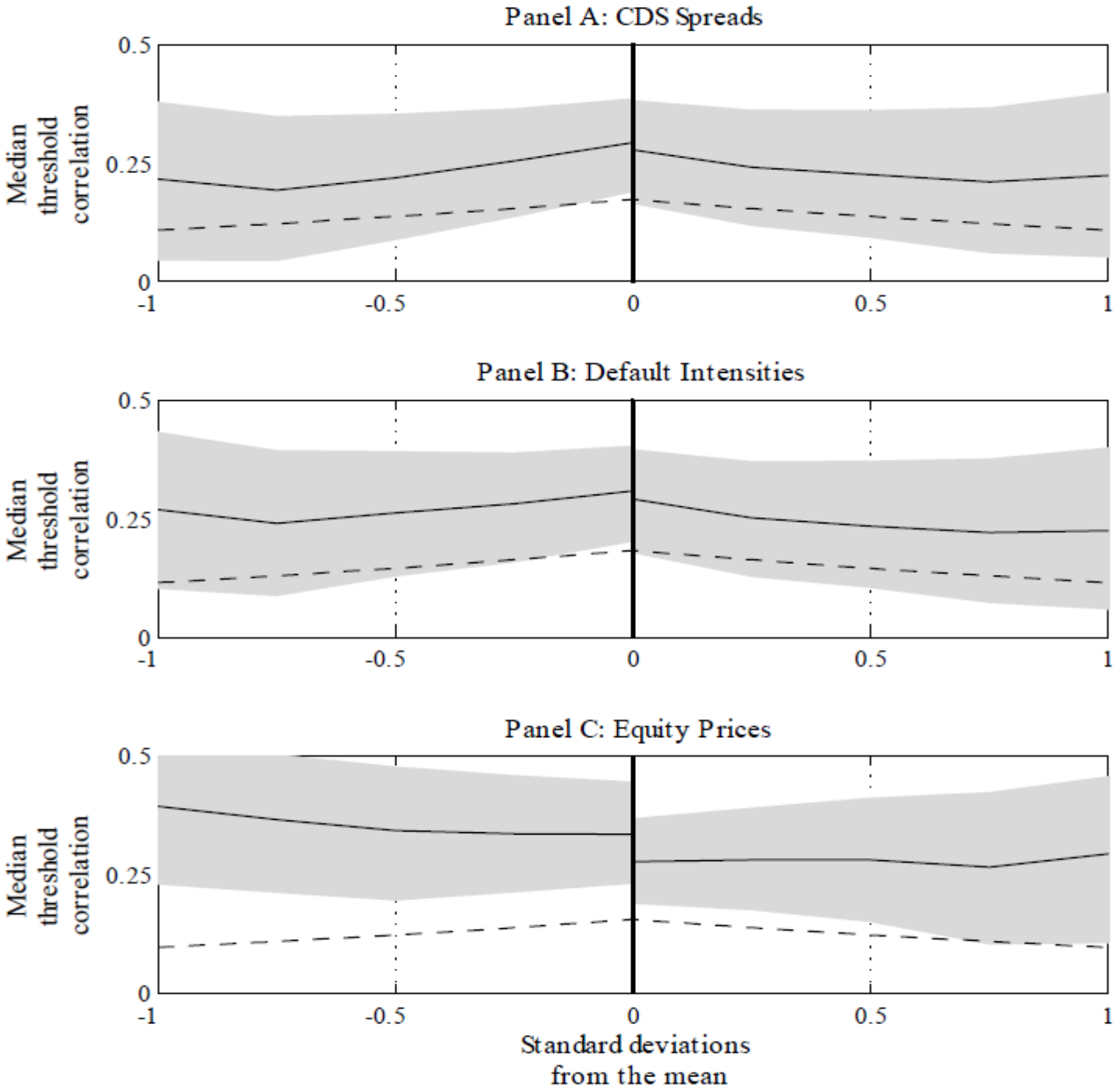
Threshold Correlations

- Use the weekly log differences in 1) CDS premia, 2) default intensity and 3) equity prices.
- Standardize the weekly "returns" using sample mean and volatility.
- Compute threshold correlations:

$$\bar{\rho}_{ij}(x) = \begin{cases} Corr(\overline{R}_i, \overline{R}_j \mid \overline{R}_i < x, \overline{R}_j < x) & \text{when } x < 0 \\ Corr(\overline{R}_i, \overline{R}_j \mid \overline{R}_i \geq x, \overline{R}_j \geq x) & \text{when } x \geq 0, \end{cases}$$

- Where x is measured in standard deviations from the mean.

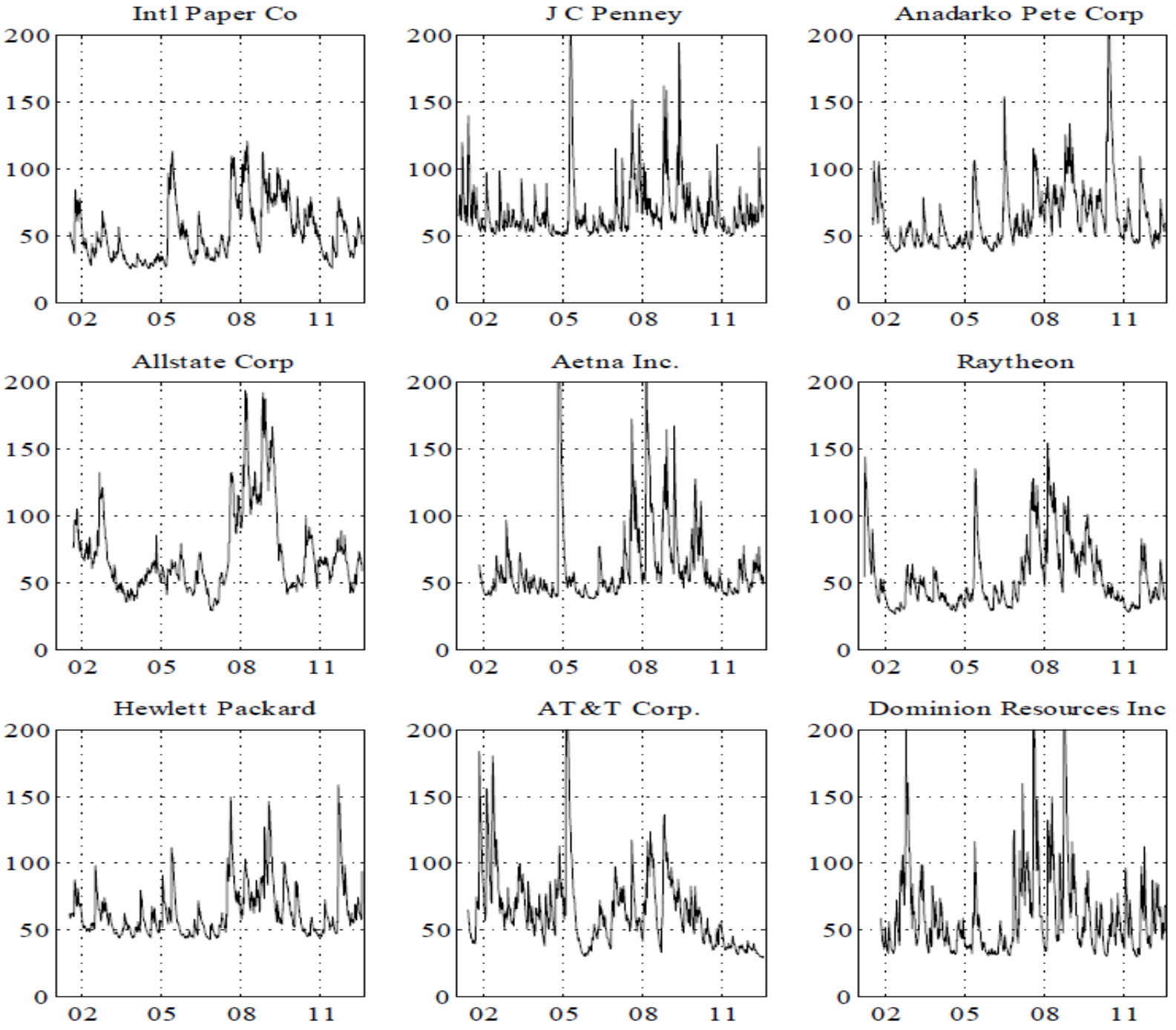
Bivariate Threshold Correlations. Median and IQR across Firm Pairs



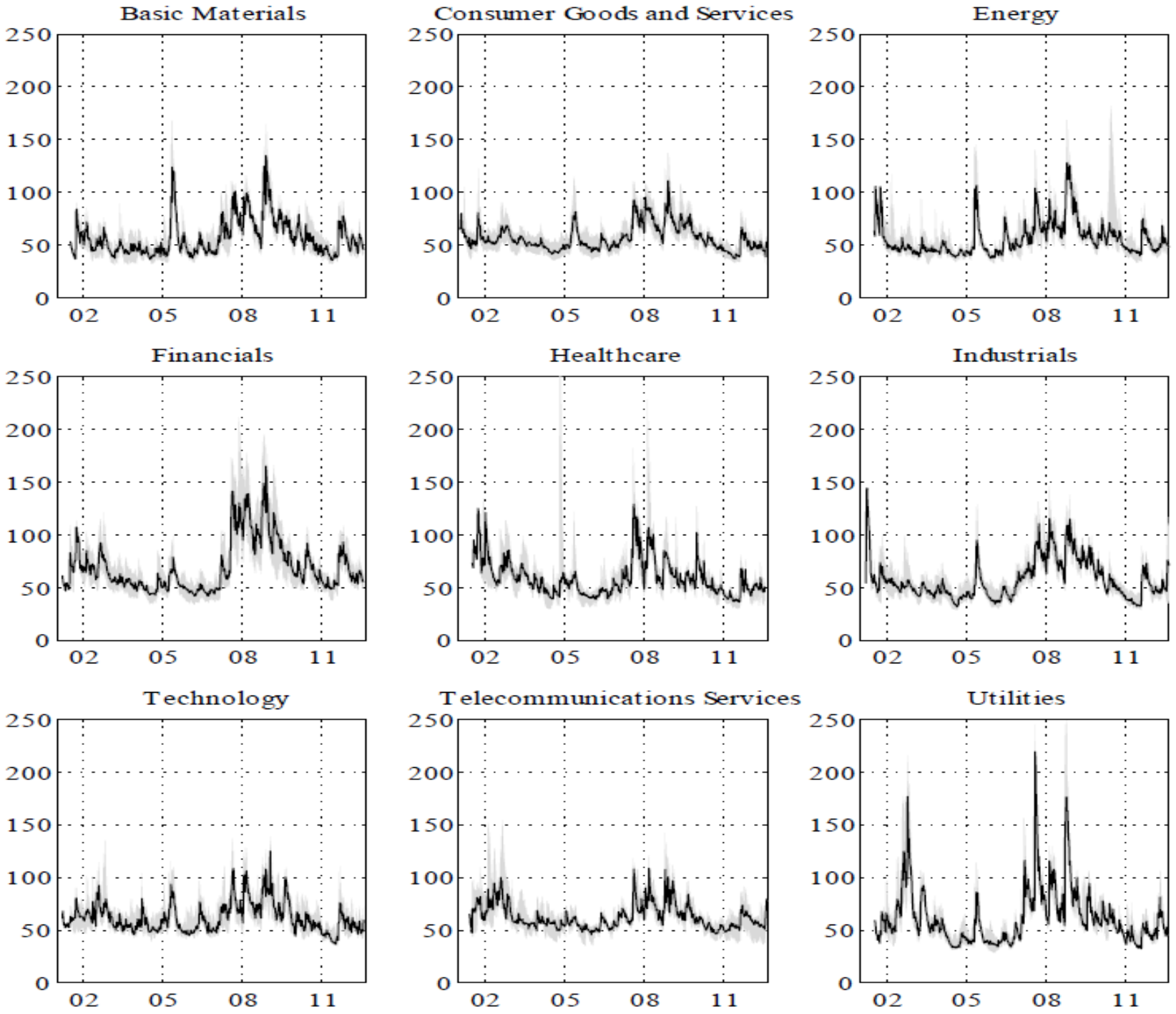
2. Dynamic Volatility Models

- Univariate models on weekly log diffs for each of 3 series on 223 firms.
- Up to ARMA(2,2) for the conditional mean. Model selection by AICC.
- Engle and Ng (1993) NGARCH(1,1) for the conditional variance.
- Hansen (1994) asymmetric standardized t distribution for ARMA-NGARCH shocks.

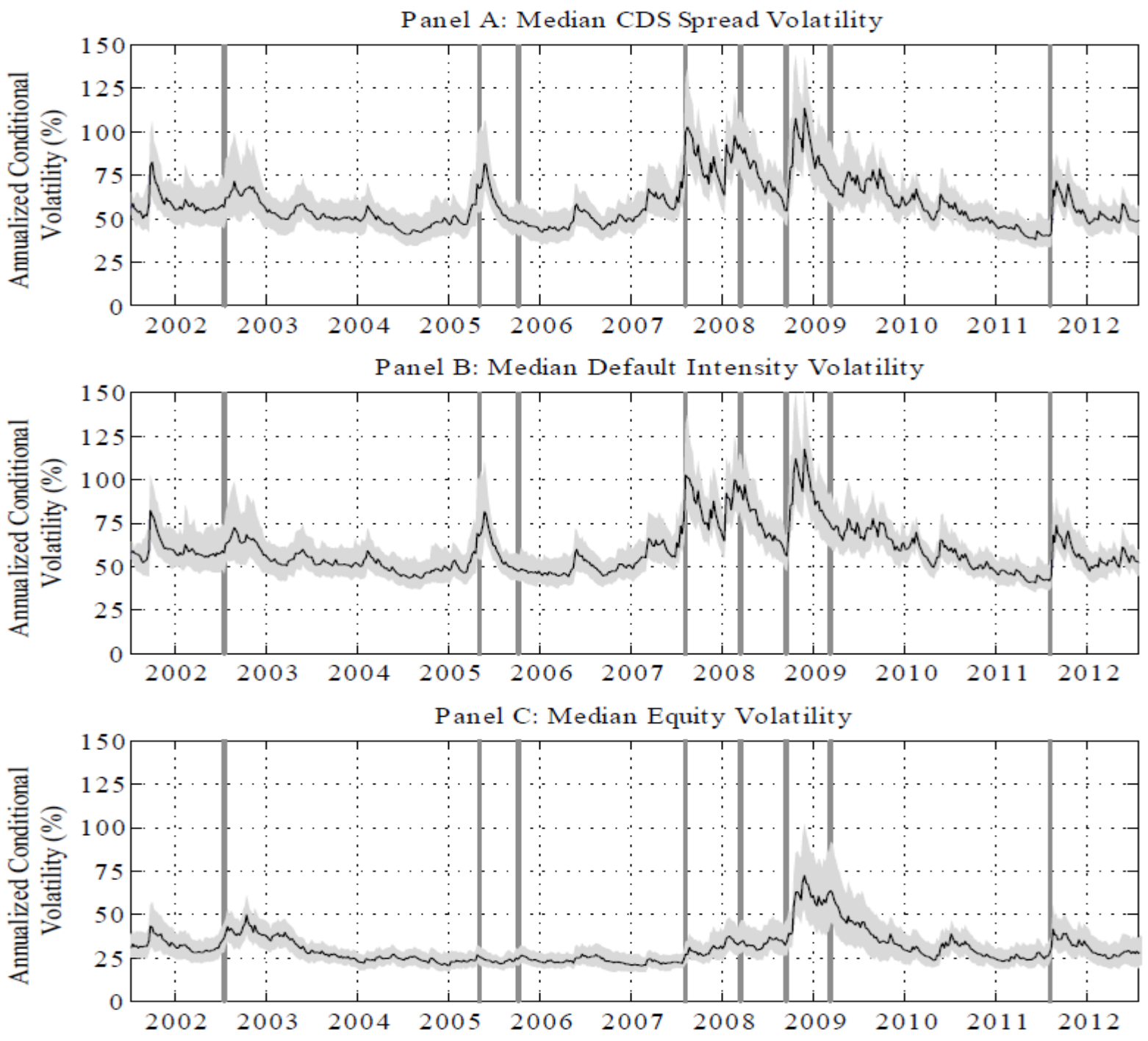
CDS Spread Vols. for 9 Firms



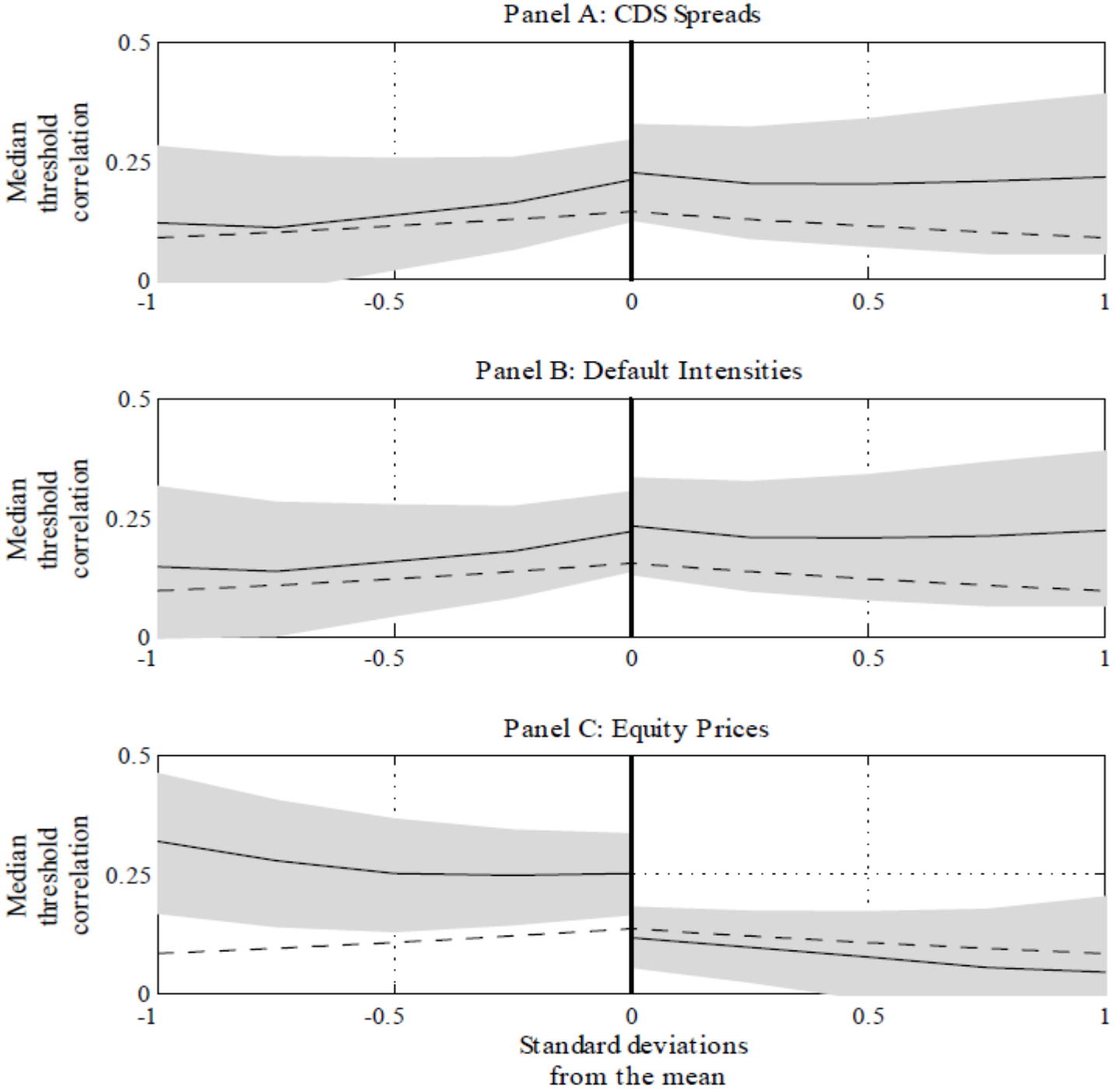
CDS Spread Vols for 9 Industries:
Industry Median and Industry IQR



NGARCH Volatility. Med and IQR



Threshold Correlations on Shocks. Median and IQR



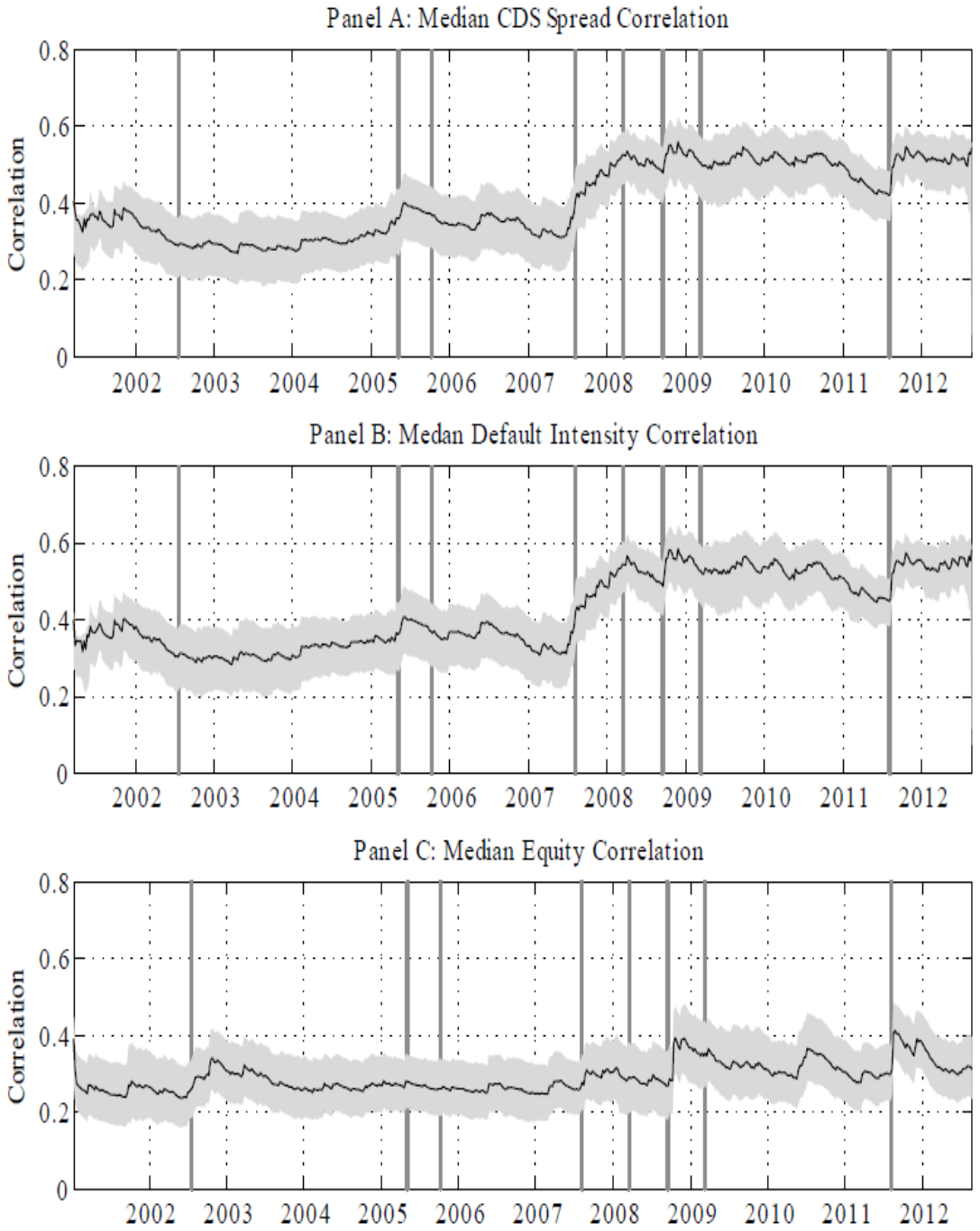
3. Dynamic Asymmetric Copula (DAC)

- Key Challenge: 223 firms and thus 24,753 correlations that change week by week.
- Crucial ingredients:
  - Parsimonious Dynamic Conditional Correlation model of Engle (2002).
  - Flexible Multivariate Skewed t Distribution in Demarta and McNeil (2004).
  - Large-scale composite likelihood estimation as in Engle, Shephard and Sheppard (2008).
  - Allow for different start and end times for each firm. Patton (2006).
- DAC model developed in Christoffersen and Langlois (JFQA, 2013) and Christoffersen, Errunza, Jacobs and Langlois (RFS, 2012).

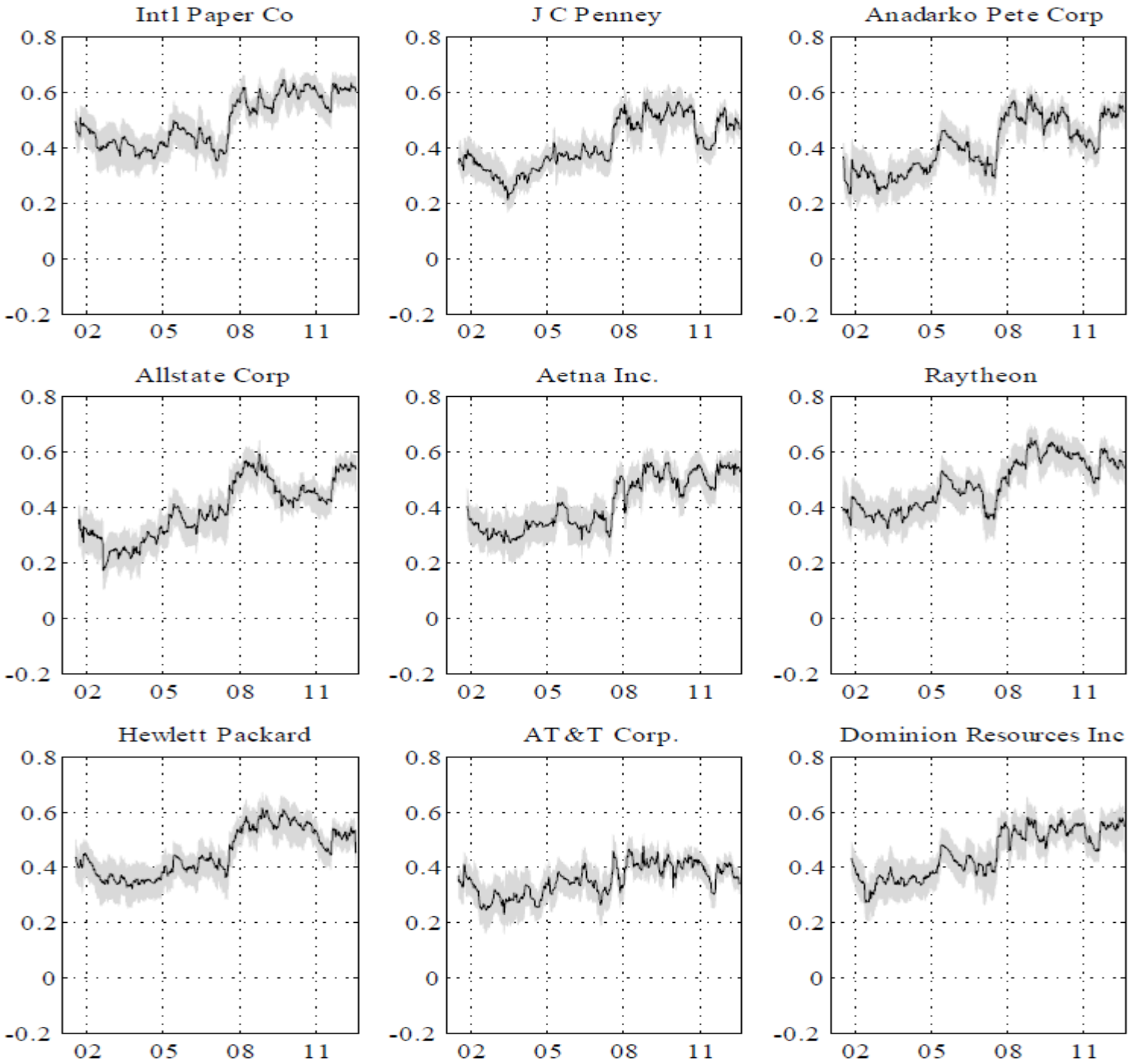
-Median and IQR of bivariate copula correlations.

- CDS spread, default intensity and equity log diffs.

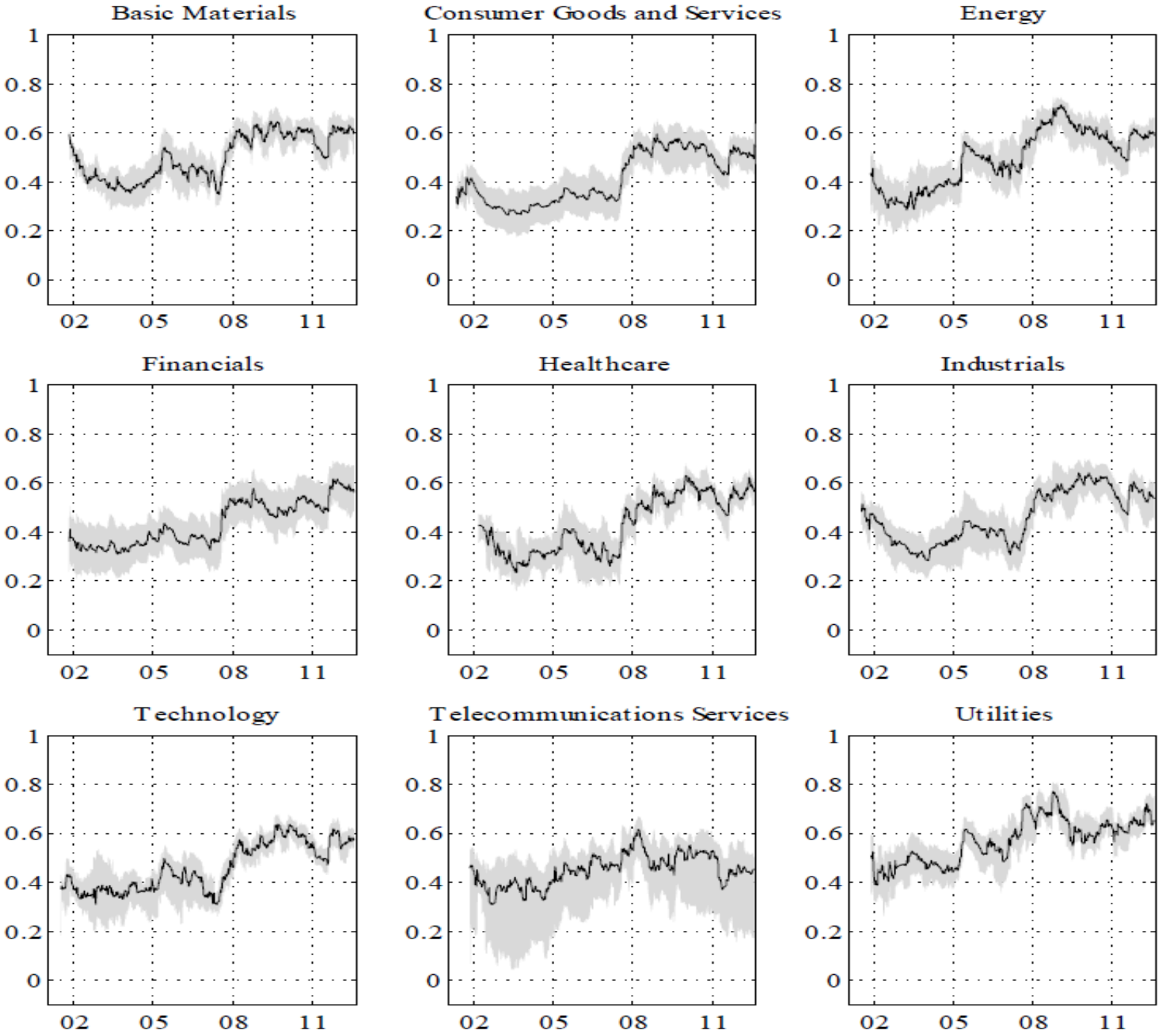
- Note shift in 2007 in credit but not in equity correlations.



CDS Spread Copula Correlations. Median and IQR with all other firms



CDS Spread Correlations for 9 Industries:
Within Industry Median and Industry IQR



4. Conditional Diversification Benefits (CDB)

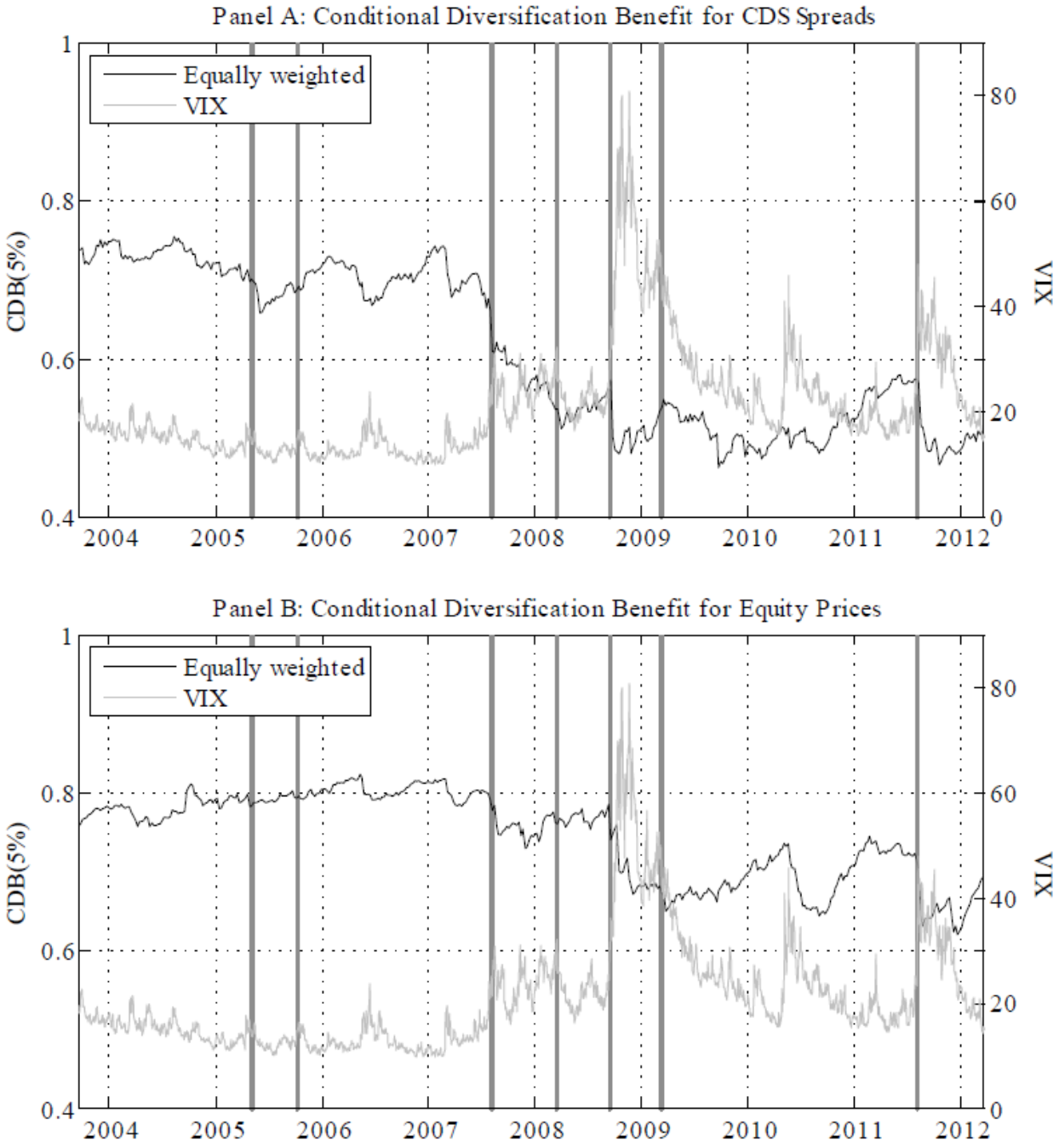
- Using Expected Shortfall (ES), We define CDB as

$$CDB_t(p) \equiv \frac{\overline{ES}_t(p) - ES_t(p)}{\overline{ES}_t(p) - \underline{ES}_t(p)},$$

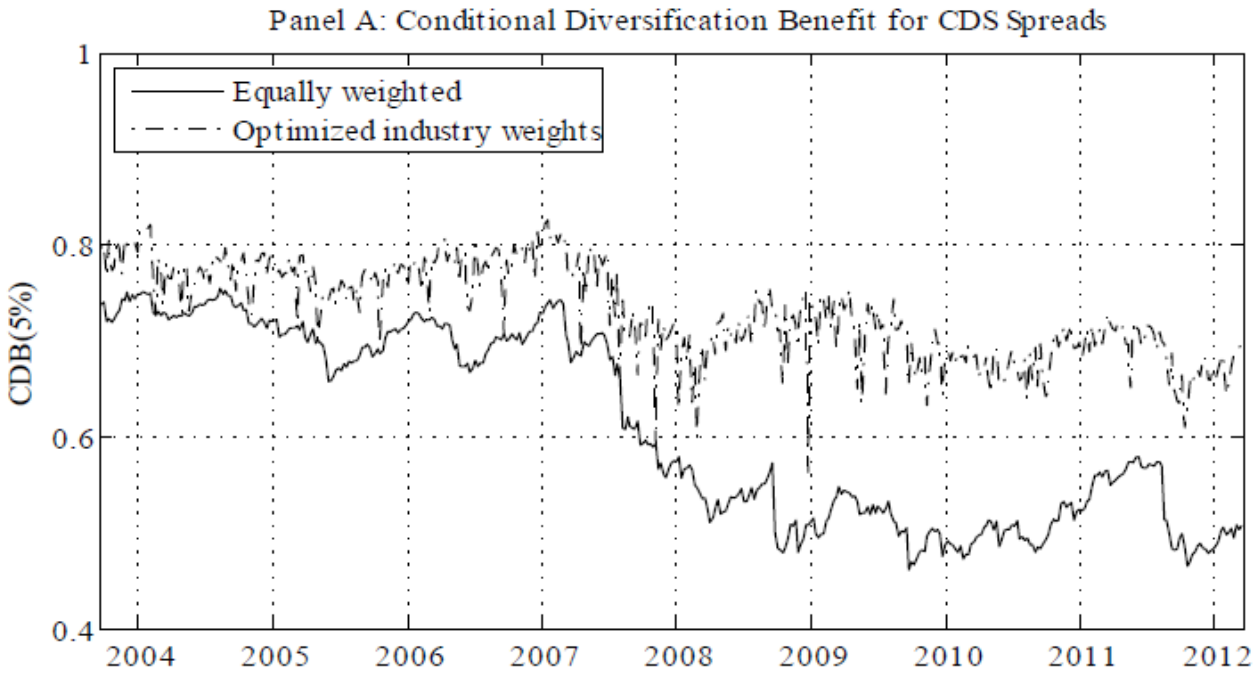
- Upper bound on CDB is ES average across firms (no diversification benefits). Lower bound is portfolio VaR (no tail).
- Gaussian version (when p=50%):

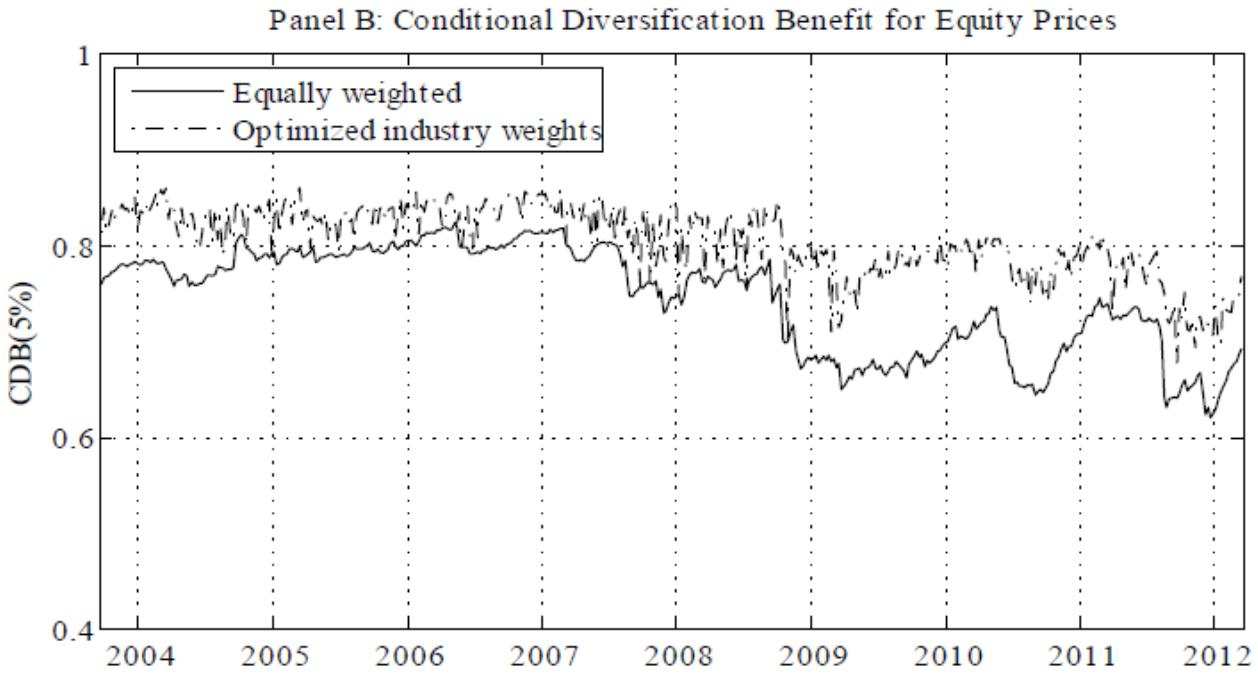
$$VolCDB_t = 1 - \frac{\sqrt{\mathbf{1}^\top \Sigma_t \mathbf{1}}}{\mathbf{1}^\top \sigma_t},$$

- 5% CDB for EW credit portfolio (top) and EW equity portfolio. (bottom).
- ***Selling*** CDS and buying equity.
- VIX on right-hand scale. Key dates in vertical bars.
- Note: Deterioration in CDB in both markets. Began in credit in 2007.



- 5% CDB for credit portfolios (top) and equity portfolio. (bottom).
- Optimized weights (dash) on industry Avr. portfolios. Also EW industry weights (solid).
- Note: Deterioration in CDB is partly circumvented when optimizing weights.





5. Economic Drivers of Credit and Equity Correlations

- Macro and market variables considered
  - The CDX North American investment grade index level is used to proxy for the overall level of risk in credit markets.
  - The VIX index represents equity market risk.
  - The term structure is captured by a level variable, the 3-month US Constant Maturity Treasury (CMT), and a slope variable, the 10 year CMT index minus the 3-month CMT.
  - The crude oil price as measured by the West Texas Intermediate Cushing Crude Oil Spot Price
  - The inflation level as measured by CPI.
  - Consumer confidence measured by the US Consumer Confidence Index (seasonally adjusted).

Correlation Regression Preliminary Findings

- When using first-differences in median correlation regressed on first-differences of macro and market variables in univariate regressions, we find that
  - VIX drives up credit and equity correlations.
  - Consumer confidence drives down both credit and equity correlations.
  - CDX drives up credit correlations.
  - Crude oil price drives down both credit and equity correlations.
  - The interest rate drives down credit correlation.
- We also run regression on spreads and spread volatility. Regressions on levels. Multivariate regressions.

Summary

- We have estimated a dynamic asymmetric copula model on 223 firms which each have different start and end dates.
- Credit spread levels, volatility and dependence are found to have separate dynamics. Credit and equity prices also have different dynamics.
- Credit dependence appears to be permanently higher after 2007. Equity dependence not so.
- Diversification benefits have declined in both EW credit and EW equity portfolios. This decline in diversification benefit can be reduced by optimizing benefits on industry portfolios.
- We find some scope for economic drivers of credit and equity dependence.

Appendix: Credit Events in the Sample

- CIT Group
- Delphi
- FHLMC
- FNMA
- Washington Mutual
- Tribune
- Lear
- Eastman Kodak
- Residential Cap

See:
http://creditfixings.com/CreditEventAuctions/fixings.jsp