Systemic Risk in a Structural Model of Bank Default Linkages

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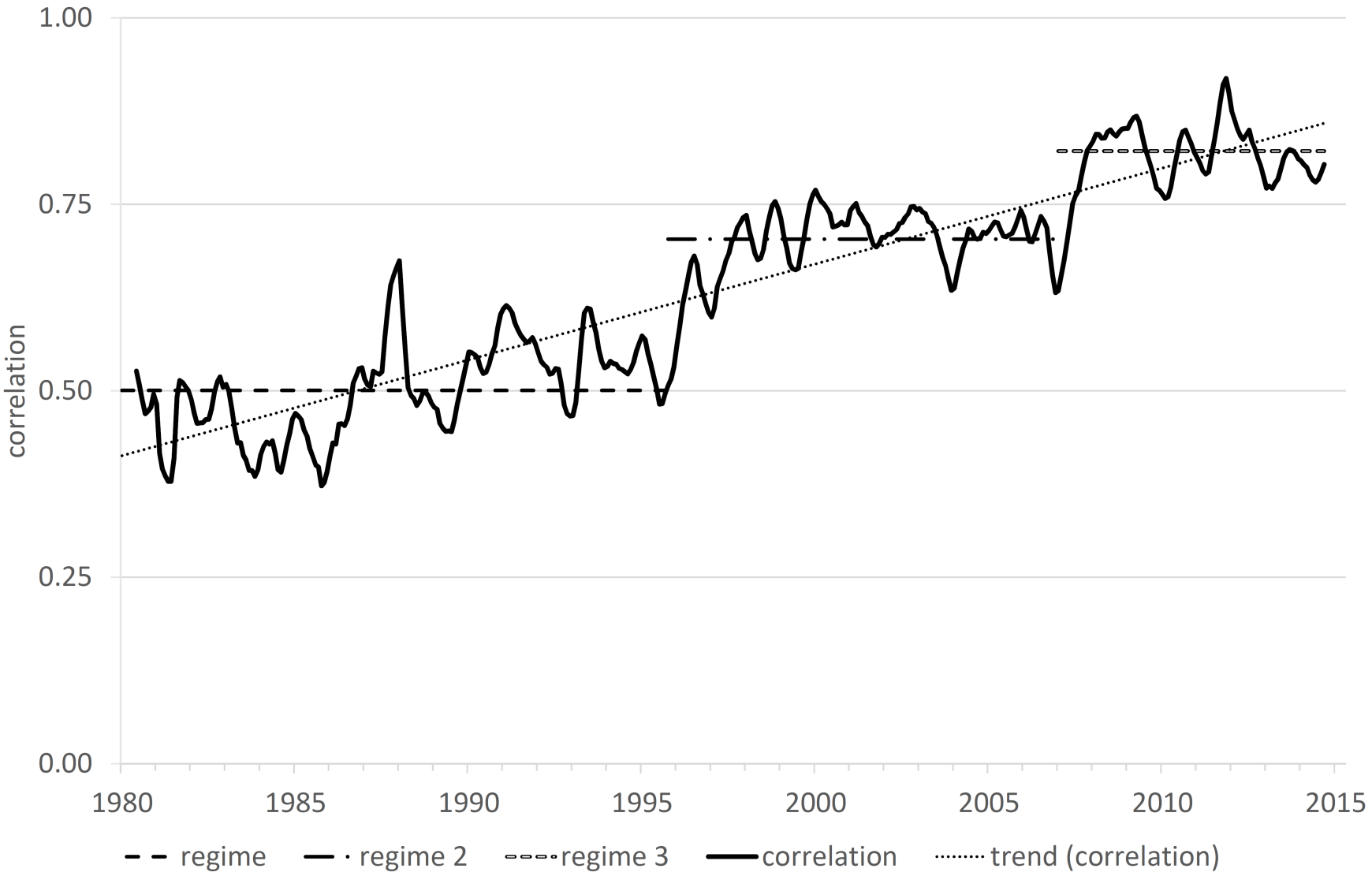
Structural Model of Default

- Description:
  - Individual bank defaults iff assets < debt
  - Introduce default correlation through asset correlation
  - Study a banking system with N individual banks
- Analogous to default risk in a bank portfolio but there are two crucial differences:
  - Typically use “small” correlation in bank portfolios, but we empirically find large correlations in the banking system
  - Typically assume “large/infinite” number N but actual number is small in the banking system

Time Series of Correlation (Averages Across Largest 15 US Banks)



Micro-prudential Regulation and Banking Sector Default

- Micro-prudential regulation addresses individual default probability $p_i=p$ for i=1,…,N banks
- To describe banking sector default, define
  - Indicator variable for default of bank i: X_i
  - Default frequency: $M_N = \frac{\sum_{i=1}^{N} X_i}{N}$
- **If** asset correlation=0, Law of Large Numbers implies

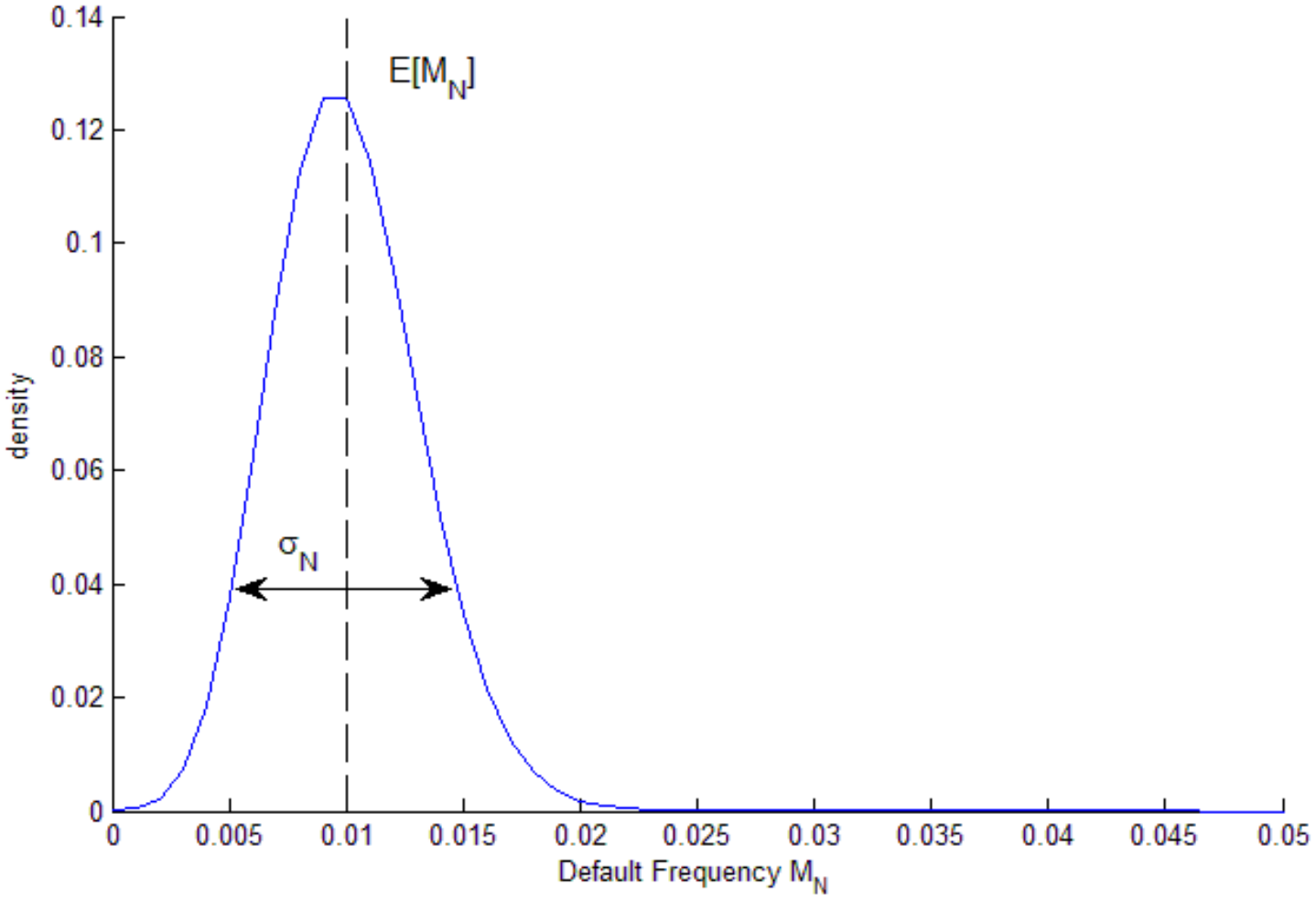
$$M_N \to p$$

  - suggests that default frequency is "close to" individual default probability,
- Focus on micro-prudential regulation

Density of Default Frequency M_N (Correlation ρ=0; N=1,000 Banks)

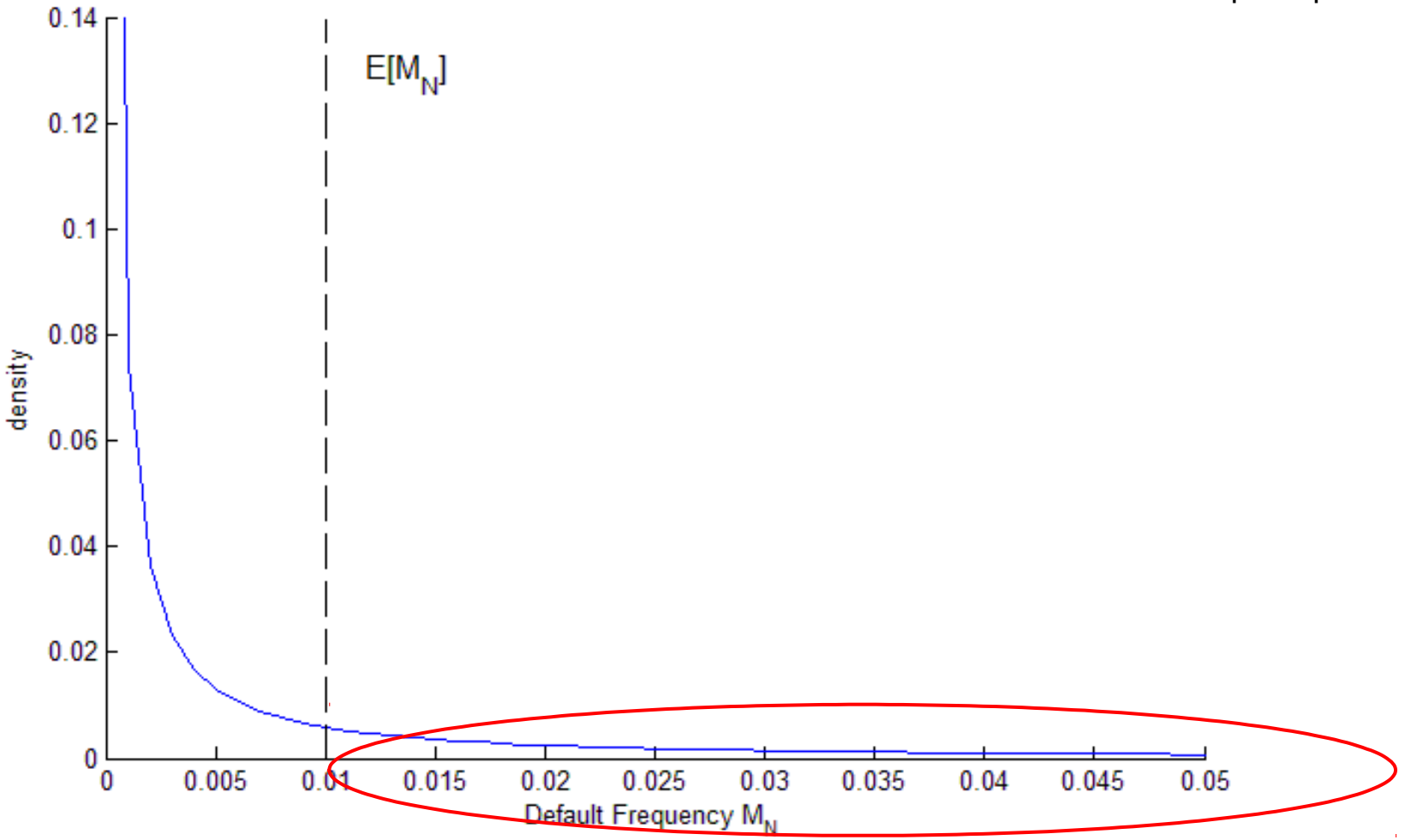
For correlation=0: $M_N \sim N(p, \sigma_N), \sigma_N = \sqrt{\frac{p(1-p)}{N}}$; Here σ_N =0.3146%

Parameter: ind. def. prob. p=1%



Density of Default Frequency M_N (Correlation ρ=63.8%; N=1,000 Banks)

Parameter: ind. def. prob. p=1%

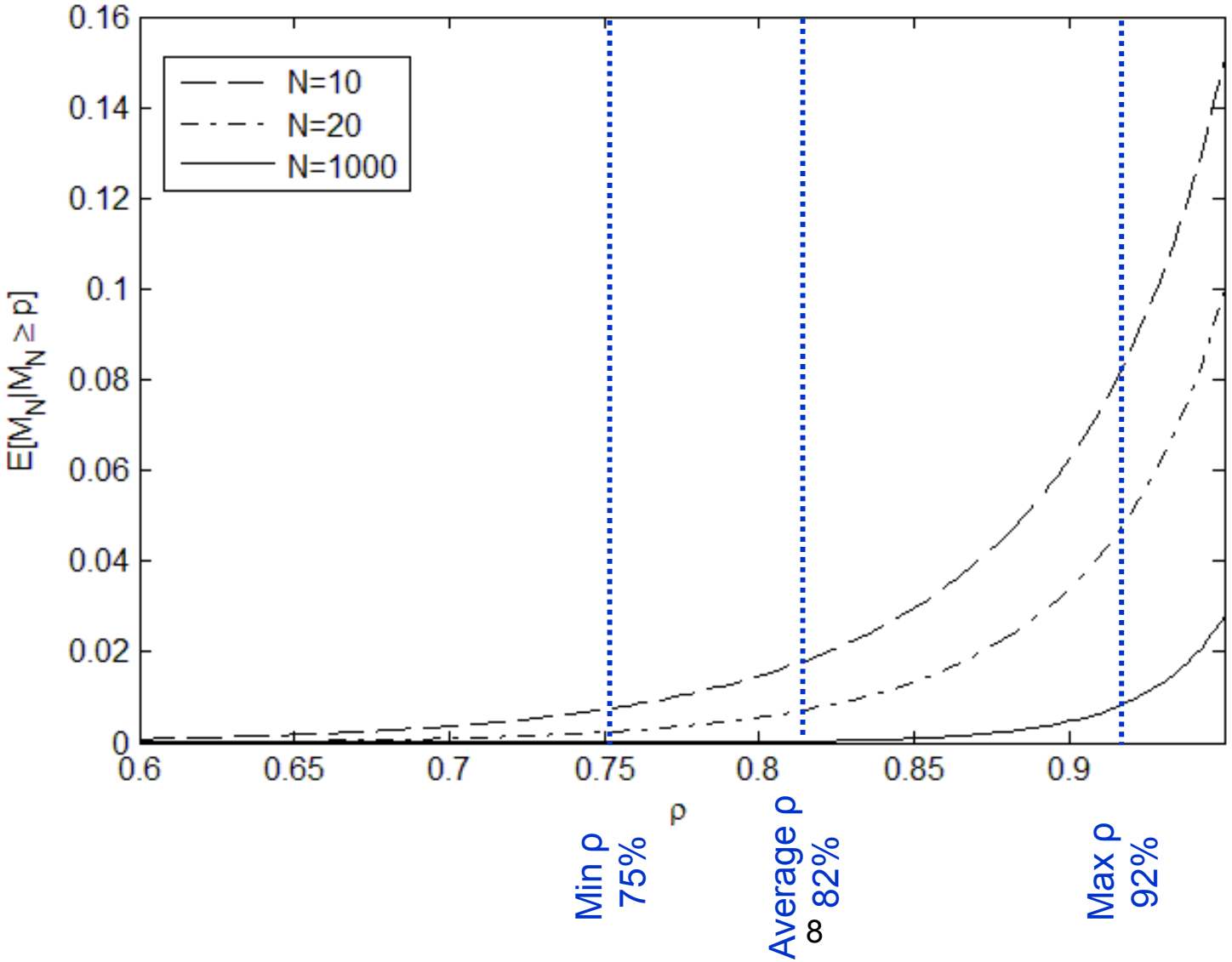


Systemic Risk Measure

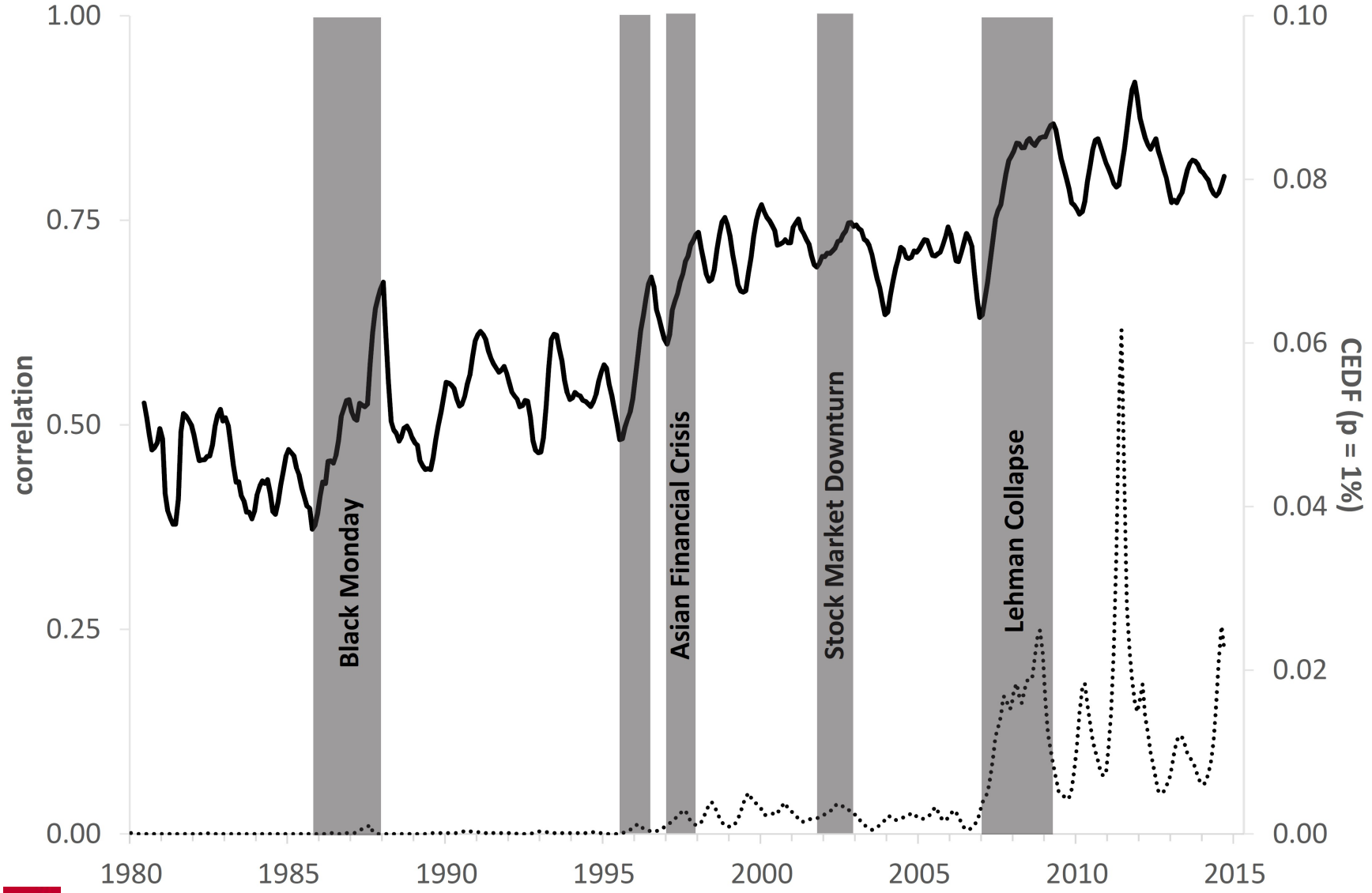
- Summary of observations from previous slides:
  - Actual numbers N are “large” but too small to adequately capture “infinity”
  - In addition, correlations are far from zero, in particular close to 1 (maximum)
  - Default frequency “spreads” out to the right.
- Default frequency larger than micro-prudential reference level $p=E[M_N]$ is problematic
  - Define Conditional Expected default frequency:
  - Systemic risk measure
  - Foundation for macro-prudential regulation

Systemic is Sizeable and Depends Non-linearly on Correlation

Parameter: ind. def. prob. p=1%



Evolution of Our Systemic Risk Measure



Conclusion

- Approach to systemic risk based on well-known structural model of credit risk
- Asset correlation
  - Strong non-linear impact on systemic risk measure
  - Empirically, increasing over time and typically “large”
  - Strong increases may signal systemic stress
- “Large” correlations mean macro-prudential regulation required