Correlation Networks and Spatial Dependence: Theory and Applications

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Motivation and Outline

- Network analysis for financial stability and policy analysis
  - Cross-sectional and spatial dependence methods: Application of Craig and Saldías (2015) and Bailey et al. (2015)
  - Understanding structures of financial correlation networks and empirical challenges
  - Overcoming data restrictions for new insights (investor-driven comovements, pervasive factor structure)

- IMF's GFSR April applications
  - Bank regionalization
  - Mutual funds and financial stability

Banking regionalization

Global Financial Stability Report (GFSR)
Navigating Monetary Policy Challenges and Managing Risks, April 2015

CHAPTER 2

INTERNATIONAL BANKING AFTER THE CRISIS: INCREASINGLY LOCAL AND SAFER?

SUMMARY

Two developments stand out among the changes in international banking since the global financial crisis. First, direct cross-border lending as a share of total banking assets has declined, mainly because of the retrenchment of European banks. Second, the share of local lending by foreign bank affiliates has remained steady. Global banks in particular have refocused their activities on some key markets, leaving space for other banks to expand. As a result, interregional financial linkages have deepened, especially in Asia.

Although the cutback in cross-border lending was triggered by the crisis, regulatory changes and weaknesses in bank balance sheets have contributed significantly to the subsequent retrenchment. Better-capitalized banks were more likely to maintain cross-border lending. Macroeconomic factors have also played a role.

The relative shift on the part of foreign banks away from cross-border lending and toward more local lending through affiliates has a positive effect on the financial stability of host countries. Cross-border lending compounds adverse domestic and global shocks. In contrast, foreign-owned subsidiaries, particularly those with better-capitalized parent banks, tend to behave less procyclically than domestic banks around domestic crises.

In principle, international banking has benefits that are not examined in this chapter. For example, global banks contribute to the allocation of global savings across countries, with positive effects on investment and growth. The reduction in cross-border lending may diminish some of those benefits.

Policymakers should therefore strive to maximize the benefits of international banking while mitigating risks. The findings of this chapter lend support to recent financial reforms that strengthen the resilience of global banks. They also emphasize the need for more international cooperation to deal with regional or global shocks.

Mutual funds: common factors and financial stability

Global Financial Stability Report (GFSR)
Navigating Monetary Policy Challenges and Managing Risks, April 2015

CHAPTER 3

THE ASSET MANAGEMENT INDUSTRY AND FINANCIAL STABILITY

SUMMARY

Financial intermediation through asset management firms has many benefits. It helps investors diversify their assets more easily and can provide financing to the real economy as a "spare tire" even when banks are distressed. The industry also has various advantages over banks from a financial stability point of view.

Nonetheless, concerns about potential financial stability risks posed by the asset management industry have increased recently as a result of that sector's growth and of structural changes in financial systems. Bond funds have grown significantly, funds have been investing in less liquid assets, and the volume of investment products offered to the general public in advanced economies has expanded substantially. Risks from some segments of the industry—leveraged hedge funds and money market funds—are already widely recognized.

However, opinions are divided about the nature and magnitude of any associated risks from less leveraged, "plain-vanilla" investment products such as mutual funds and exchange-traded funds. This chapter examines systemic risks related to these products conceptually and empirically.

In principle, even these plain-vanilla funds can pose financial stability risks. The delegation of day-to-day portfolio management introduces incentive problems between end investors and portfolio managers, which can encourage destabilizing behavior and amplify shocks. Easy redemption options and the presence of a "first mover" advantage can create risks of a run, and the resulting price dynamics can spread to other parts of the financial system through funding markets and balance sheet and collateral channels.

The empirical analysis finds evidence for many of these risk-creating mechanisms, although their importance varies across asset markets. Mutual fund investments appear to affect asset price dynamics, at least in less liquid

Correlation networks

Related literature

- Graph theory methods: Mantegna (1999) Minimum Spanning Trees (MST), Planar Maximally Filtered Graphs (PMFG), etc.
- Multivariate time series methods: Diebold and Yilmaz (2014), Billio et al. (2012), Barigozzi and Brownlees (2013), etc.

This method

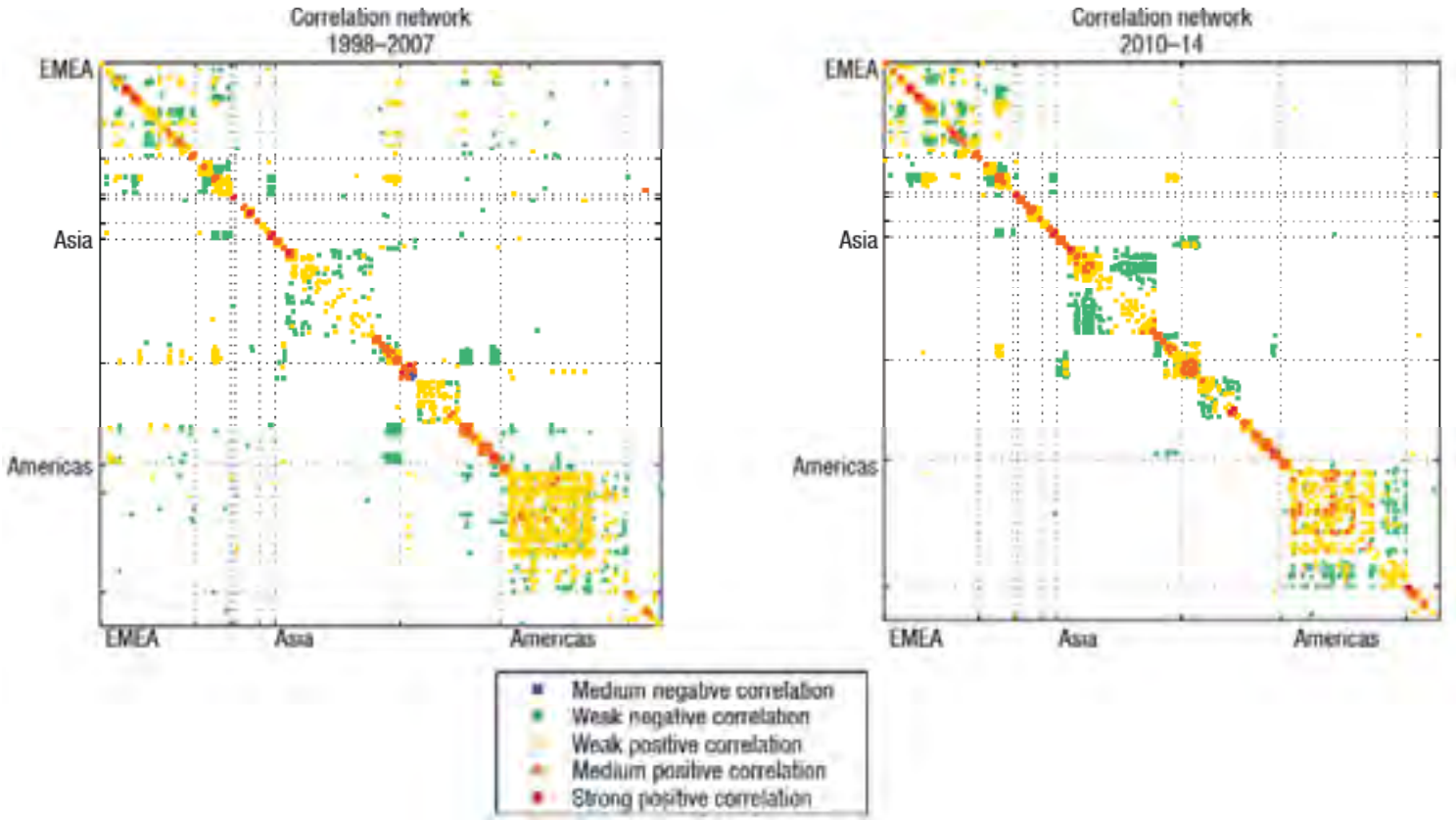
- **Cross-sectional and spatial dependence methods:**
  - Focus on the role of spatial dependence in the data and its implications in terms of interdependence
  - Strong common factors need to be detected and removed from the data in order to highlight the purely spatial dependence
  - Purely spatial dependence in an abstract sense (economic proximity) without the effect of strong common factors
  - In Craig and Saldías (2015): Spatial proximity equals similarity of business lines, common balance-sheet or market exposures, common geographical exposures, accounting practices or technological linkages.

Application 1: Banking regionalization

Sample

- Daily log-returns between Jan-1998 and Dec-2014
- 506 banks, 3 large regions, 9 WEO subregions, 62 countries, market-cap size
- Sample includes delisted, bankrupt, M&A and newly listed banks (unbalanced panel)
- PCA in two-step procedure

Banks' returns correlation network



Summary of results

- Changes in financial interconnections between pre-crisis (1998-2007) and post-crisis (2010-2014) periods
  - Clusters by countries and regions (importance of local factors)
  - Linkages within countries and within regions account for over 90 percent of total linkages in the two periods of analysis, specially post-crisis, pointing to regionalization.
  - Presence of hub banks allows for a rapid transmission of shocks across regions.

Summary of results

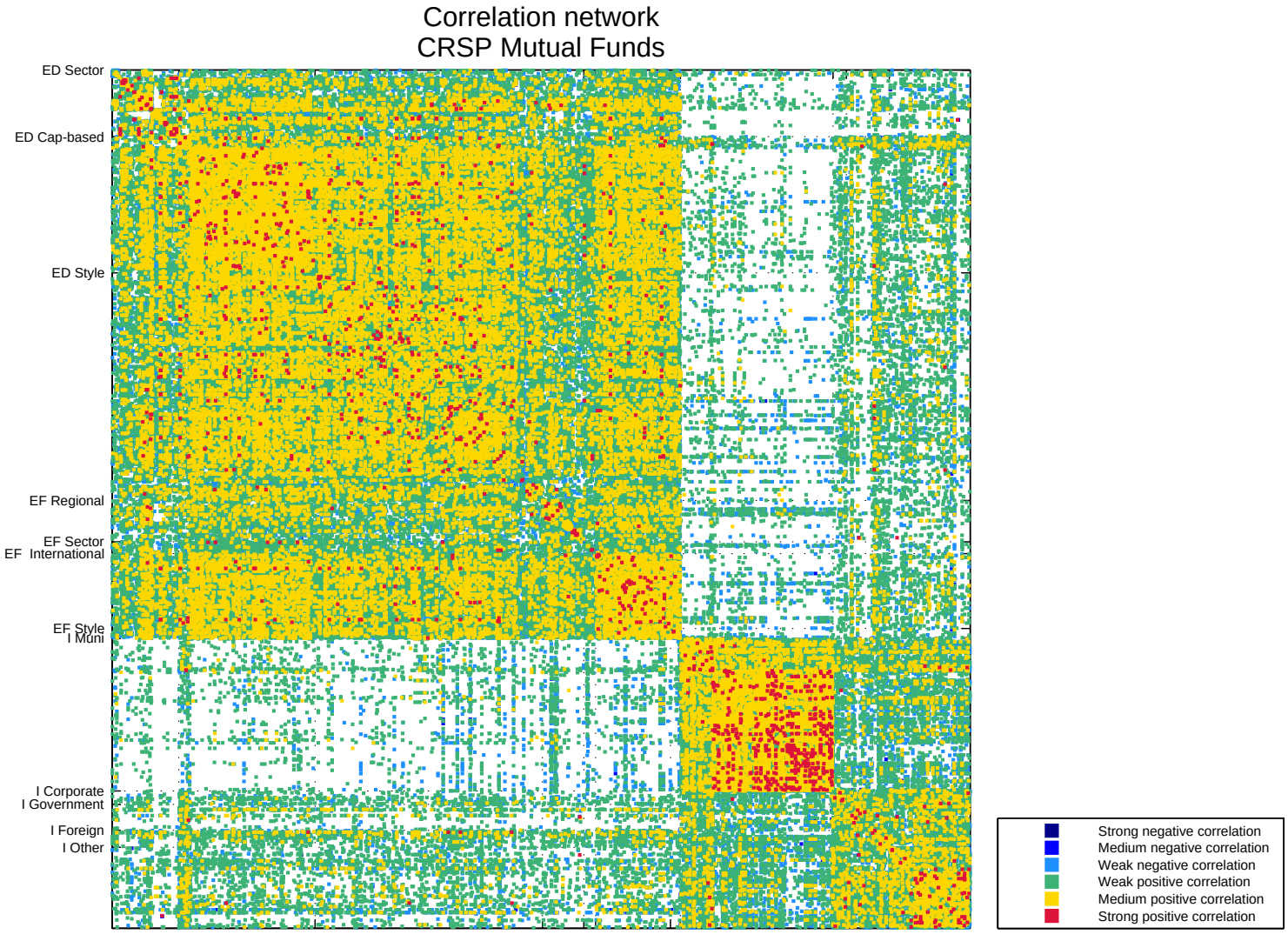
- Intraregional linkages picked up in the post crisis period in EMEA countries and especially in Asia.
  - Cross-regional linkages were stronger during the pre-crisis period (1998-2007).
  - EMEA banks main contributors to interregional interconnectedness and establishment of transmission channels
  - Regionalization of banking linkages in the post-crisis period partially reflects increased correlations at the country level, especially in Asia, but also an actual growth in the share of cross-country interconnections after the crisis.

Application 2: Mutual funds

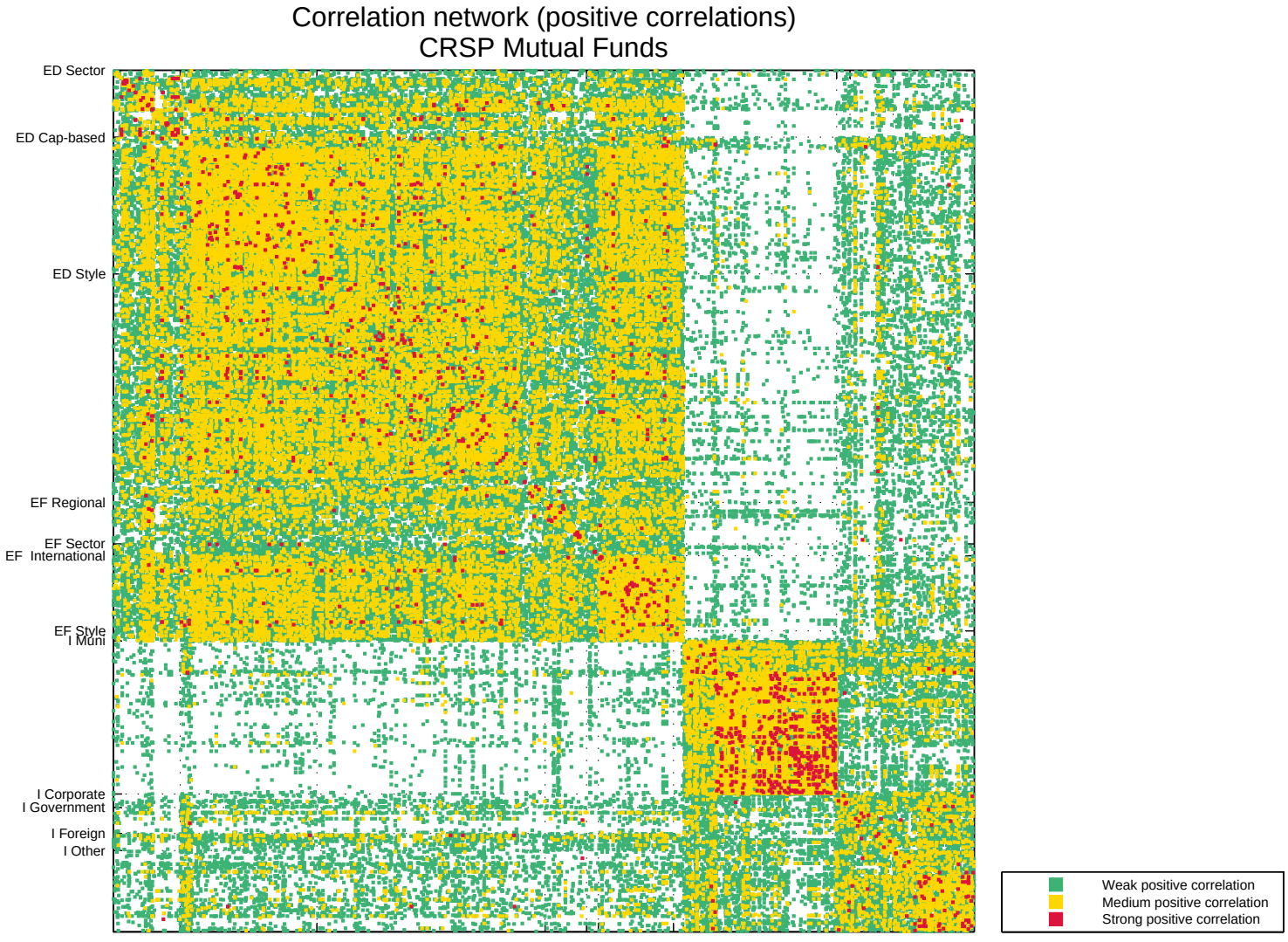
Sample

- Net Asset Value (NAV) log-returns of 2179 mutual funds (CRSP Survivor-bias-free US Mutual Fund Database) from January 2000 to September 2014
- Grouped by: 1) asset classes; 2) geographical focus; and investment style
  - Equities (E)
    - Domestic (Sector, Cap-based, Style)
    - Foreign (Sector, Cap-based, Style)
  - Fixed Income (I)
    - Muni,Government, Corporate, Foreign, Other
- Balanced sample, filtered from illiquid funds, each fund group represented by the asset class with the largest total net assets at the end of the sample.
- Strong common factors approximated by cross-section averages using the four levels of aggregation.

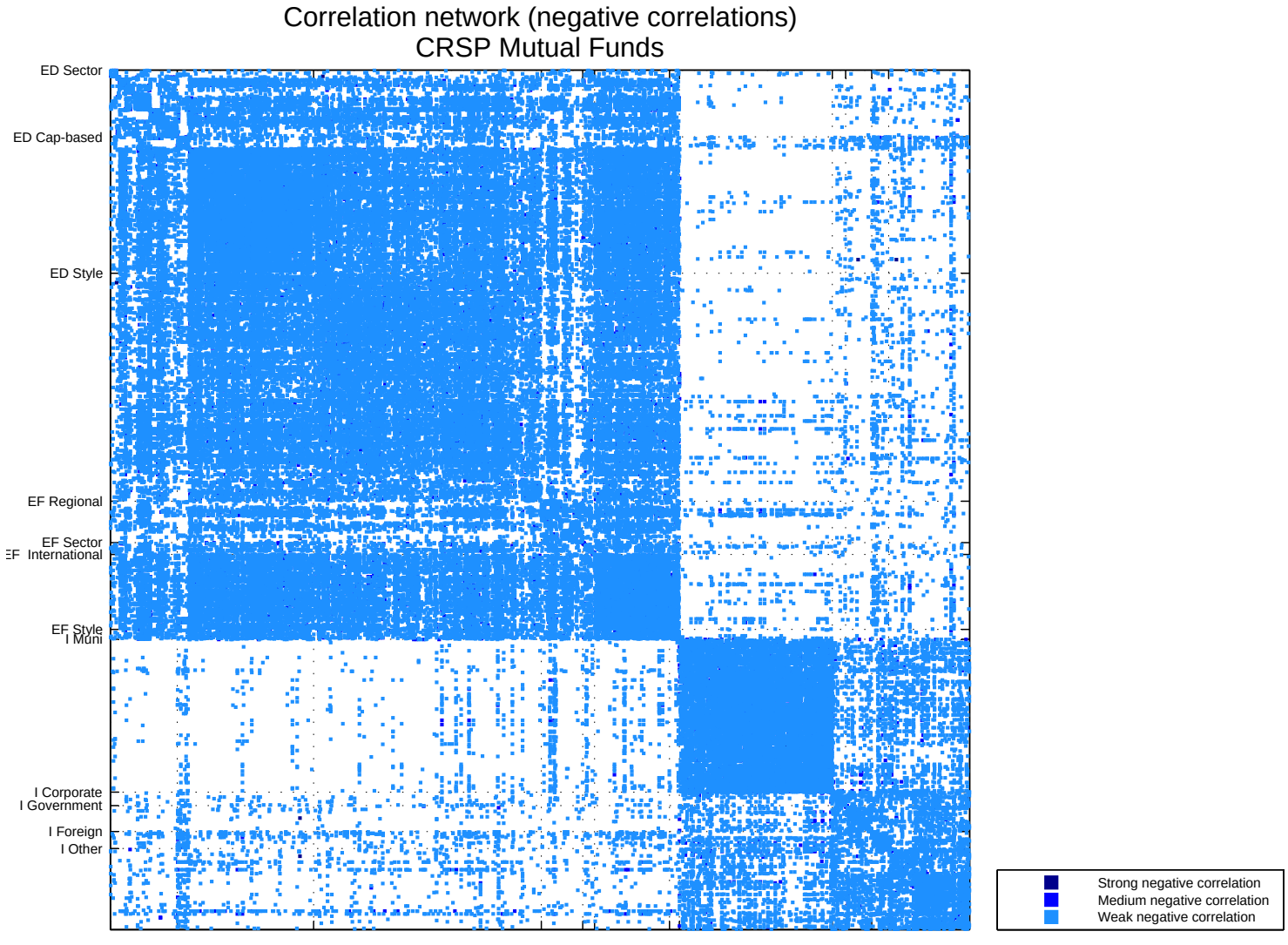
Mutual funds correlation network



Mutual funds: common factors and financial stability



Mutual funds: common factors and financial stability



Network metrics

	Size	Density	Diameter	Average Path Length	Average Degree	Assortativity Coefficient	Clustering Coefficient
Network	2179	6.32%	6	2.24	137.6	0.248	0.36
ED Sector	169	9.59%	5	2.46	16.1	0.099	0.42
ED Cap-based	346	20.41%	5	1.88	70.4	0.180	0.49
ED Style	578	11.40%	6	2.01	65.8	0.078	0.35
EF Regional	105	18.00%	4	2.02	18.7	0.125	0.41
EF Sector	30	13.79%	7	2.91	4.0	0.352	0.52
EF International	190	22.34%	5	1.85	42.2	0.013	0.47
EF Style	25	31.33%	3	1.80	7.5	-0.154	0.41
I Muni	388	22.79%	4	1.80	88.2	0.176	0.46
I Corporate	34	24.60%	4	1.96	8.1	0.127	0.38
I Government	66	13.66%	4	2.23	8.9	0.066	0.30
I Foreign	43	21.93%	4	2.04	9.2	0.156	0.37
I Other	205	12.46%	6	2.14	25.4	0.195	0.37

Density heatmap

	ED Sector	ED Cap-based	ED Style	EF Regional	EF Sector	EF International	EF Style	I Muni	I Corporate	I Government	I Foreign	I Other
ED Sector	9.6	8.5	6.6	4.5	5.7	8.8	9.5	0.4	1.1	0.7	2.1	1.2
ED Cap-based		20.4	11.2	6.5	6.8	15.6	14.8	0.6	2.0	1.4	3.6	1.8
ED Style			11.4	4.6	5.4	11.0	10.3	0.4	1.4	0.8	2.7	1.4
EF Regional				18.0	5.7	9.8	9.9	0.9	1.2	0.7	2.6	0.8
EF Sector					13.8	7.0	8.7	1.1	1.2	0.2	2.0	0.8
EF International						22.3	18.9	0.6	1.2	1.0	4.2	1.5
EF Style							31.3	0.8	1.3	0.6	3.2	1.2
I Muni								22.8	3.2	3.0	3.4	3.9
I Corporate									24.6	6.9	5.6	8.9
I Government										13.7	5.1	7.0
I Foreign											21.9	6.1
I Other												12.5

Summary of results

- Great degree of interconnectedness both within and across different asset classes and investment styles
- Overlapping portfolio composition determines high interconnectedness in the mutual fund industry and may curb diversification benefits
  - Style box effect, indexation
  - Not possible to eliminate strong CSD
- International propagation of shocks is still more likely within asset classes

Thank you for your attention

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