Interconnectedness in the Caribbean Regional Financial System:

Preliminary Results from the Caribbean Regional Financial Project (CRFP)

Elie Canetti – International Monetary Fund

Agenda

I. Project Objectives

II. Data Issues

III. Interconnectedness
   A. Cross-Border Claims
   B. Network Maps

IV. Credit and Liquidity Shocks

V. Next Steps

I. Project Objectives [1/]

- To identify factors creating financial stability risks due to **interconnections** involving ownership, common funding channels and exposures to regional sovereigns and corporates
- To determine the level of resilience of the regional financial system to key **macroeconomic shocks**
- To strengthen the current policies and practices of the **financial stability framework**, including regional supervision and crisis management and resolution

1/ From Terms of Engagement, Caribbean Regional Financial Project, 6/18/13

II. Data Issues

- Design Considerations
  - Level of Aggregation
  - Respondents
  - Data Choices
- Actual Data Template
- Data Quality Issues

Design Considerations

Level of Data Aggregation – Institutions or Aggregates?

Question: Report Data at Institutional or Aggregate Level?

Choice: Aggregate (By Country/Sector)

Determining Factor: Confidentiality Concerns

Details:

- Could Supervisors Share Individual Institution Data with IMF?
  - Yes, Given IMF's Confidentiality Framework (data may need to be coded)
- Could Supervisors Share Counterparty Information
  - With Other Supervisors?
  - With IMF?

Design Considerations

Respondents - Whose Data?

Question: Which Institutions to Survey?

Choice: Banks and Insurers

Determining Factor: Practicality, Cost of Collection and Lack of Jurisdiction

Details

- Institutions Not Surveyed Directly:
  - Credit Unions
  - Securities Companies
  - Finance Companies
  - Offshore Banks
  - Non-Financial Companies

Design Considerations:

Data Choices - Risk Concept

Question: On Which Risk Basis to Collect Data?

Choice: Immediate Risk

Determining Factor: Final Risk Basis May Not be Available

Details:

- Final Risk Basis
  - Nets out Collateral
  - Nets out "Risk Transfers" (Guarantees, Hedges)
  - Extremely Difficult to Measure
    - Degree of Risk Transfer May Be Contingent on Circumstances

Design Considerations

Data Choices - Which Data?

Question: Which Specific Data to Collect?

Choice: See Below

Determining Factor: Cost of Collection, Concern that Excessive Complexity Would Increase Errors

Details:

- Disaggregated Exposure Data
  - Assets
  - Liabilities and Equity
- Balance Sheet Data

Design Considerations:

Data Choices – "Crossings"

Question: How Many Data Crossings To Collect?

Determining Factor: More Crossings Imply Exponentially More Data [1/]

Choice:

- By Sector - Yes
- By Country
  - Yes, for banks, insurers, sovereigns
  - No, for non-financial private sector
- By Instrument
  - Loans and Debt Securities
  - Deposits
  - Equity (both shares and direct ownership stakes)
- Currency - No
- Maturity - No

1/ Note a 5-way crossing with x categories in each would require x^5 separate data entries per institution

Design Implications: Drawbacks

- Aggregate Data Misses a Lot
  - Financial Crises Associated with Individual Institution Failures
    - Knickerbocker Trust – Panic of 1907
    - Long-Term Asset Management - 1998
    - Lehman Brothers and Bear Stearns – GFC, 2007-09
    - Clico - CL Financial Crisis, 2009
  - Aggregate Data May Mask Individual Institutional Weaknesses
  - Simulations Unrealistic, Shocks Need to be Large
- Incomplete Data "Crossings" Miss Some Risks
  - No currency crisis simulations
- Immediate Risk Basis misses Risk Transfers
  - Risk transfer may be limited in Caribbean

Data Template - Terminology

- Node – The unit of analysis
- Network Nodes
  - In the CRFP, the 18 nodes consisting of the bank sector and insurance sector for each of 8 countries + the ECCU
  - A network node can both be the source of, and recipient of, contagion
- Network (or "System") – The collective of all the network nodes
- Trigger Nodes – A Node Outside the System
  - A trigger node can only be the source of contagion (i.e. feedback effects are discounted)
  - Includes sovereigns, global financial sector, and private sector other than network nodes
  - In principle, trigger nodes could have been included as part of the system (thus becoming network nodes) had we collected data from them
- Global Sectors – As used in CRFP template, sovereigns, banks and insurers outside of the core 8 countries + ECCU

NETWORK NODES		DATA COLLECTED ON EACH NETWORK NODE		
Participating Countries	Participating Institutions	Within Network Claims on/ Liabilities/Equity To Disaggregated by Network Country	Global Claims on/ Liabilities/Equity To Disaggregated by Global Region	Exposures to Other Sectors Claims on No disaggregation by country/region
ECCU	Banks	Claims	Claims	*Tourism*
The Bahamas		*Sovereigns*	*Sovereigns*	*Oil/Energy*
Barbados		**Banks ***	*Banks*	*Construction*
Belize		**Insurers***	*Insurers*	*Real Estate*
Guyana	Insurers	Liabilities To/Equity Held By	Liabilities To/Equity Held By	*RRE* / *CRE* *Households*
Haiti				
Jamaica		*Sovereigns*	*Sovereigns*	*Central Banks*
Suriname		**Banks ***	*Banks*	*Offshore banks*
Trinidad and Tobago		**Insurers***	*Insurers*	*Credit Unions* *Other NBFIs*

Key

Connections to Other Network Nodes*

Connections to Trigger Nodes

Data Quality

- Internal Consistency Checks
  - There were some internal inconsistencies in country's submissions.
- "Smell Tests"[1/]
  - Some numbers simply appear to small or large to be plausible
- Cross-Matching Claims Against Counterpart Liabilities
  - One country's claims on another country can be cross-checked by looking at the second country's liabilities to the first country
  - Note that less than full responses from a country's banks and insurers can introduce inconsistencies

1/ Some *ad hoc* adjustments were made for interconnectedness maps, but not for tables

Data Matching Was Poor

Asset-Liability Discrepancies

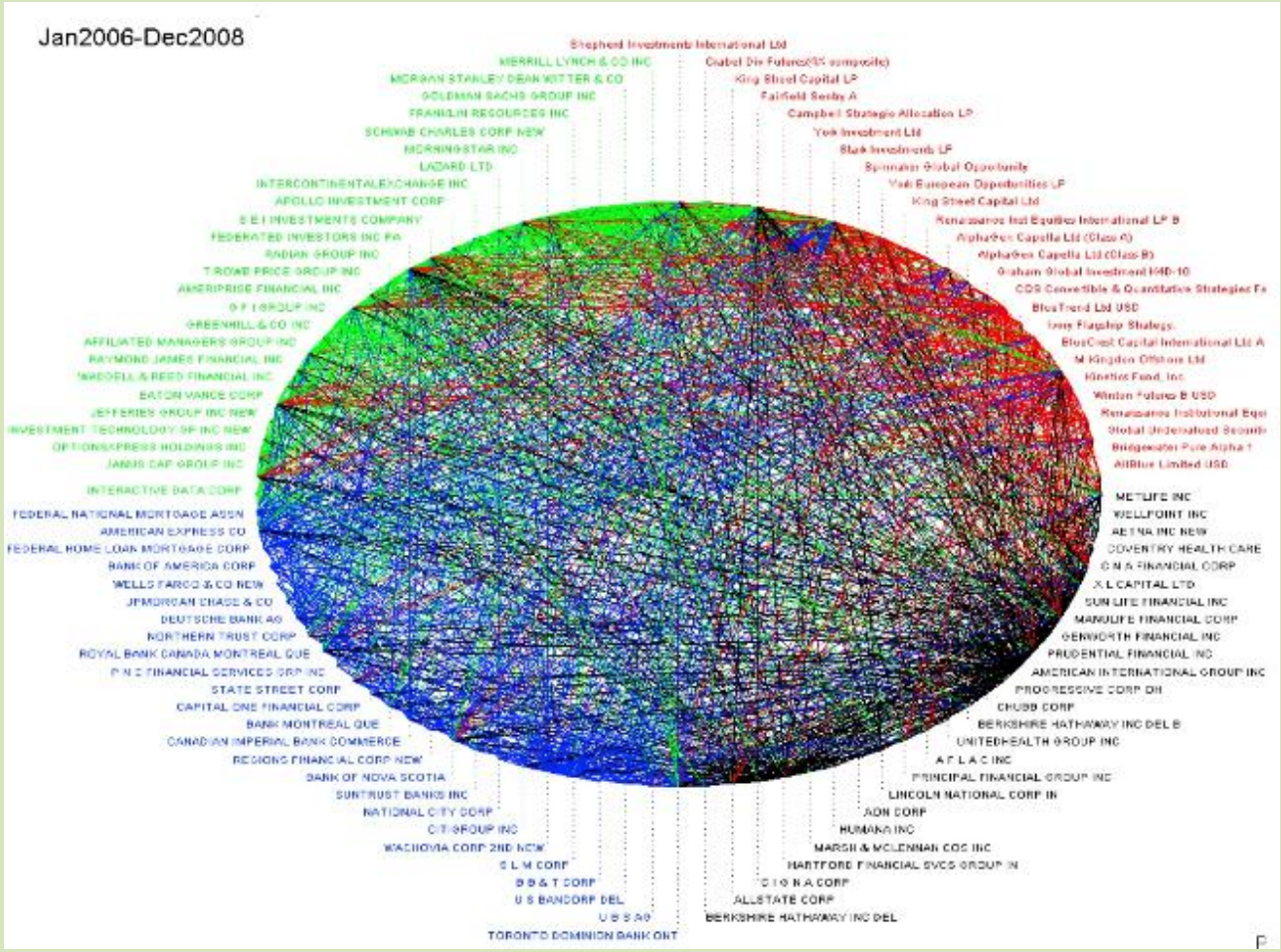
Claims Of			Banks									Insurers								
			BRB	BLZ	GUY	HTI	JAM	SUR	BHS	TTO	ECCU	BRB	BLZ	GUY	HTI	JAM	SUR	BHS	TTO	ECCU
Banks		BRB		.	100	.	93	.	39	93	49		.	.	.	.	.	.	.	76
		BLZ	100		.	.	.	.	.	100	100	78		.	.	.	.	.	.	.
		GUY	100	.		.	38	.	.	100	100	100	.		.	.	.	.	100	61
		HTI	.	.	.		.	.	.	.	.	.	.	.		.	.	.	.	.
		JAM	100	.	.	.		.	99	100	91	.	.	.	.		.	.	.	.
		SUR	.	.	.	.	.		.	100	100	.	.	.	.	.		.	.	.
		BHS	100	.	.	.	62	.		.	75	100	.	.	.	.	.		.	.
		TTO	100	100	11	.	95	.	100		79	100	.	.	.	39	.	.		100
		ECCU	80	.	.	100	26	.	100	82		100	.	.	.	.	.	.	.	
Insurers		BRB		.	100	100	.	.	100	100	100		.	100	.	100	.	100	88	100
		BLZ	.		.	.	.	.	.	.	.	.		.	.	.	.	.	.	.
		GUY	.	.		.	.	.	.	.	.	100	.		.	.	100	.	100	100
		HTI	.	.	.		.	.	.	.	.	.	.	.		.	.	.	.	.
		JAM	100	.	.	.		.	.	.	100	100	.	.	.		.	.	.	.
		SUR	.	.	.	.	.		.	.	.	.	.	.	.	.		.	.	.
		BHS	.	.	.	.	.	.		.	.	100	.	.	.	.	.		.	.
		TTO	100	100	100	.	100	.	100		100	100	.	.	.	100	.	.		100
		ECCU	.	.	.	.	.	.	.	.		100	.	.	.	.	.	.	100	

Green: discrepancy is below 25 percent in absolute value
Yellow: discrepancy is from 25 to 50 percent in absolute value
Red: discrepancy is greater than 50 percent in absolute value
Grey: both claims and liabilities are zero

Note: discrepancies are on a scale from 0 - 100. In comparing claims and corresponding liabilities, the greater of the two was used as the denominator

Note: The Bahamas, the ECCU and Haiti did not report insurance data.

III. Interconnectedness

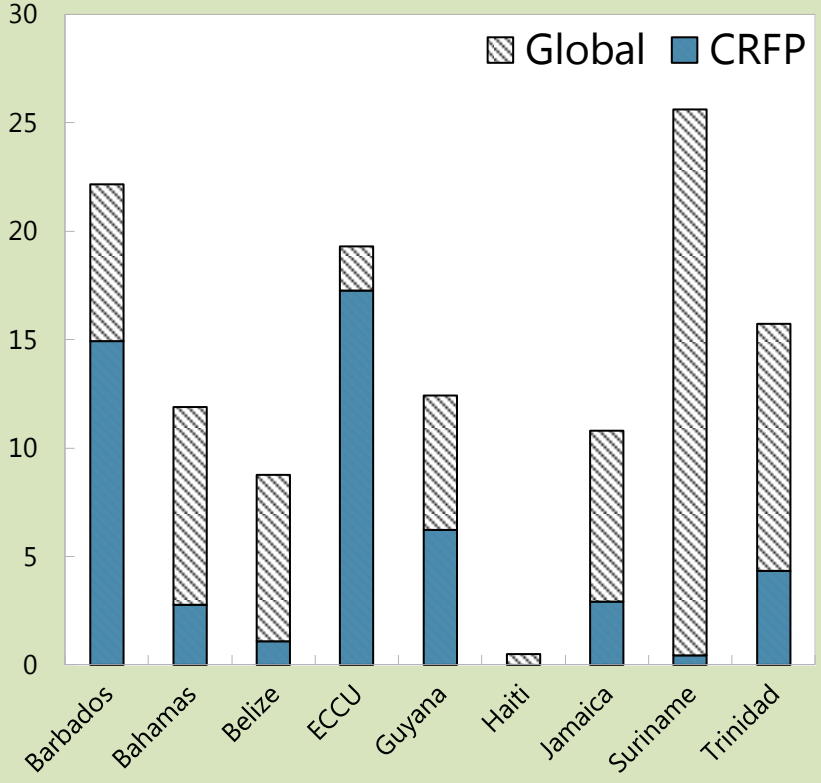


Source: “Econometric Measures of Connectedness and Systemic Risk in the Finance and Insurance Sectors”, by Monica Billio, Andrew Lo, Mila Getmanksy Sherman and Loriana Pelizzon, 11/1/11

III A. Cross-Border Claims

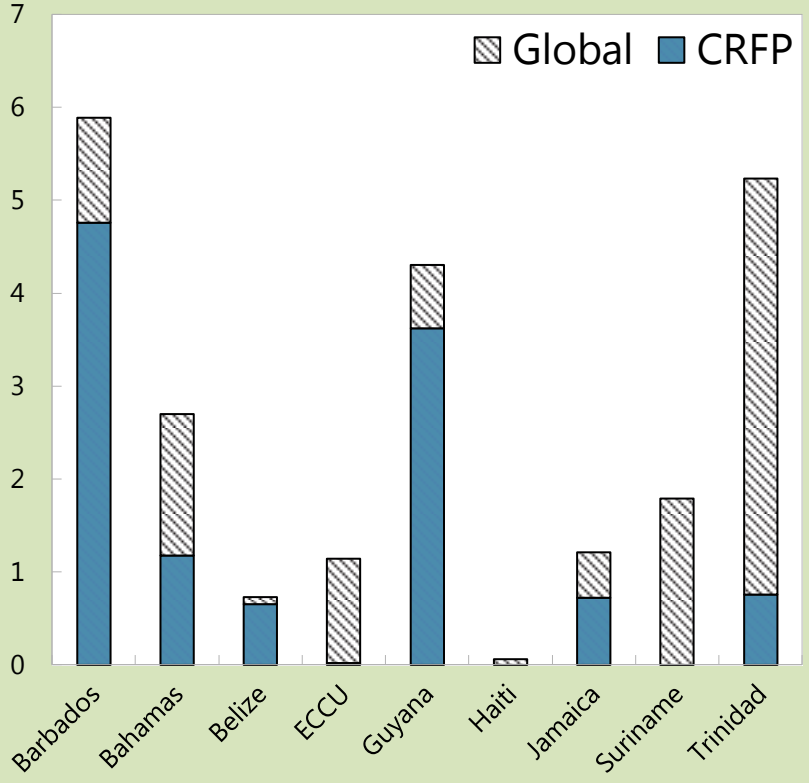
(By Network Node versus Global, percent of assets)

Total Cross-border Claims 1/
(Percent of total assets)



1/ Excludes claims on non-financial private sector

Total Cross-border Claims on Sovereigns 1/
(Percent of total assets)



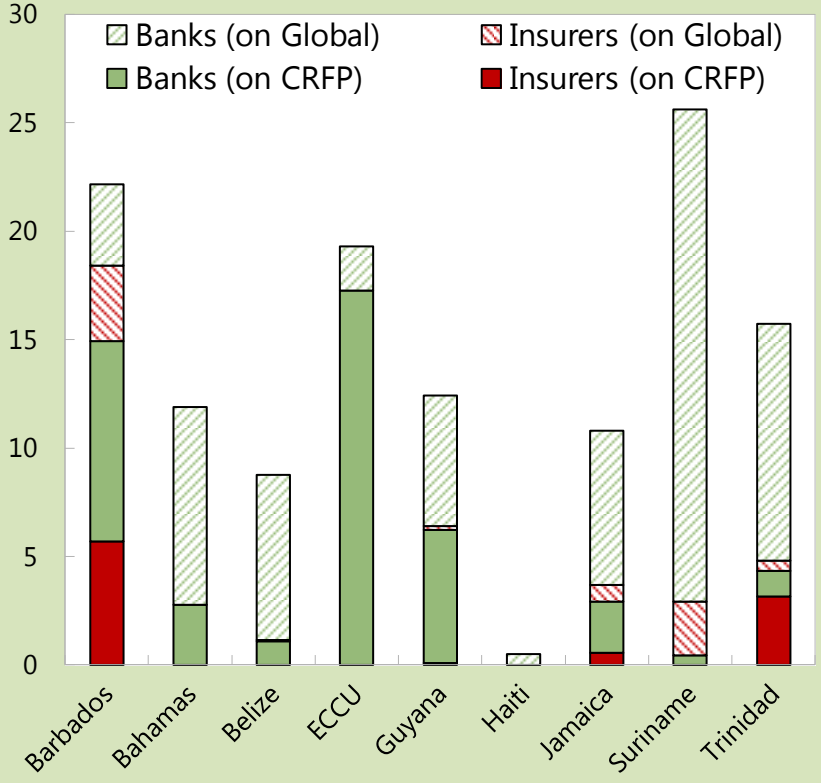
1/ Excludes claims on non-financial private sector

Cross-Border Claims

(By Network Node versus Global, percent of assets, Banks and Insurers)

Total Cross-border Claims 1/

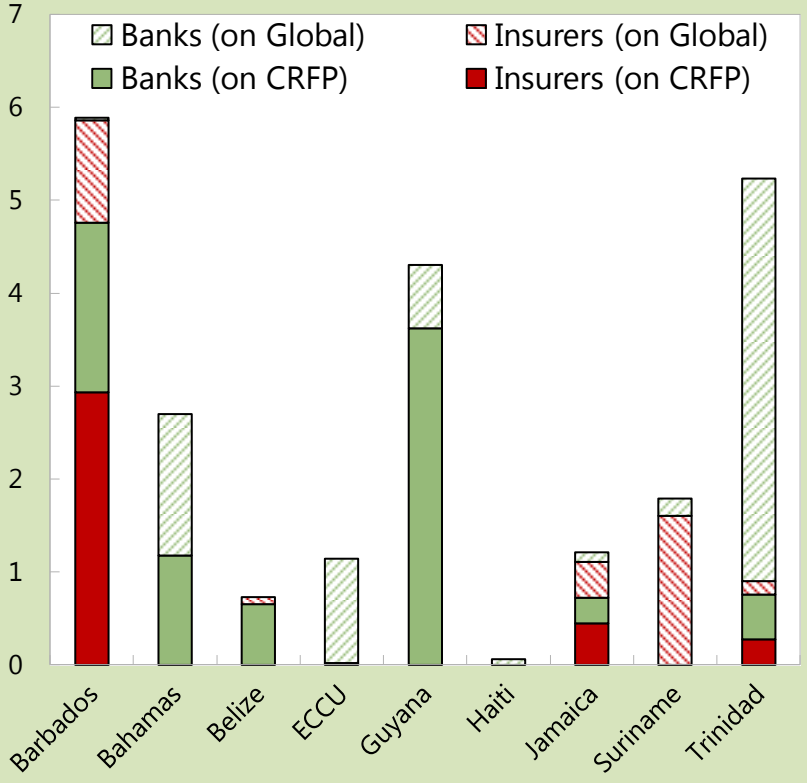
(Percent of total assets)



1/ Excludes claims on non-financial private sector

Total Cross-border Claims on Sovereigns 1/

(Percent of total assets)

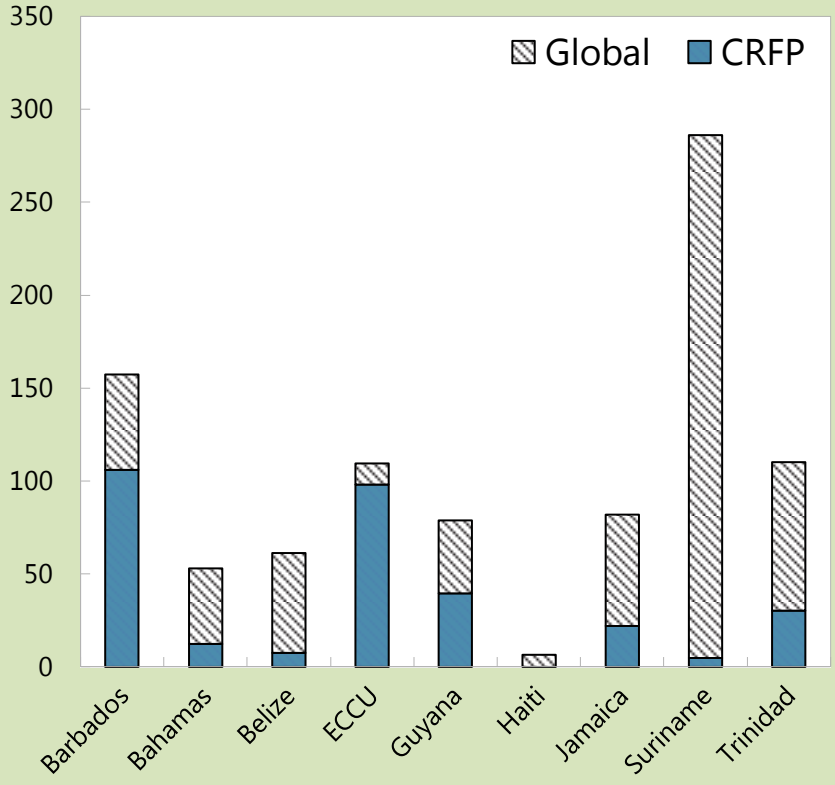


1/ Excludes claims on non-financial private sector

Cross-Border Claims

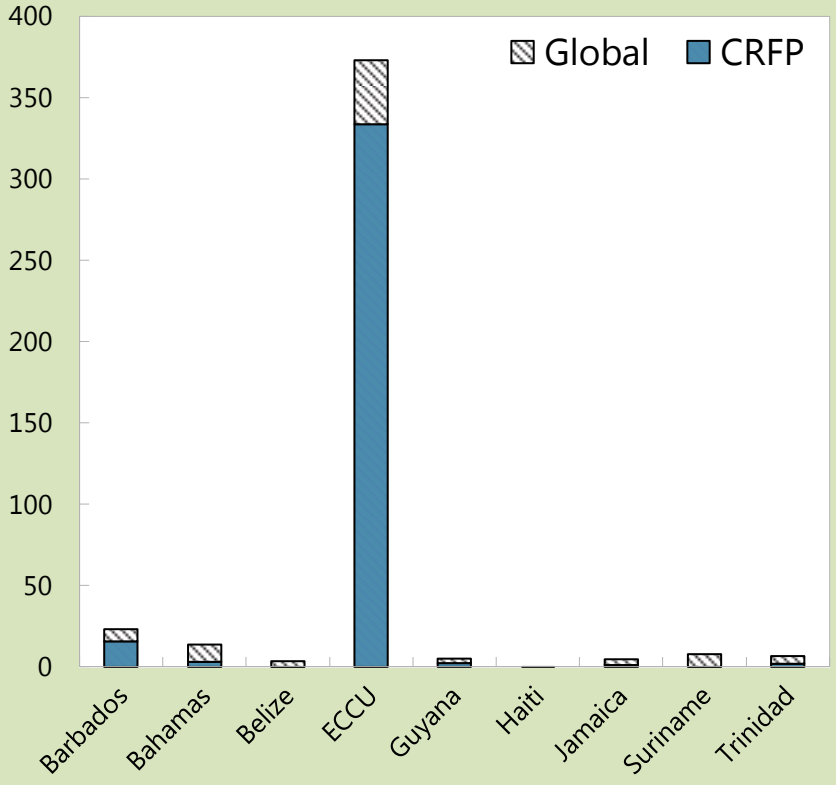
(By Network Node versus Global, percent of capital and GDP)

Total Cross-border Claims 1/
(Percent of total capital)



1/ Excludes claims on non-financial private sector

Total Cross-border Claims 1/
(Percent of GDP)

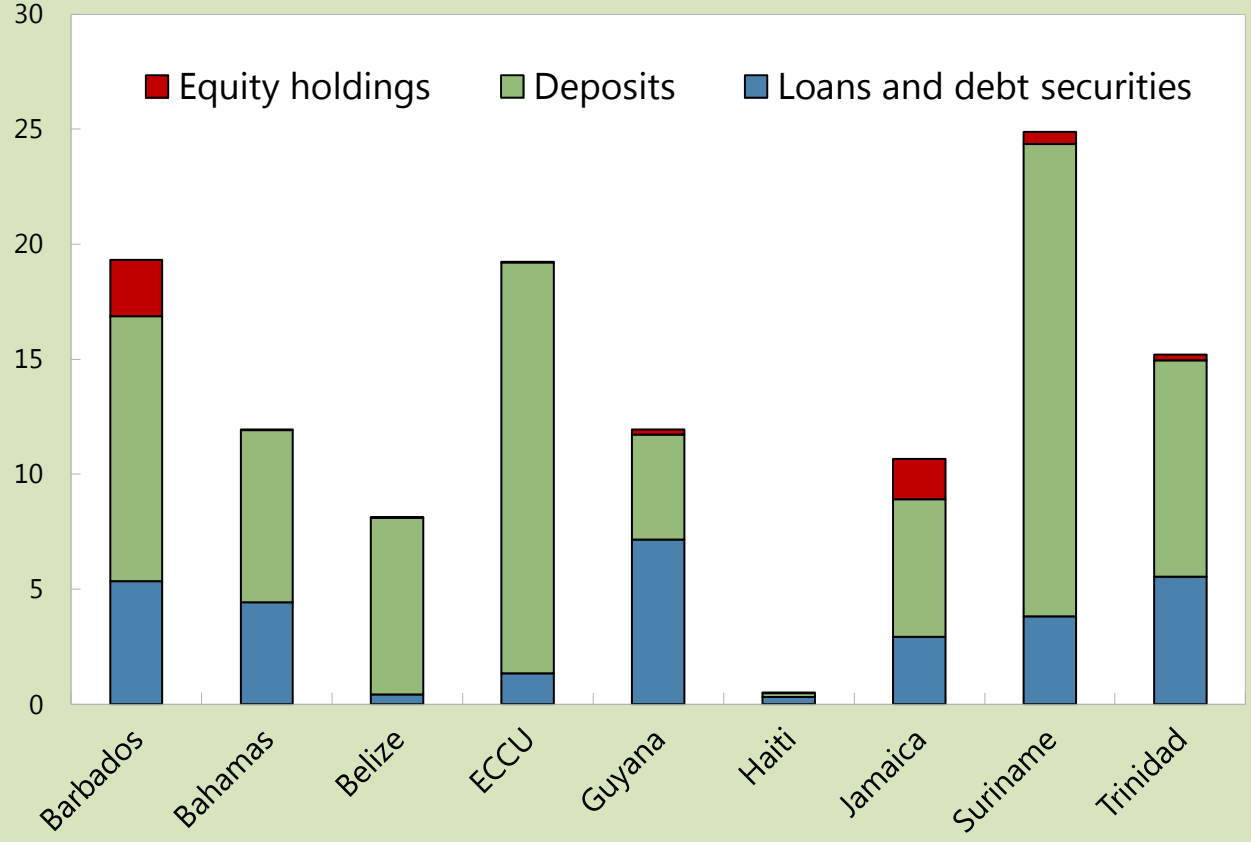


1/ Excludes claims on non-financial private sector

Cross-Border Claims

(By Instrument, percent of assets)

Total Cross-border Claims by type 1/
(Percent of total assets)

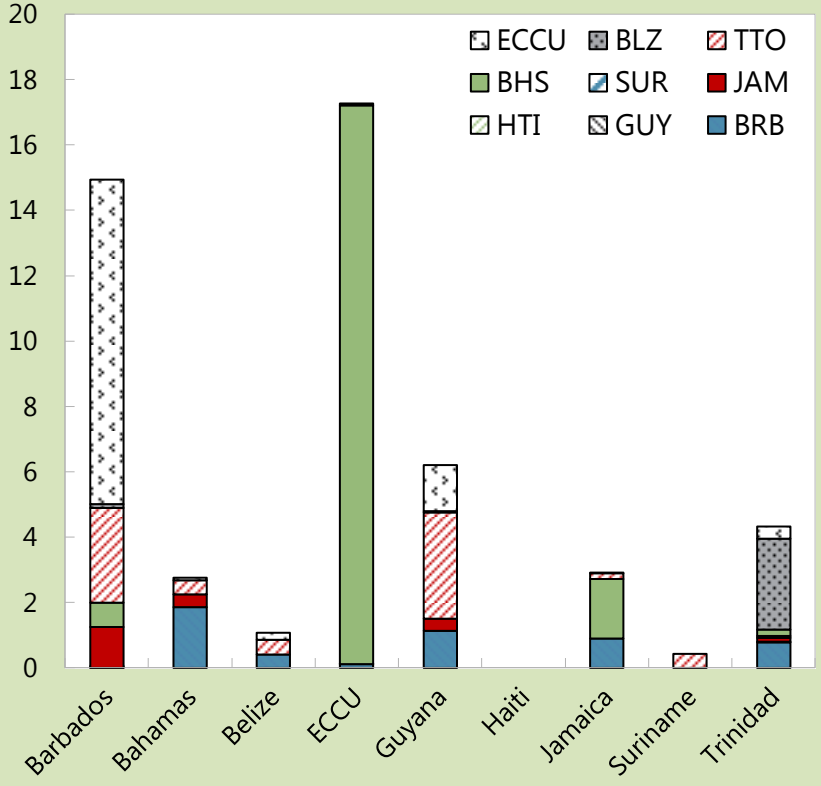


1/ Excludes claims on non-financial private sector

Total Cross-Border Claims

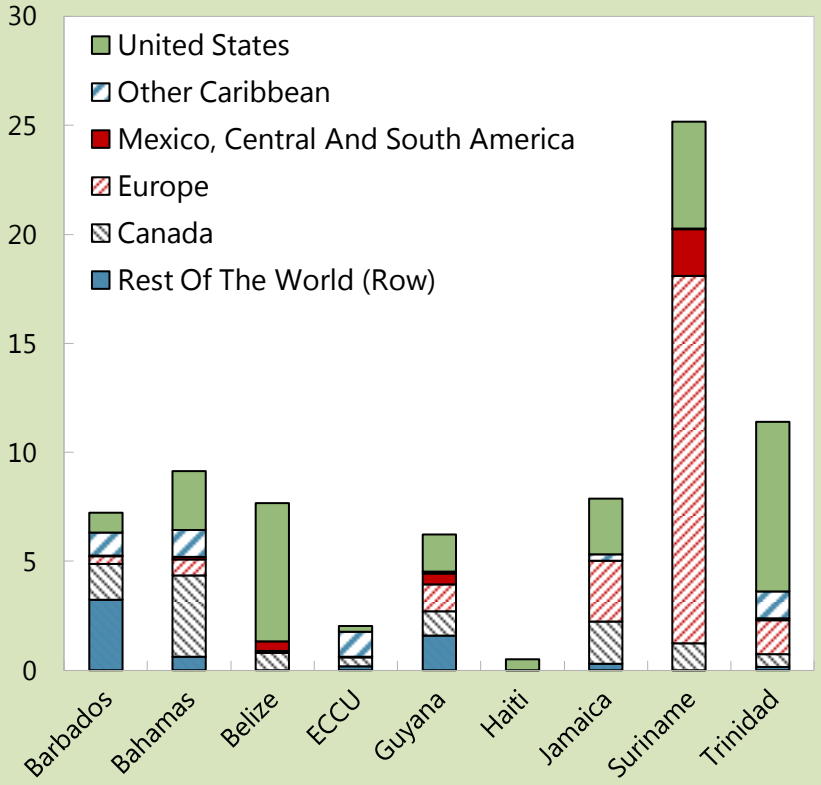
(By Counterparty, percent of assets)

Total Cross-border Claims on CRFP Nodes 1/
(Percent of total assets)



1/ Excludes claims on non-financial private sector

Total Cross-border Claims on Global Sectors 1/

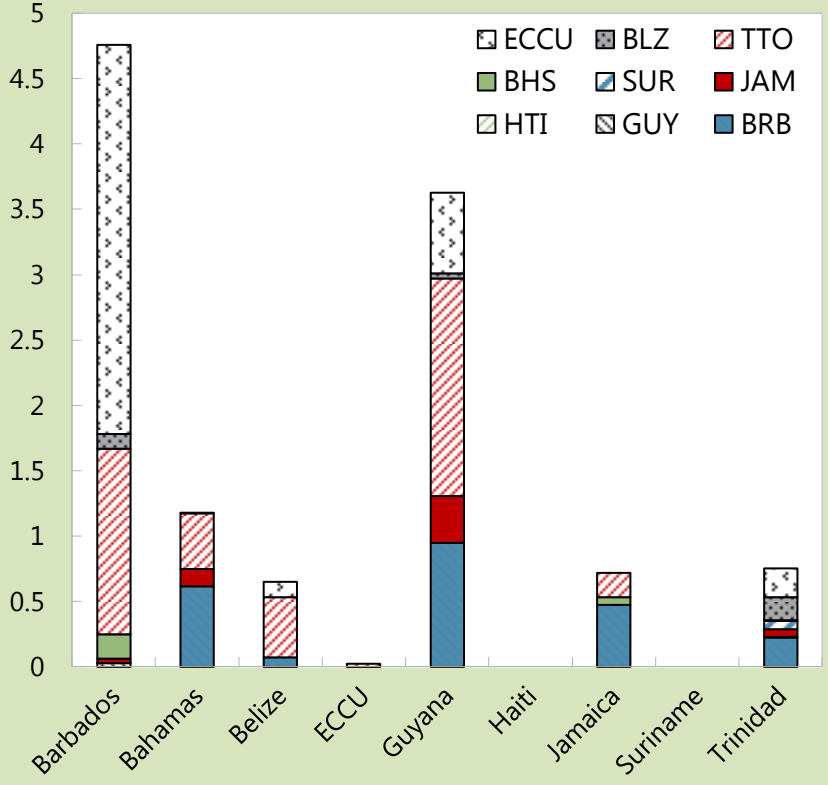


1/ Excludes claims on non-financial private sector

Total Cross-Border Claims on Sovereigns

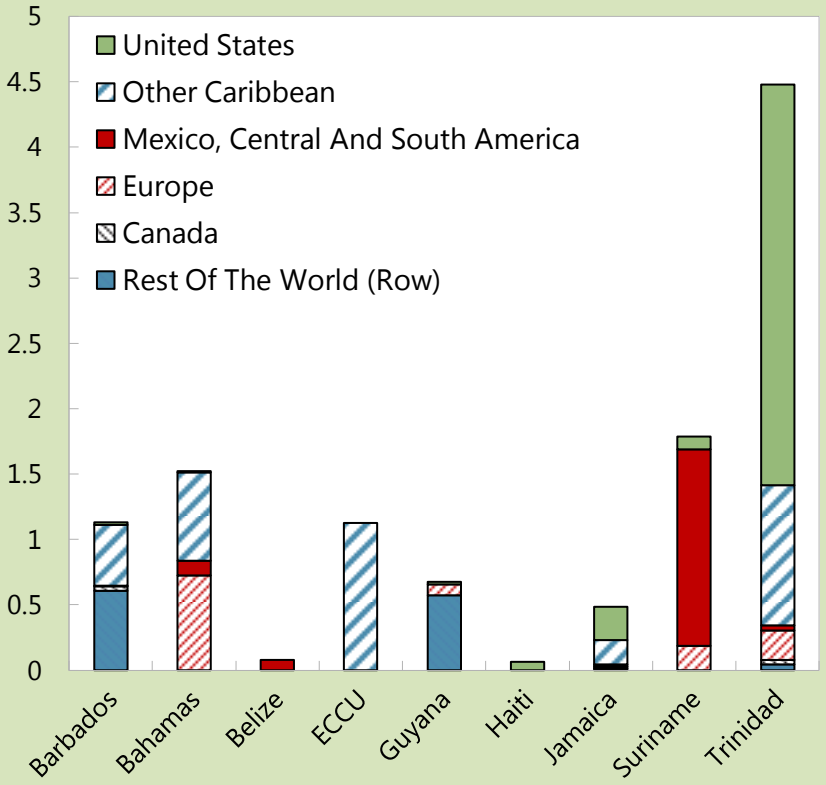
(By Counterparty, percent of assets)

Total Cross-border Claims on CRFP Sovereigns 1/



1/ Excludes claims on non-financial private sector

Total Cross-border Claims on Global Sovereigns 1/



1/ Excludes claims on non-financial private sector

III B: Interconnectedness

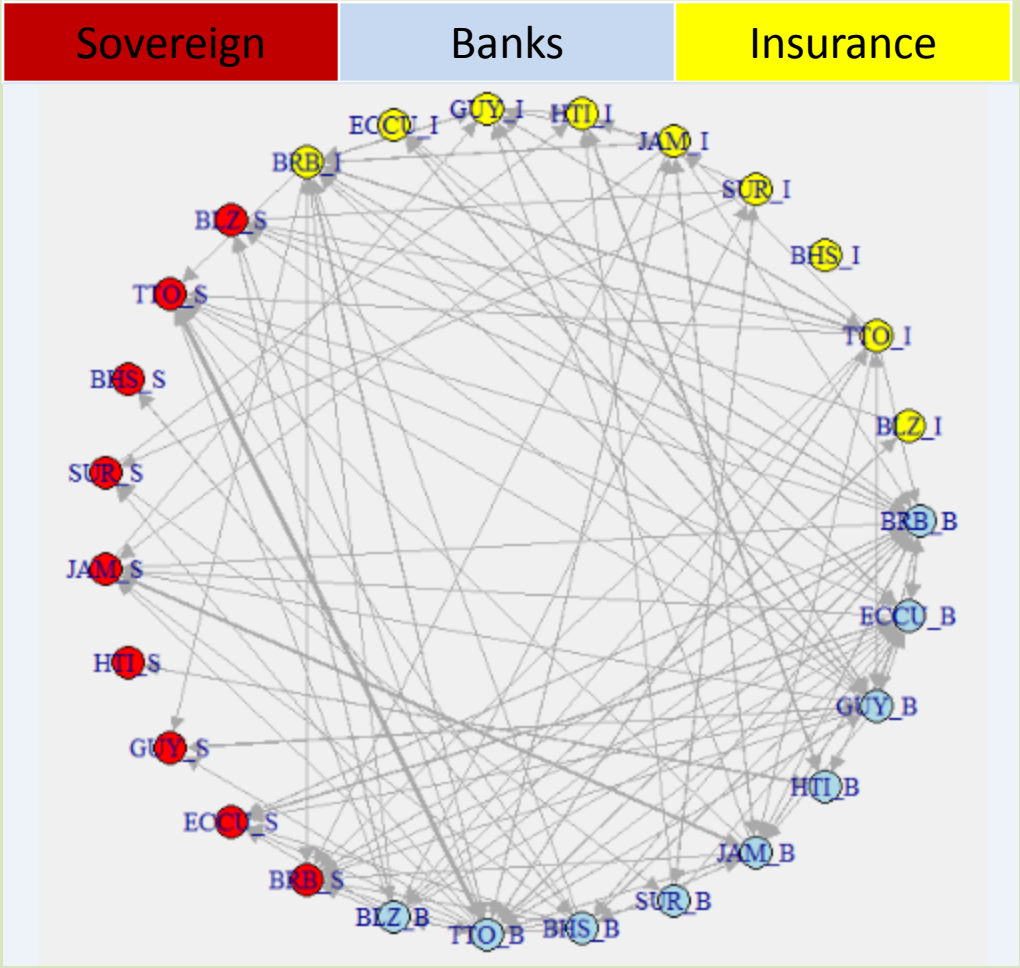
Network Maps:Basic Concepts

- Eigenvalue – Measures the influence (systemic connectedness) of a node in a system.
  - Centrally located among other nodes that are connected with lots of connections, and large connections (i.e. large balance sheet links).
- Cluster (Clique) – A cluster is a subset of nodes in which each has bilateral connections to each other node in the cluster.
- Betweenness – Measures the centrality of a node by totaling the number of times a node acts as a bridge along the shortest path between two other nodes
  - In other words, it is a measure of how important that node is as a financial intermediary within the system)
- Closeness – Measures the number of total steps required to connect that node to all other nodes in the system

Note, closeness does not take into account the size of bilateral connections (i.e. the size of claims between nodes).

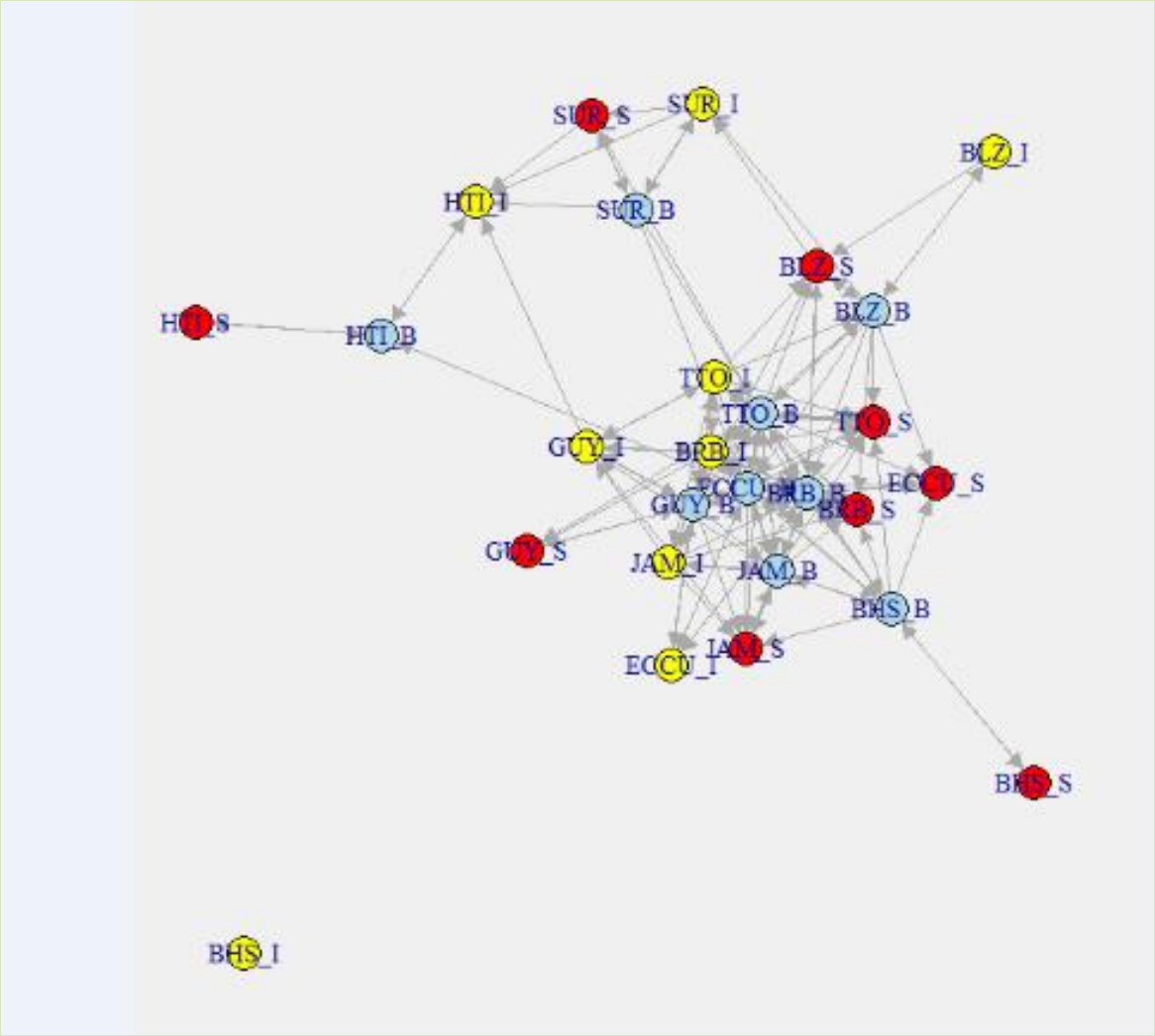
Total network

(Cross-border, Total Gross Asset Claims)



Note: As “trigger nodes”, sovereigns only show “claims on” connections. Banks and Insurers show “claims on” and “liabilities to and equity held by”

Total Network
(with like nodes adjacency)



Network Metrics

(Banks, Insurers and Sovereigns)

Rankings	Eigenvalue	Betweenness	Closeness
1	JAM	JAM	TTO
2	JAM	TTO	JAM
3	BRB	GUY	BLZ
4	BRB	TTO	JAM
5	BRB	ECCU	ECCU
6	ECCU	JAM	HTI
7	TTO	BRB	TTO
8	HTI	BLZ	GUY
9	BHS	GUY	GUY
10	HTI	BLZ	BRB

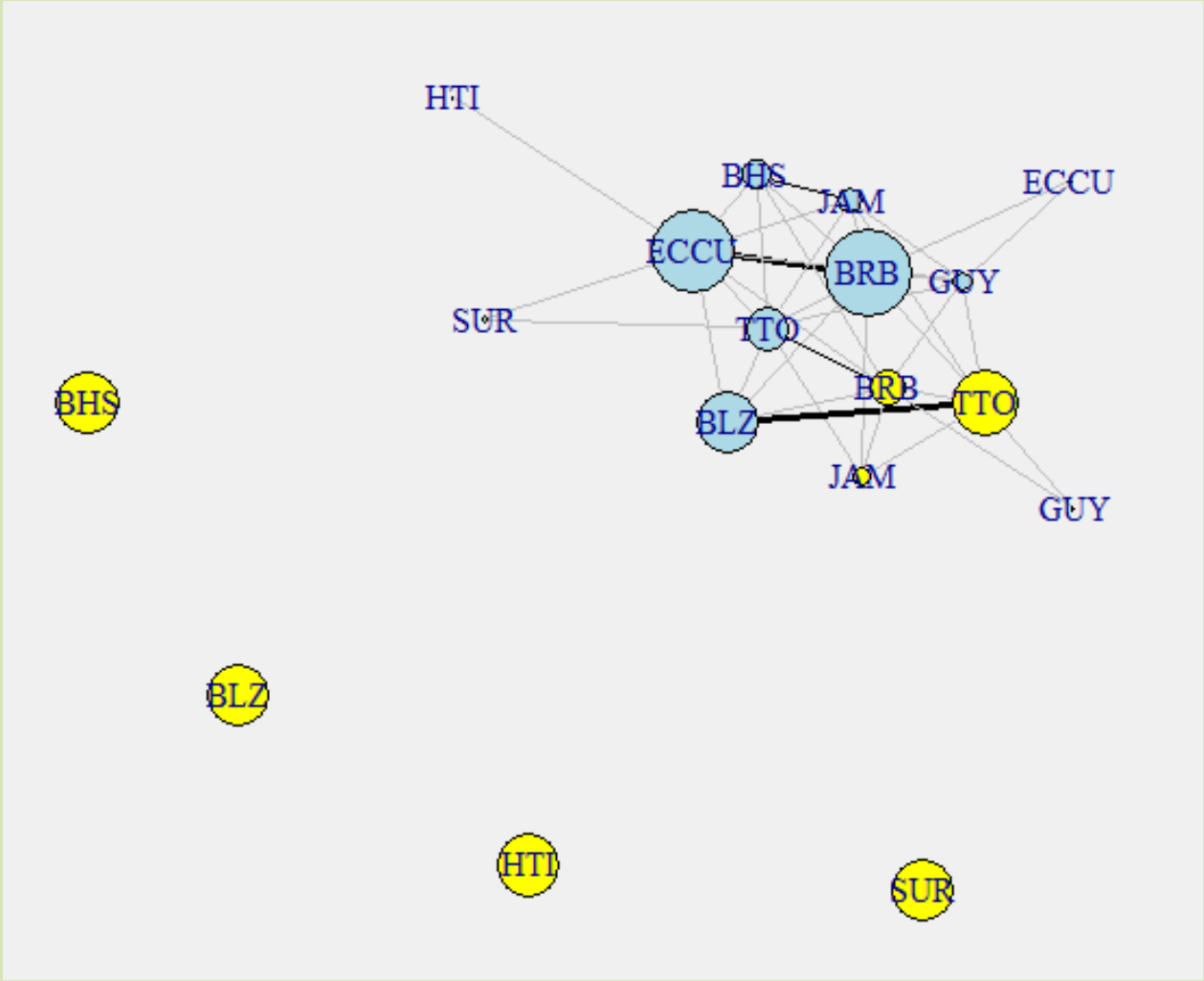
Bank

Sovereign

Insurance

Bank - Insurer network

(Bubble Size Represents Eigenvalue)

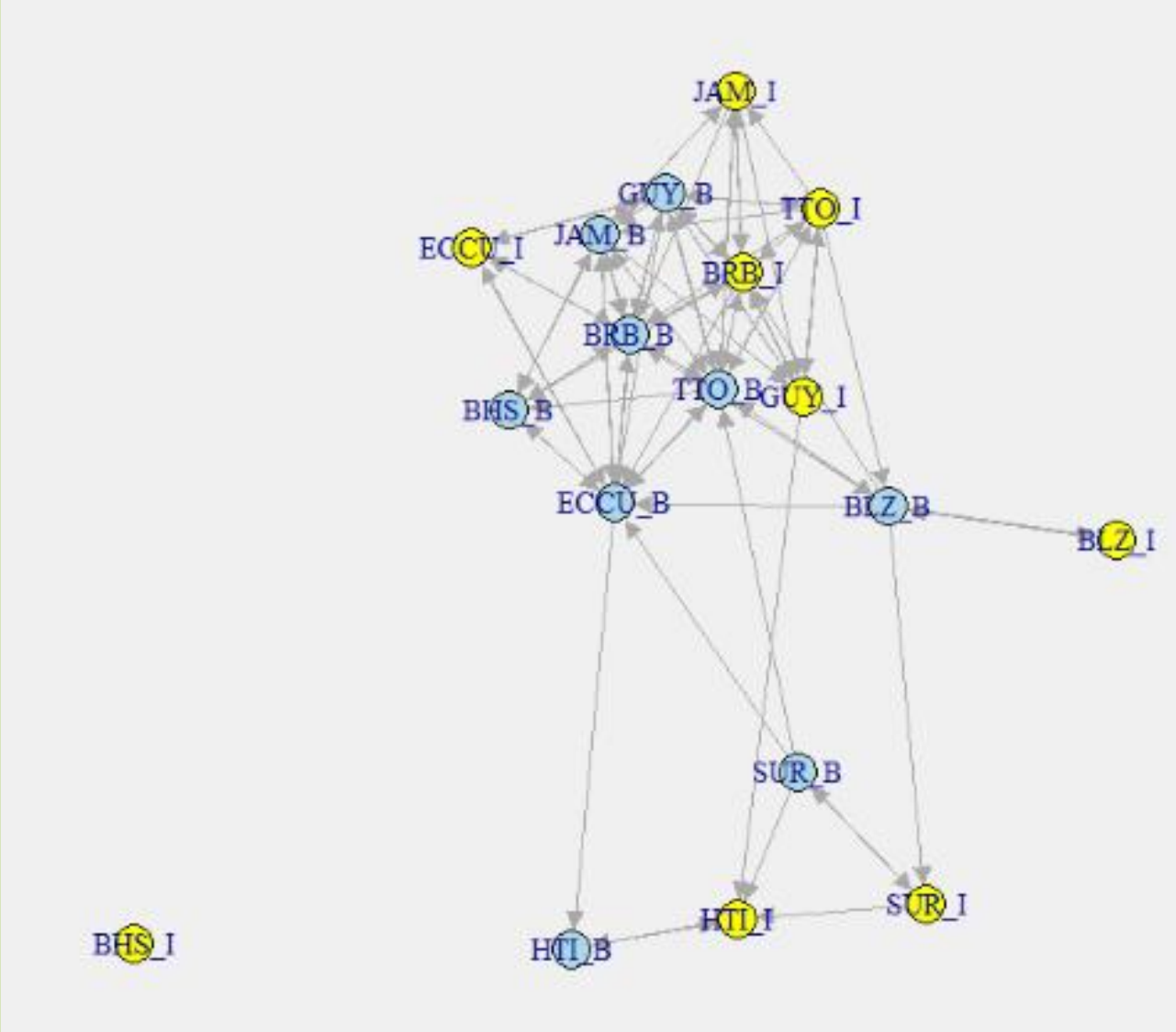


Banks

Insurers

Note: The Bahamas, Haiti and the ECCU did not provide insurance templates

Bank - Insurer Directional Network



Banks

Insurers

Note: The Bahamas, Haiti and the ECCU did not provide insurance templates

Network Metrics

(Banks and Insurers)

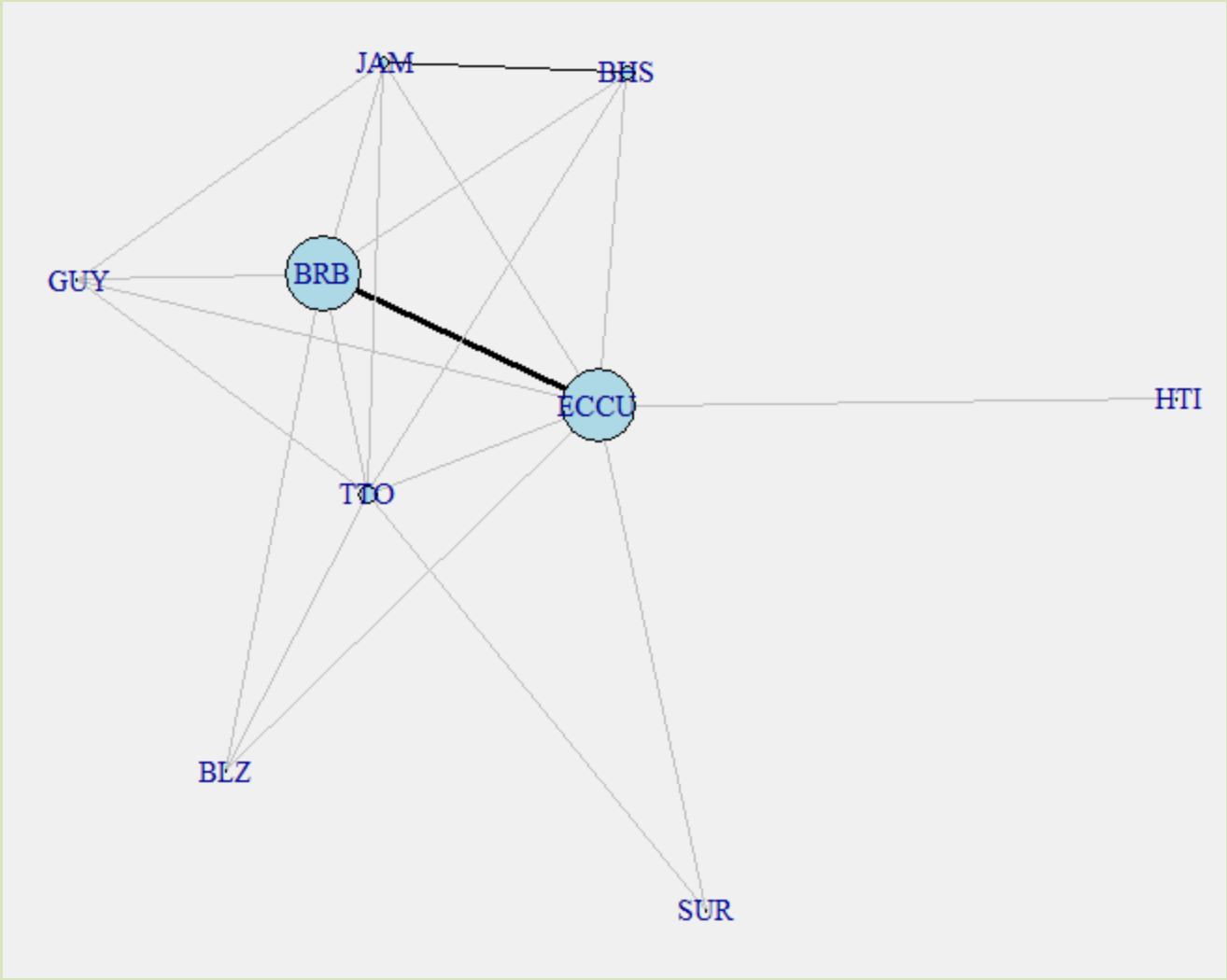
Rankings	Eigenvalue	Betweenness	Closeness
1	BRB	JAM	JAM
2	ECCU	TTO	TTO
3	HTI	TTO	TTO
4	SUR	JAM	ECCU
5	BHS	ECCU	HTI
6	BLZ	GUY	BLZ
7	TTO	GUY	JAM
8	TTO	BLZ	GUY
9	BLZ	BRB	GUY
10	BRB	HTI	BRB

Bank

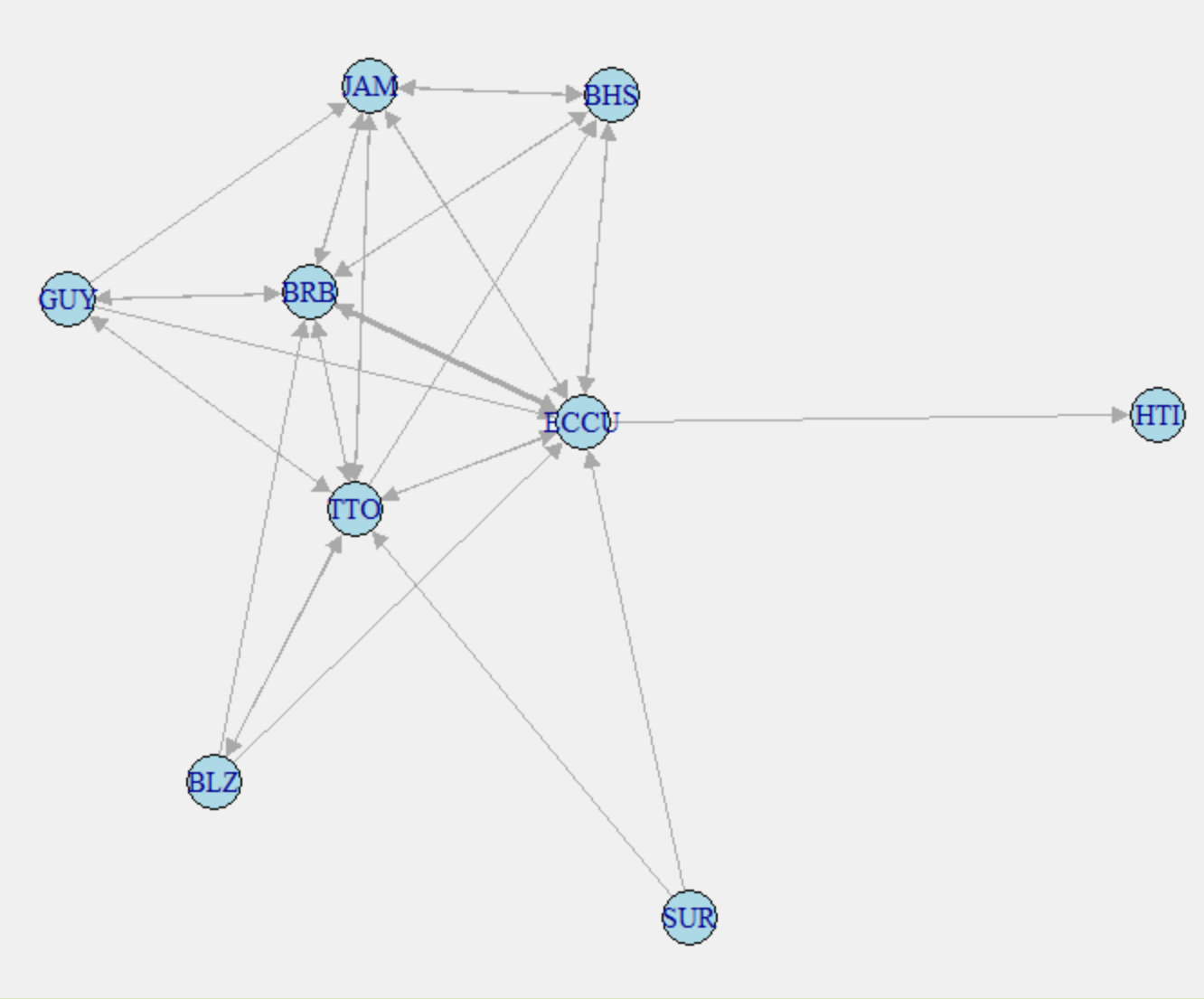
Insurance

Bank Network

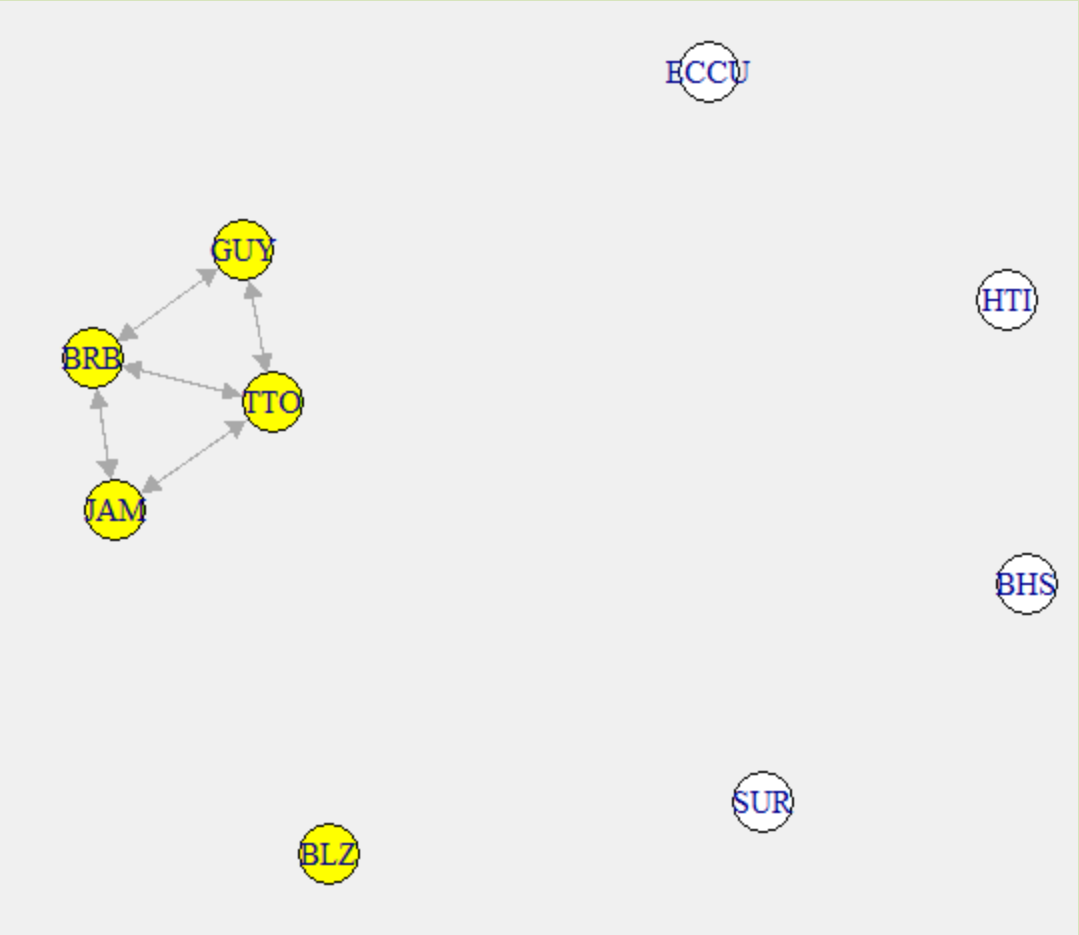
(Bubble Size Represents Eigenvalue)



Bank Directional Network



Insurer Directional Network



Note: The Bahamas, Haiti and the ECCU did not provide insurance templates

Limitations of Interconnectedness Analysis

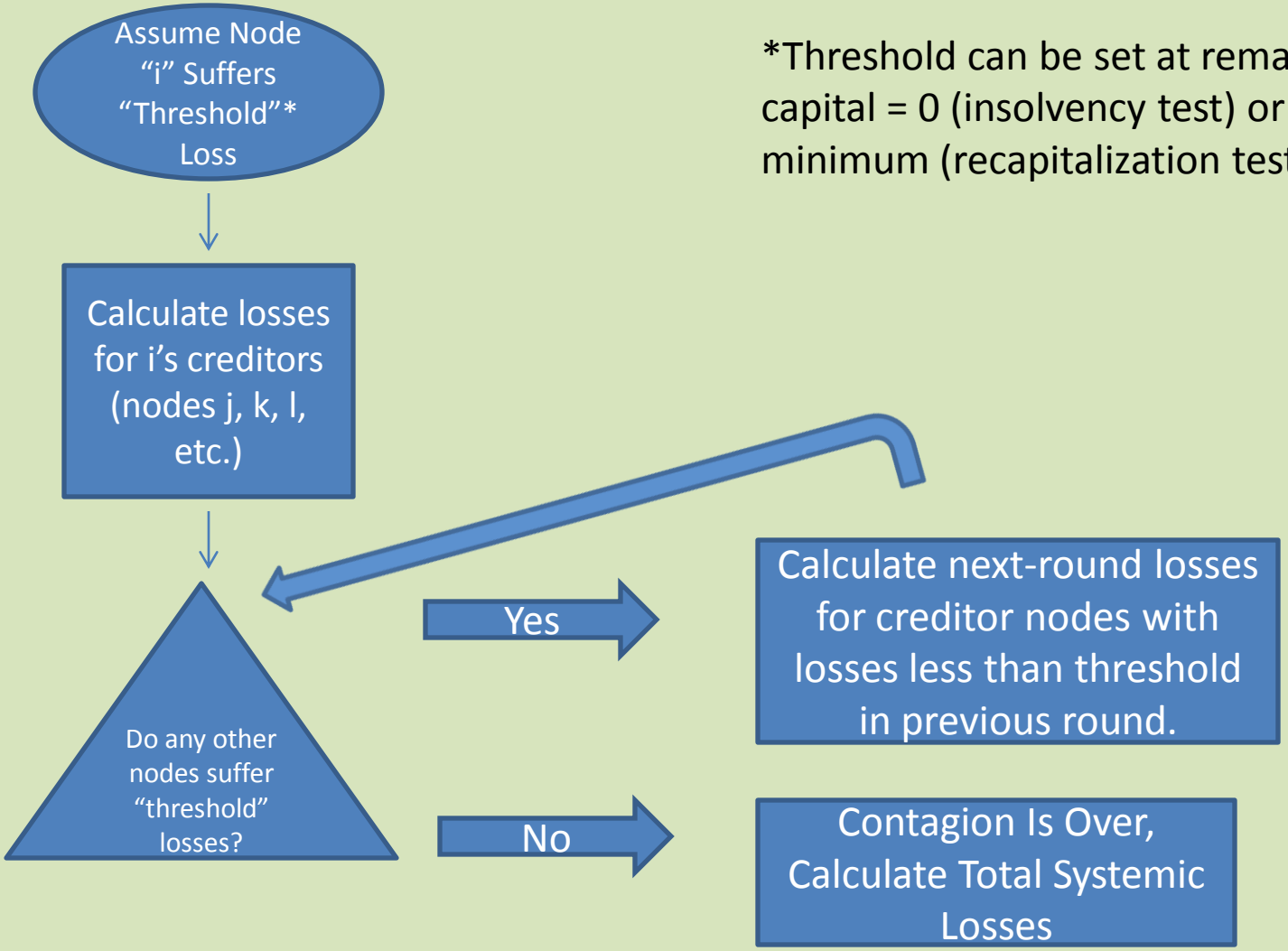
- Financial Contagion Does Not Require Balance Sheet Links
  - "Business-Model" Contagion Leads Panic/Risk-Off Behavior to Occur Among Similar Institutions Even Absent Balance Sheet Links
    - U.S. Investment Banks During GFC
    - "Peripheral" European countries during Eurozone crisis
  - More transparency about knowledge of balance sheet links may stem such contagion stemming from ignorance

IV. Credit and Liquidity Shocks

- Espinosa-Vega and Solé*
  - Widely used in IMF Financial Sector Assessment Programs
  - Available as an Excel Add-In
  - Simulates Credit Shocks in a Financial Network
  - Can Also Add a Liquidity Shock
  - Assumes no recapitalization, gives a “clean” measure of the importance of a node in a network

* “Cross-Border Financial Surveillance: A Network Perspective”, by Marco A. Espinosa-Vega and Juan Solé, IMF Working Paper WP/10/105, April 2010

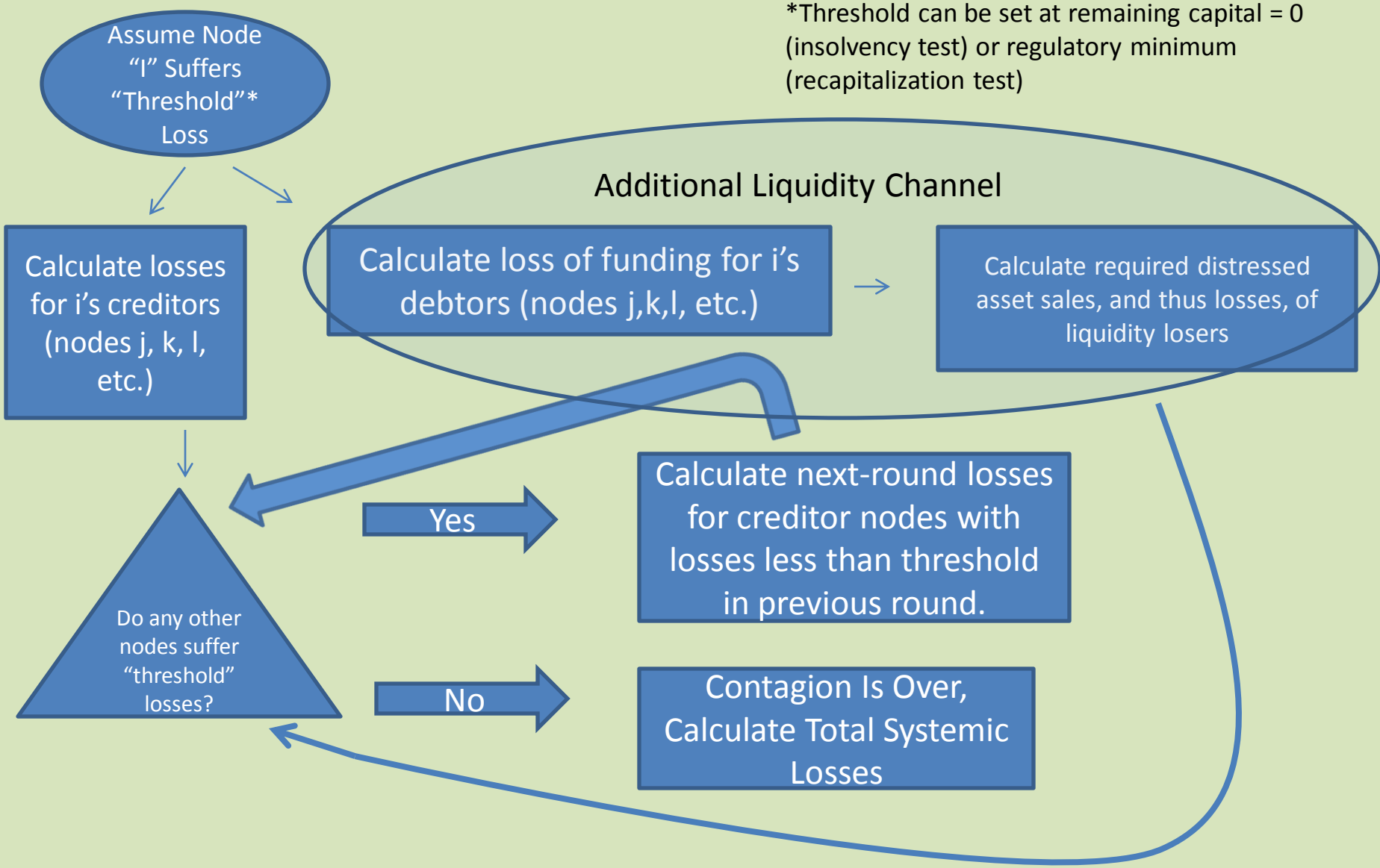
Espinosa-Sole Credit Shocks Algorithm



*Threshold can be set at remaining capital = 0 (insolvency test) or regulatory minimum (recapitalization test)

Espinosa-Sole Credit + Liquidity Shocks Algorithm

*Threshold can be set at remaining capital = 0 (insolvency test) or regulatory minimum (recapitalization test)



Next Steps: Short-Term

- Increase Data Accuracy
- Further Analysis
  - Data slicing (e.g. cross-border claims by instrument)
  - Conduct economic stress tests
    - Sovereigns
    - Economic Sectors (e.g. tourism, real estate, energy)
    - Downside Macroeconomic Scenarios
- Write-Up

Next Steps – Long-Term

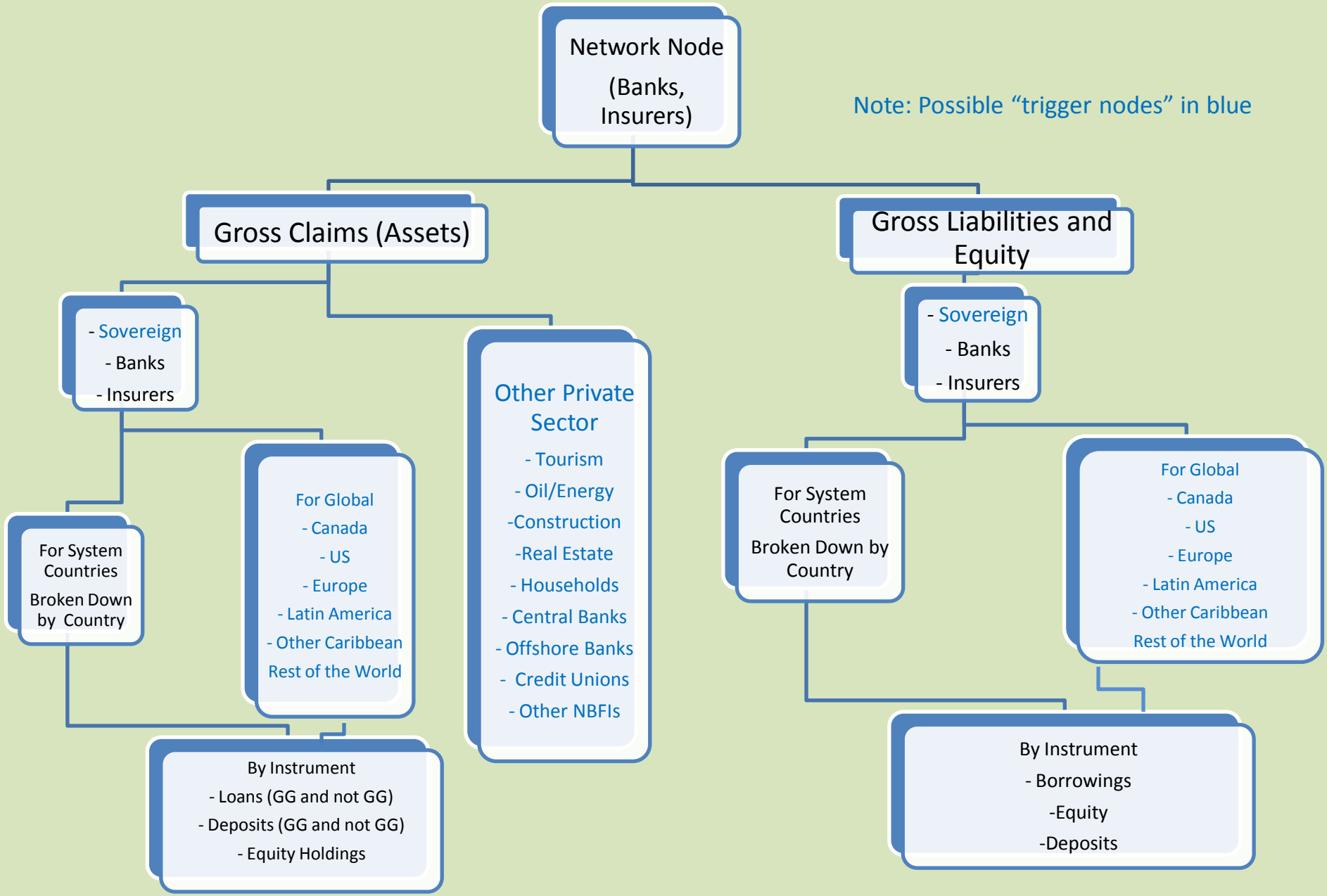
- Institutionalize
  - Regular Data Collection
  - Develop Regional Capacity
  - Future IMF Role?
- Move to Institution-to-Institution Data
  - Develop Legal Frameworks for Information Sharing
- Survey Policy Framework
  - Supervision
  - Cross-Border Crisis Management and Resolution
- Develop Policy Recommendations

The End

(of the beginning)

EXTRA SLIDES

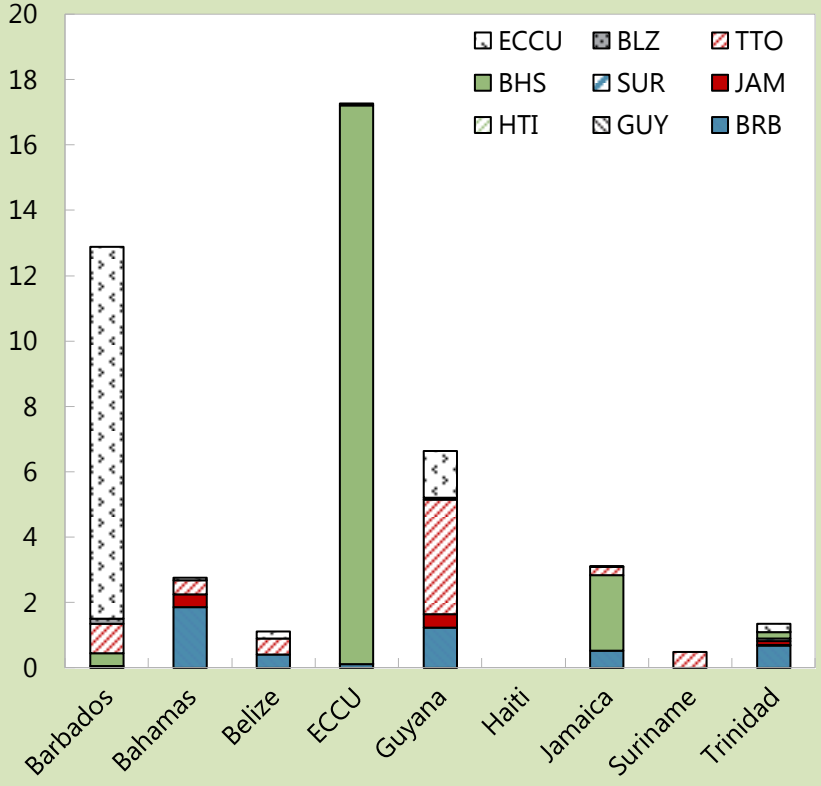
Actual Data Template – Exposures Map



Banks' Cross-Border Claims

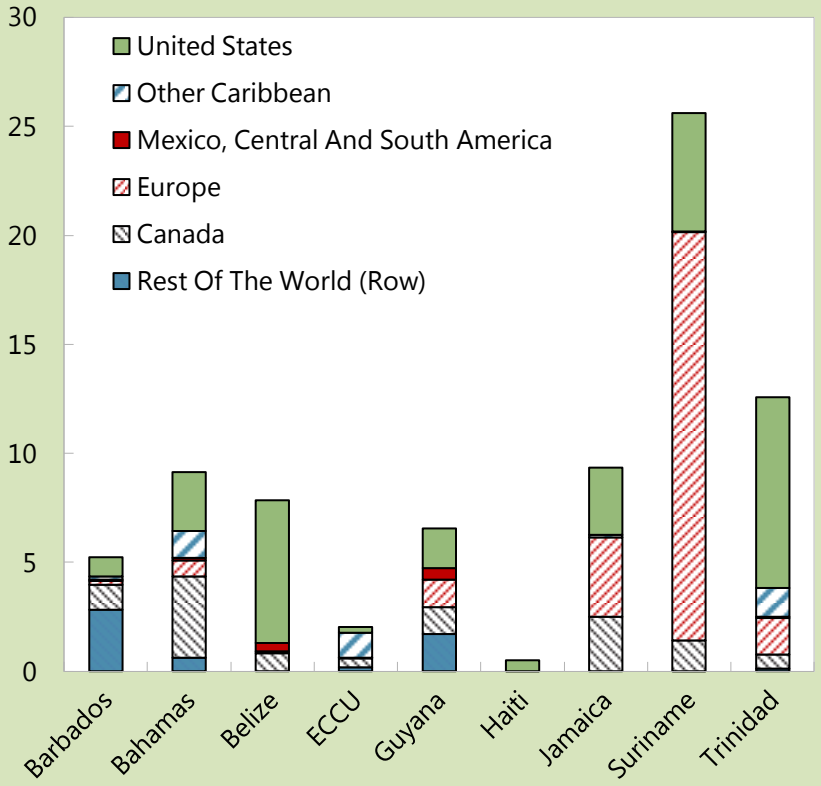
(By Counterparty, percent of assets)

Banks' Cross-border Claims on CRFP Nodes 1/
(Percent of total assets)



1/ Excludes claims on non-financial private sector

Banks' Cross-border Claims on Global Sectors 1/
(Percent of total assets)

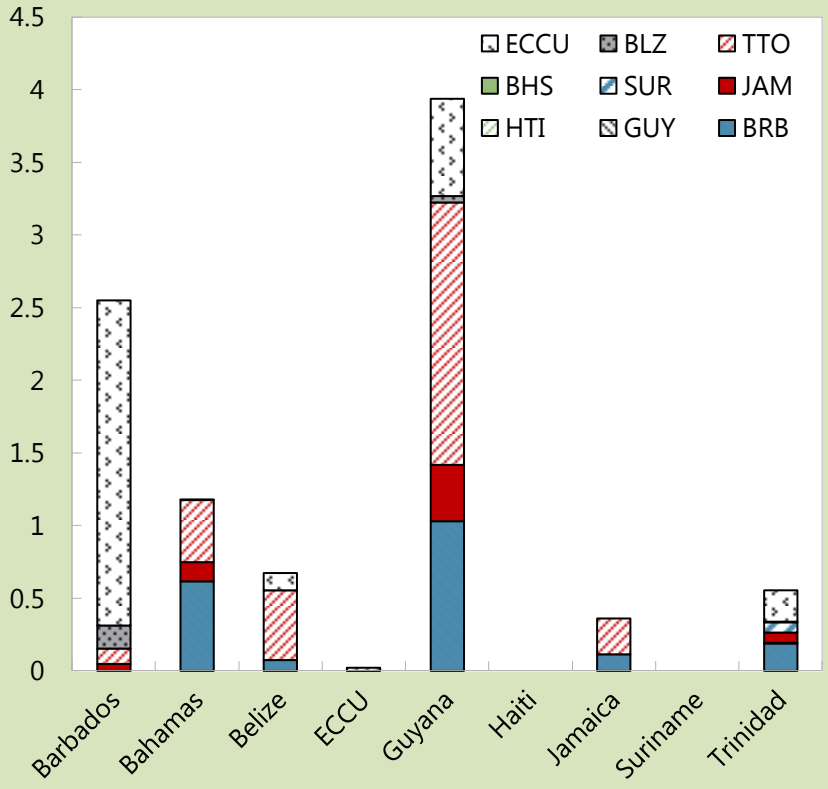


1/ Excludes claims on non-financial private sector

Banks' Cross-Border Claims on Sovereigns

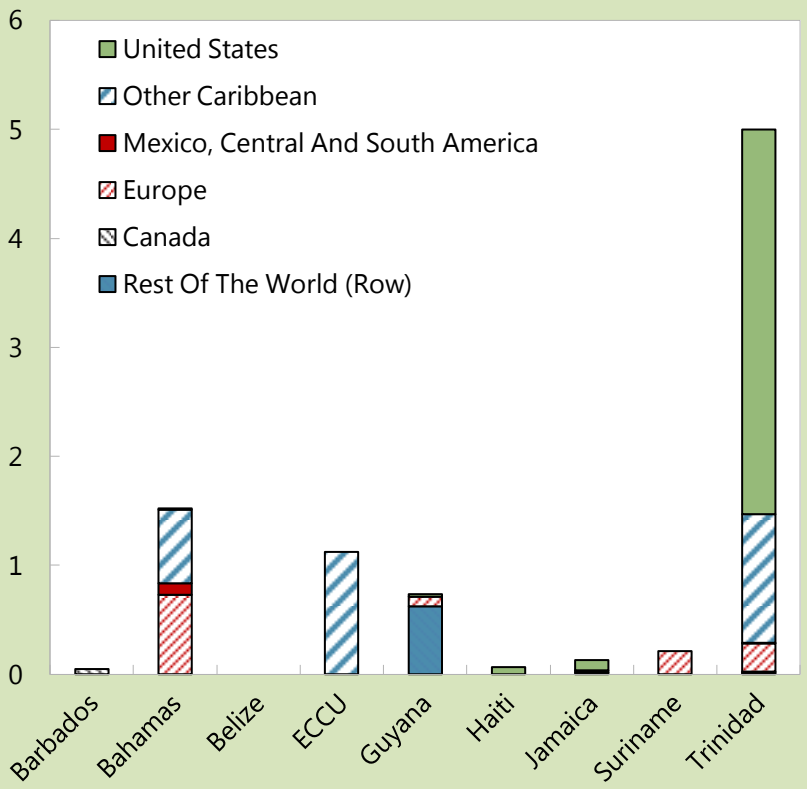
(By Counterparty, percent of assets)

Banks' Cross-border Claims on CRFP Sovereigns 1/
(Percent of total assets)



1/ Excludes claims on non-financial private sector

Banks' Cross-border Claims on Global Sovereigns 1/
(Percent of total assets)

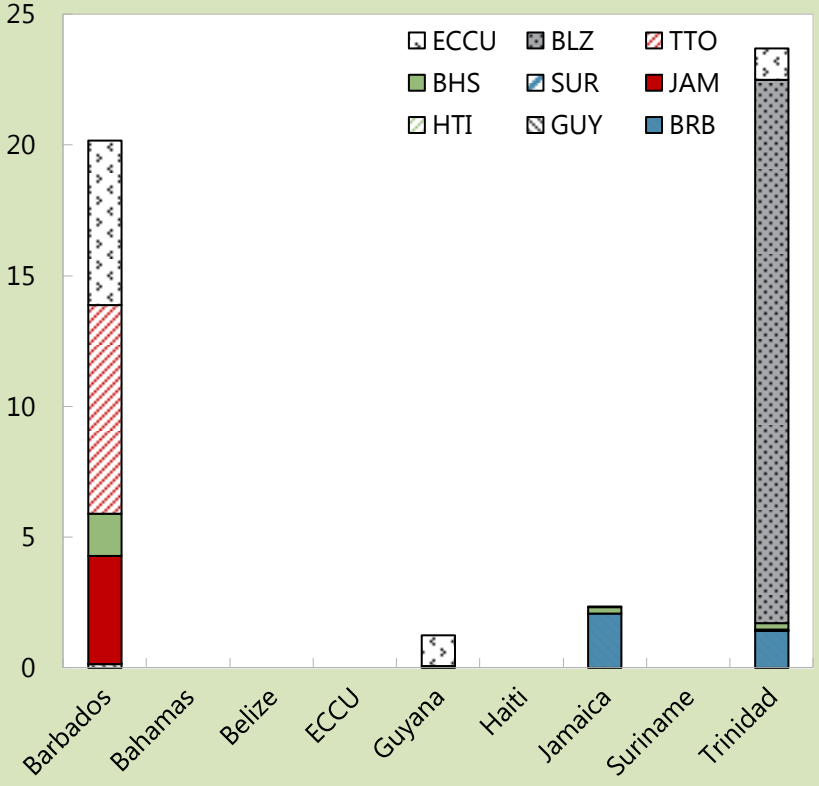


1/ Excludes claims on non-financial private sector

Insurers' Cross-Border Claims

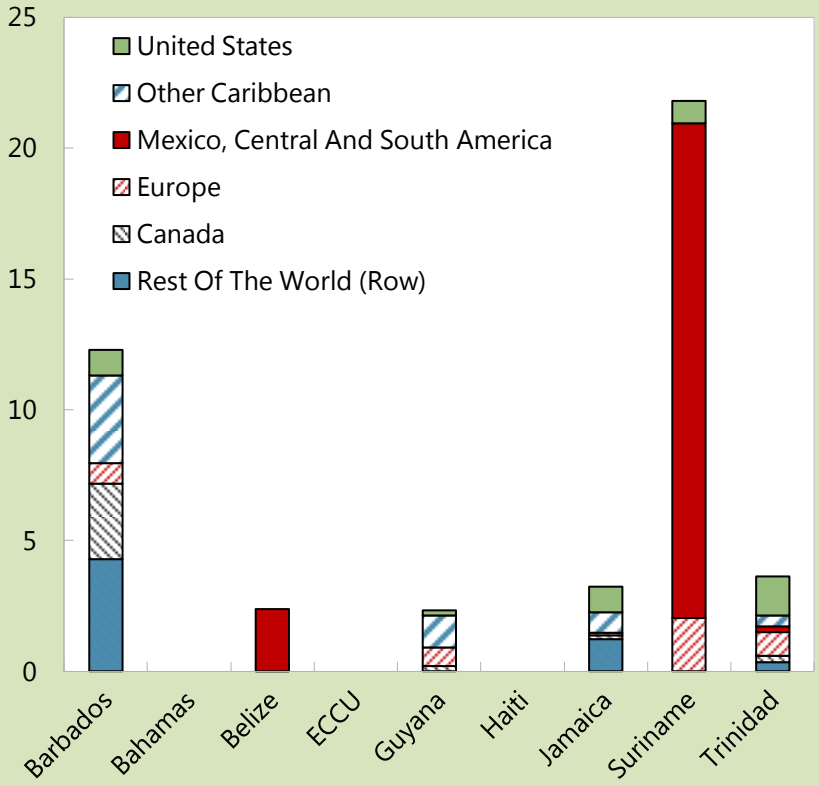
(By Counterparty, percent of assets)

Insurers' Cross-border Claims on CRFP Nodes 1/
(Percent of total assets)



1/ Excludes claims on non-financial private sector

Insurers' Cross-border Claims on Global Sectors 1/
(Percent of total assets)

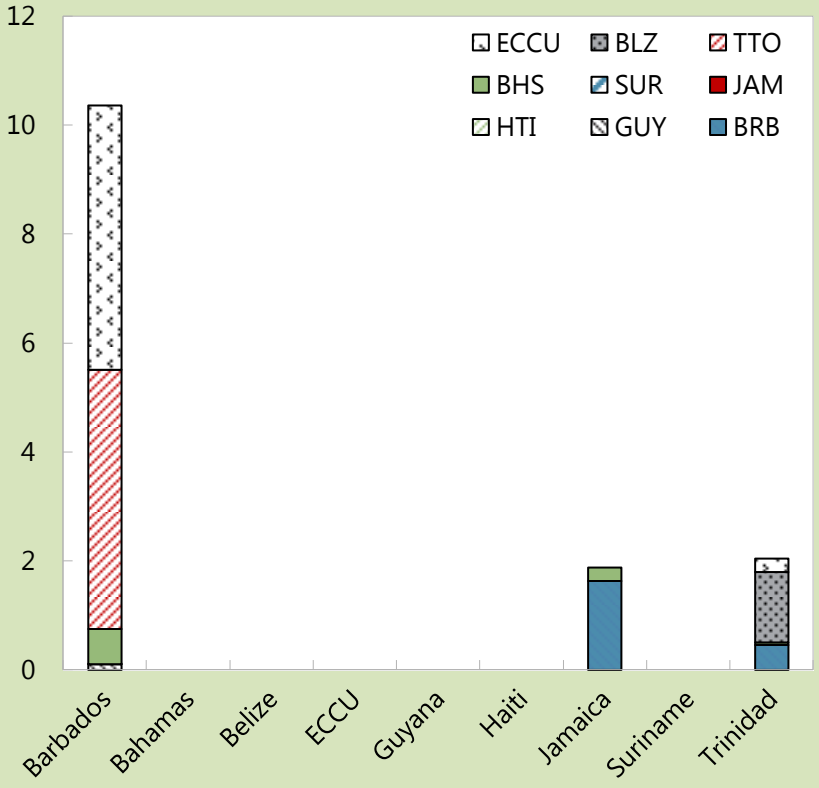


1/ Excludes claims on non-financial private sector

Insurers' Cross-Border Claims on Sovereigns

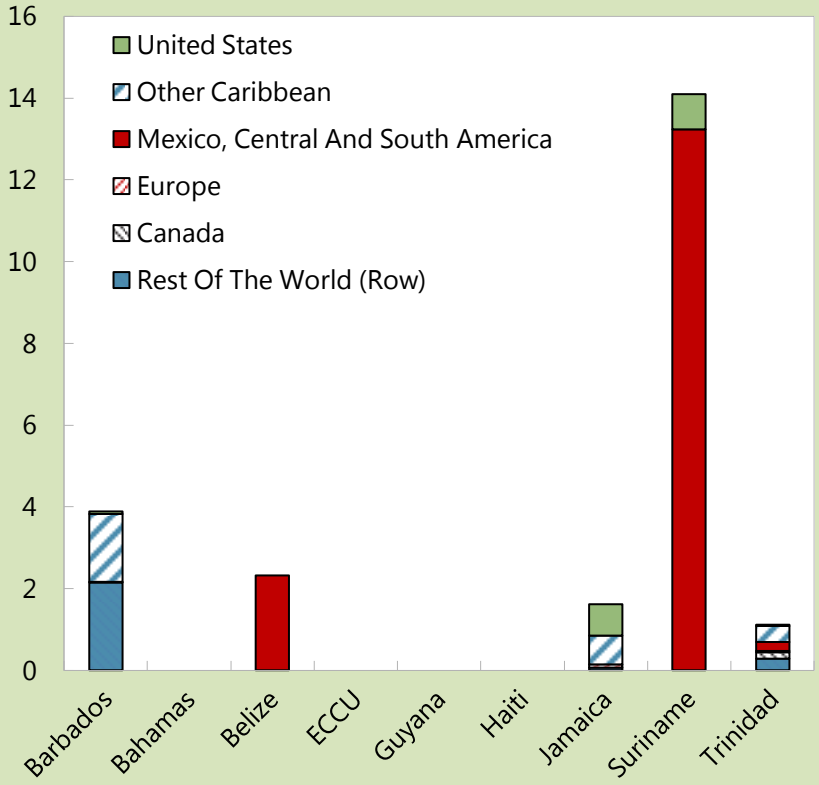
(By Counterparty, percent of assets)

Insurers' Cross-border Claims on CRFP Sovereigns 1/
(Percent of total assets)



1/ Excludes claims on non-financial private sector

Insurers' Cross-border Claims on Global Sovereigns 1/
(Percent of total assets)



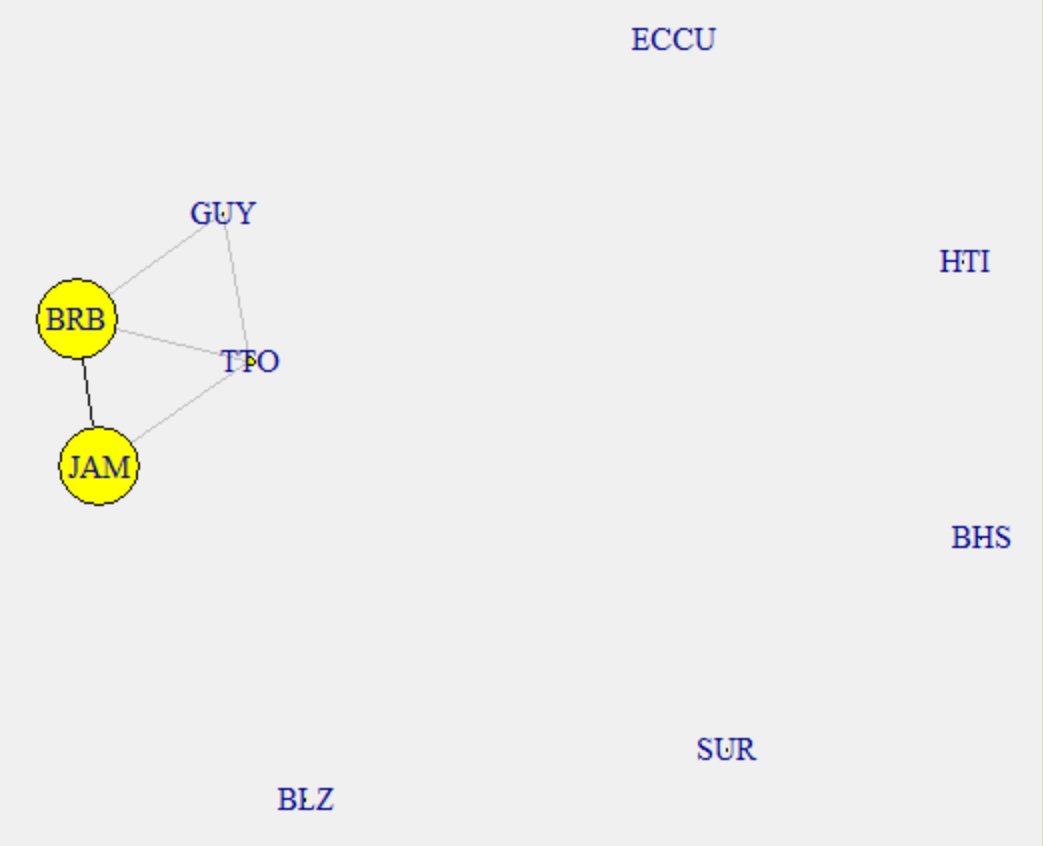
1/ Excludes claims on non-financial private sector

Network Metrics
(Banks)

Ranking	Eigenvalue	Betweenness	Closeness
1	BRB	ECCU	JAM
2	ECCU	JAM	ECCU
3	TTO	TTO	HTI
4	BHS	GUY	TTO
5	JAM	BLZ	BLZ
6	GUY	BRB	GUY
7	SUR	HTI	BRB
8	BLZ	SUR	BHS
9	HTI	BHS	SUR

Insurer network

(Bubble Size Represents Eigenvalue)



Note: The Bahamas, Haiti and the ECCU did not provide insurance templates

Network Metrics
(Insurance)

Ranking	Eigenvalue		Betweenness		Closeness
1	BRB	1	GUY	1	GUY
2	JAM	2	TTO	2	TTO
3	TTO	3	BRB	3	BRB
4	GUY		ECCU	4	JAM
5	ECCU		HTI		ECCU
	HTI		JAM		HTI
	SUR		SUR		SUR
	BHS		BHS		BHS
	BLZ		BLZ		BLZ

Note: The Bahamas, Haiti and the ECCU did not provide insurance templates

IV. Credit and Liquidity Shocks

- Espinosa-Vega and Solé*
  - Widely used in IMF Financial Sector Assessment Programs
  - Available as an Excel Add-In
  - Simulates Credit Shocks in a Financial Network
    - Financial losses/failures impose losses on other network nodes' assets
    - Requires assuming parameter on "loss given default" ("lambda")
  - Can Also Add a Liquidity Shock
    - Financial losses/failure impose losses indirectly by reducing available funding to other network nodes
    - Assumes funding can only be partially replaced, thus requiring loss recognition as assets are sold at a discount ("fire sales")
    - Requires assuming parameters for amount of funding replacement ("rho") and asset discounts ("delta")
  - Assumes no recapitalization
    - Assumption May be Unrealistic, but allows a "clean" measure of the importance of a node in a network

* "Cross-Border Financial Surveillance: A Network Perspective", by Marco A. Espinosa-Vega and Juan Solé, IMF Working Paper WP/10/105, April 2010