Tracking Illicit Activities in Correspondent Banking Networks

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Correspondent Banking (CB) Network

Background

Correspondent Banking (CB) Relationship

A financial institution (the **correspondent**) providing banking services to another financial institution (the **respondent**) in another country/jurisdiction

Correspondent Banking (CB) Network

A network of financial institutions (FIs) in different jurisdictions providing cross-border payment services for customers through different channels such as SWIFT, Fedwire, etc. FIs communicate thru. *Vostro/Nostro** accounts in CB network

Vostro: Our money with you
Nostro: Your money with us

CB Relationships

Common Structures

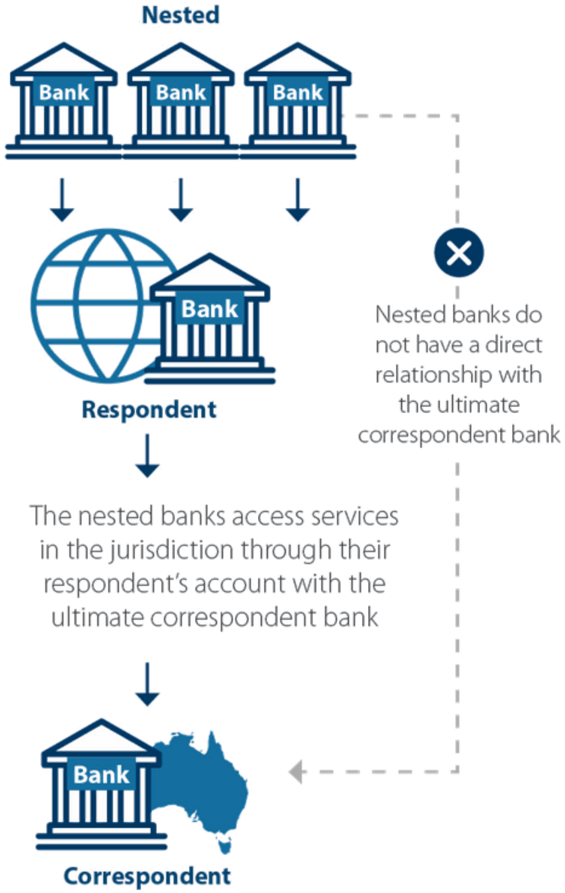
COMMON CORRESPONDENT BANKING STRUCTURES

Traditional

A bank wants to provide its customers with services in a foreign jurisdiction

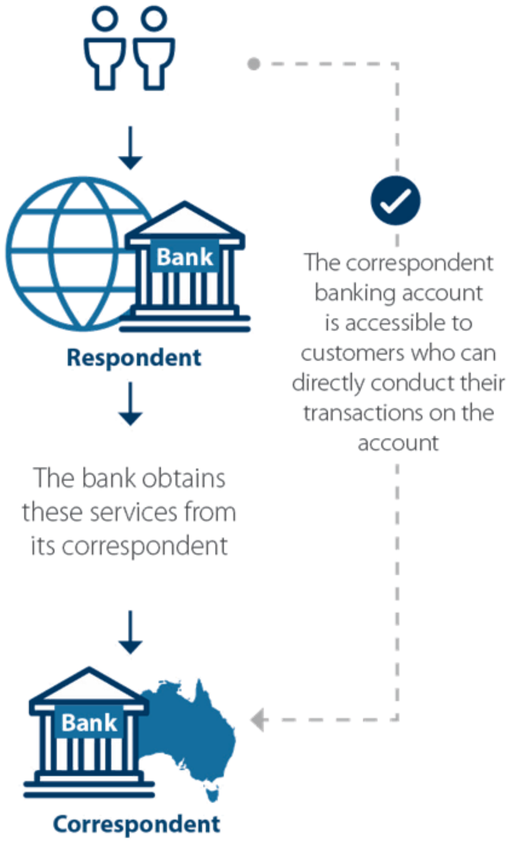
Nested

A number of banks use another bank's correspondent relationship to conduct transactions and access other financial services



Payable-through or pass-through

A bank wants to provide its customers with services in a foreign jurisdiction

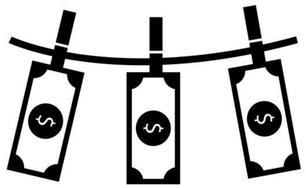


Risks in CB Networks

Global Risks

- Risk of being used by criminal organizations to launder money.
- Risk of being used by terrorist groups to facilitate the financing of their activities.
- 13 Biggest AML Fines ($500 Million Plus):
  - Standard Chartered fined **$1.1 billion** (violating **Anti-Money Laundering [AML]** regulations - 2019)
  - Binance fined **$4.3 billion** (violating federal AML and sanctions laws, citing poor internal controls in the company for its decision)
  - Deutsche Bank fined **$630 million** (for accepting over $10 billion from Russian customers linked to money laundering activity - 2017)
  - UBS fined **$4.2 billion** (for its role in facilitating tax evasion and for inadequate AML controls - 2019)
- Violation Tracker:
  - **Industry**: financial services
  - **Penalty Total since 2000:** $388,802,802,308
  - **Number of Records:** 7,734

(Anti-) Money Laundering



Risks in CB Networks

Risks in CB Networks

Money Laundering

Definition

Money laundering is the process whereby money obtained from criminal activity or illegal sources ("Dirty Money") is disguised to have the appearance of having come from a legitimate source ("Clean Money") by going through a series of transactions ("washing it").

Three Stages of Money Laundering

- Placement: How funds from illegal activities or illegitimate sources are placed into the financial system? It has historically been associated with cash transactions but also take other forms due to evolving digital banking and payment methods.

- Layering: Creating complex layers of transactions to obscure the original source and ownership of funds.

- Integration: This stage allows illicit proceeds to be brought back into the financial system and appear to be clean or legitimate funds.

A Money Laundering Real Case

Placement thru. Cash Transactions[1]

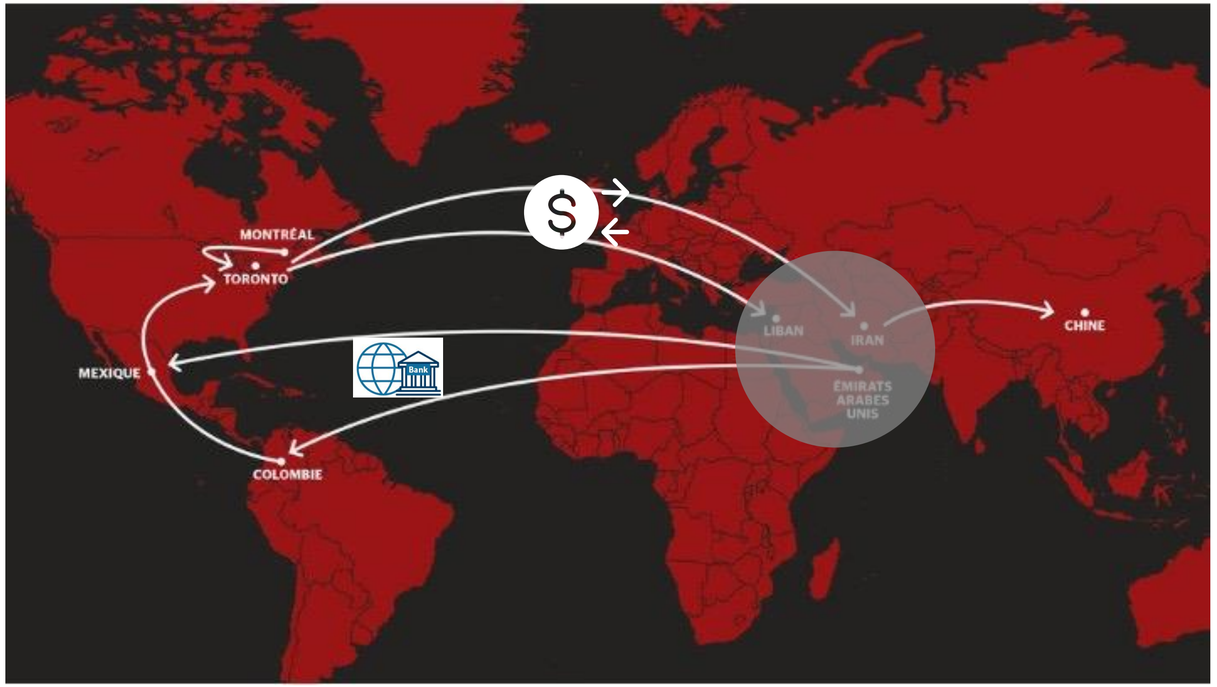
Distributing Cash among Toronto FX (Foreign Exchanges) businesses

Cash Shipment

(Montreal → Toronto)

Drug Shipment

(Colombia/Mexico → Montreal)



Layering thru.

- Shell banks[2]
- Real FIs in countries that do not honor sanctions to obfuscate true originations.
- Luxury/high-value goods
- Real States
- Cryptocurrency
- Charity to relief organization
- Credit card fraud

Integration thru. CB Network

1 Multiple individuals making multiple remittances or exchanges, in multiple currencies, through a number of firms

2 Shell bank: a bank that has no physical presence in the country in which it is incorporated and licensed, and which is unaffiliated with a regulated financial group that is subject to effective consolidated supervision.

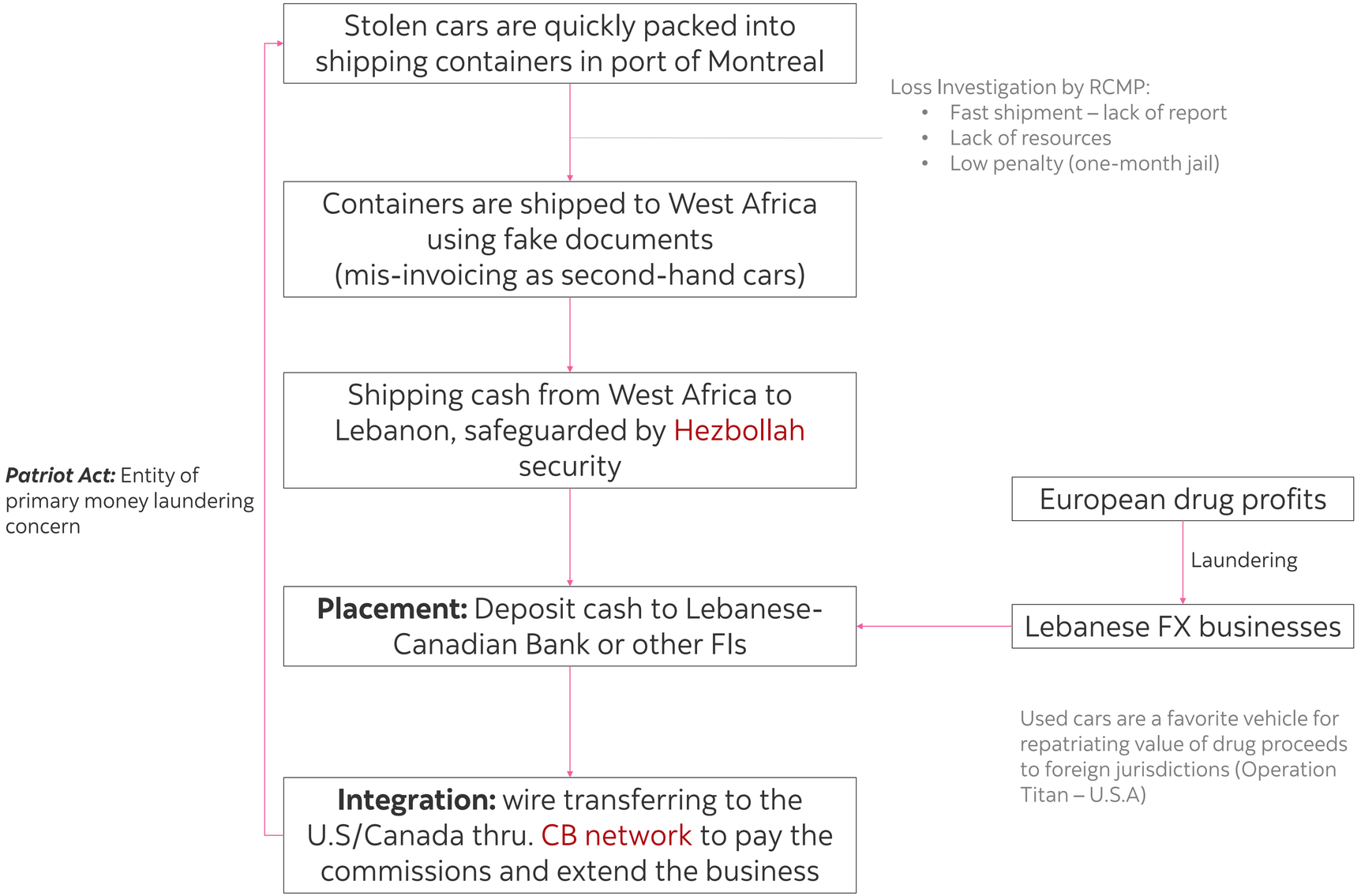
A Money Laundering & Terrorist Financing Real Case

Trade-based Money Laundering (TBML)

Shipment and re-sale of goods overseas

The Grey Market of Export Vehicles

In the News: Auto theft is on the rise in Canada…



Challenges With AML in CB Networks

- Partial Info.: Only the ***integration*** stage is going thru. CB network
- AML is a time-consuming process. (watching list is required!)
- AML process require **different data types**, sources, and quality (structured and unstructured)
- Humans are social beings and criminals involving a network of individuals
- The complexity of **AML remittance and FX regulations in different international jurisdictions** also help criminals to launder money.
- A Report by C.D. Howe Institute (May 2019):
  - Canadian institutions fail to detect money launders more than 99% of the time.
  - Canada's AML protections (particularly as they pertain to real estate) are among the weakest of those of the western liberal democracies.
  - Estimate of the magnitude of dirty money laundered in Canada each year : **$100- $130 billion** (C.D. Howe Institute – May 2019).

Research Contribution

CB Networks Analysis & Optimization

Research Contribution

AML Risk Mitigation thru. Network Optimization (Value vs. Risk trade-off)

- Onboarding, Offboarding (termination) or Restricting CB relationships decisions to be made to optimize the value of the bank to the network vs. risk.
- Offboarding (Termination): Detecting vertices, the removal of which does not affect the key properties of the network (Connectivity and Diameter).
- Restricting: Detecting connections, the removal of which does not affect the network properties.
- Enhanced Monitoring/Tracking of illicit activities by deviating from the features of an optimized network

Novelties:

- First of its kind: study the structure and key properties of the CB network (https://arxiv.org/abs/1912.02262).
- Banks Evaluation Criteria: Identify network-based criteria (hidden in payment data) to measure the value of banks (i.e., access criticality, directional flow, etc.)
- High Visibility for Proactive Strategy: Monitoring/tracking illicit components hidden within the network which are higher risks such as Money-laundering, Terrorist financing, credit, U-turning, and Nesting.

Literature Gap

Little work has been done on theoretical foundation of the CB networks as directed graphs.

CB Network Construction

Transactions

CB Network

Optimization

Insights

Cross-boarder Payments Data (>3M daily)

Current Practice

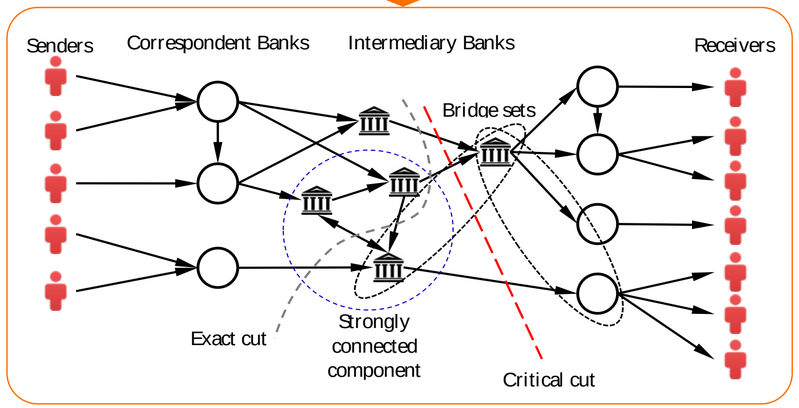
Feature Engineering

Benefit Features
Amount Thru.
Volume Thru.
Access to Banks
Access to BNS Customers
Touchpoints
# of currency cleared
Top-segment customer
Credit Facility

Risk Features
Vostro Rate (%)
AML/TF Risk
Product Risk (%)
Internal Grade Score
Flow direction (KYC)

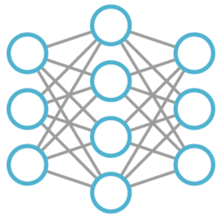
Data Ingestion

- Fuzzy name matching (customers/banks' unique id)
- Text mining (typo errors, incomplete info,…LLMs usage)



Source-Sink DAG

Machine Learning



FIs Evaluation (Scoring) thru. clustering

Suspicious Transactions Classification (Monitoring & Screening)

Network Optimization (Value vs. Risk) – On/Off-boarding

Flow Analysis (Critical paths detection)

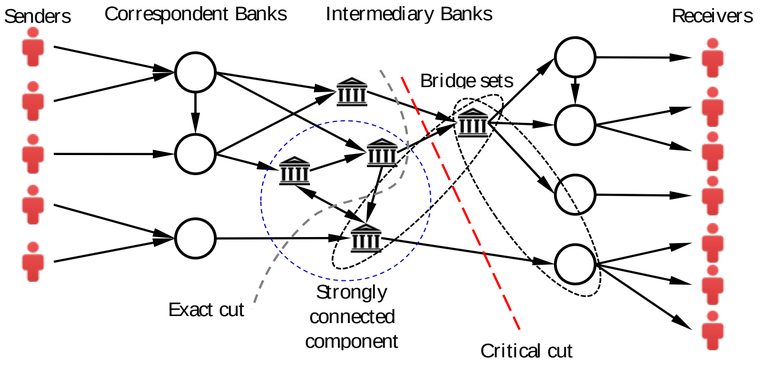
Theoretical Developments

Using Operations Research & Graph Theory to Explore the Topology of CB Networks

Network Definitions

Understanding the Topology of CB Network

- **Client:** A sender or receiver
- **Correspondent Bank:** A bank with inward/outward flow from/to customer
- **Intermediary bank:** bank without direct connection with customers
- **Network Flow**: *Amount* and *Volume* of transactions between pair entities
- **Strongly Connected Component (SCC):** maximal subgraph in a directed network such that for every pair of vertices u, v in the subgraph, there is a directed path from u to v and vise versa.
- **Circumference:** the length of longest cycle in the digraph



Network Definitions

understanding the Topology of CB Network

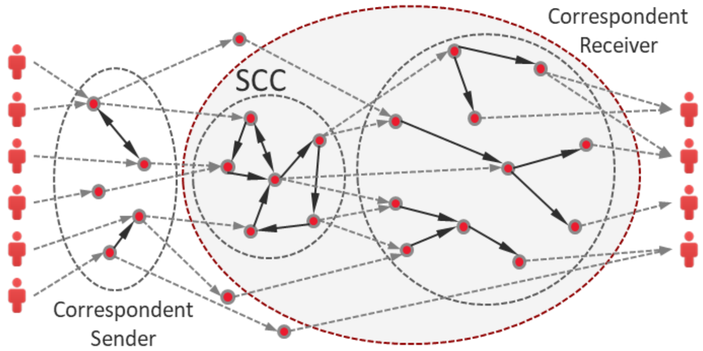
- **Distance:** length of shortest path
- **Vertex Accessibility:** Set of all successor vertices accessible (directly or indirectly) through a given vertex.
- **Vertex Eccentricity:** The maximum distance from a given vertex to any other vertex in the network
- **Network Diameter:** the maximum distance between any pair of vertexes = maximal *vertex eccentricity* in the network.
- ***K*-Clan digraph:** An SCC with diameter *k* – any vertex is reachable through a shortest path of size at most *k* from any other vertex (Analogous with Milgram's experiment on 6-degrees of separation theory in social networks – Small World theroy)
- **Bridge Set:** minimal set of vertices the removal of which divides the network into two disjoint sub-networks of senders and receivers (NP-hard).
- **Critical Cut:** minimal set of *connections* the removal of which divides the network into two disjoint sub-networks of senders and receivers (NP-hard).
- **Bifurcated pattern:** lack of unique path between each sender-receiver pair

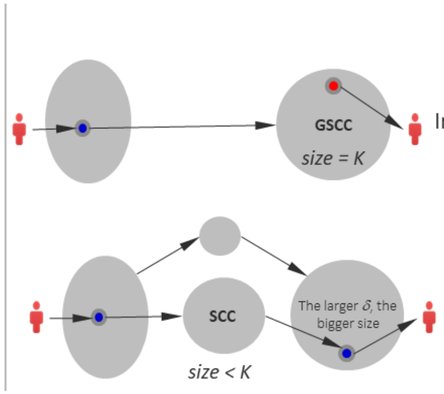
Findings

Optimized CB Network ≡ Minimal *k*-accessible Digraph

Illicit Activity ≡ Deviation from Optimality (Change in Connectivity over time)

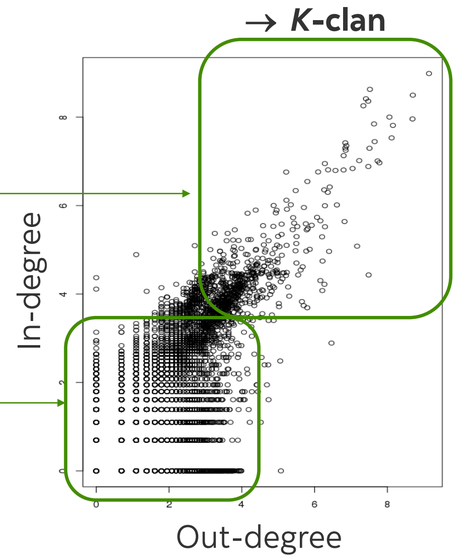
- *k*-accessible Feature: A set of banks exist in CB network each of which has access to, on average, $\boldsymbol{k}$ other banks with a negligible standard deviation ($\boldsymbol{\delta}$) – One possible reason for such feature might be the child-parent relationship between branches and their head offices.
- A number of fundamental theorems for *k*-accessible digraphs have been proved:
  - Reduced the search space and computational efforts for CB network analysis; particularly, at branch level.
  - Conditions under which the removal of risky entities has least negative effect on the customers
- Connectivity (Client's accessibility to CB services) and Diameter (Time/Cost concerns) are two key characteristics of a CB network to be preserved during the optimization phase.
- $\boldsymbol{\delta}$ sorely represents the macro-structure of the network. The illicit activities are most likely link to the entities with significant deviated or fluctuated $\boldsymbol{\delta}$.





Giant SCC
Intermediate + correspondent
($\delta \approx 0$)

SCC
Bridge Set
($\delta > 0$)



https://arxiv.org/abs/1912.02262

Fundamental Theorems

An Linear Integer Programming model to construct a minimal *K*-accessible digraph

Theorem: Each Minimal k-accessible digraph D with $k \geq N/2$ has smallest vertex accessibility variance and at least one SCC of size $k + 1$.

$$\min \sigma_{acc}^{D} = \frac{1}{N}\sum_{e=0}^{N-1} x_e (k-e)^2,$$

To calculate the variance of vertex accessibility

Subject to:

$$1 \leq x_0 \leq N-1,$$

Upper bound on x_0 as sink (acyclic digraph)

$$x_e \leq N - \sum_{l=0}^{e-1} x_l\,; \quad 1 \leq e \leq N-1,$$

Upper bound on the rest of vertices

$$\sum_{e=0}^{N-1} x_e = N,$$

to guarantee the order of digraph

$$k - \frac{1}{2} < \frac{\sum_{e=1}^{N-1} e x_e}{N} < k + \frac{1}{2},$$

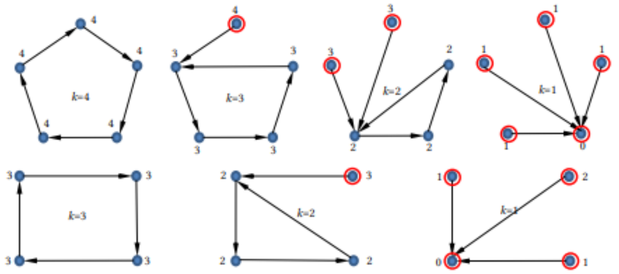
K-accessible definition: the average accessibility over all vertices must be enough close to *K*.

$$x_e \leq M^{+} \times x_{e-1} \quad \forall e > 0.$$

to guarantee the digraph connectivity

$$x_e \in \mathbb{Z}^{+}.$$

x_e: number of vertices with accessibility equals e where $0 \leq e \leq N-1$.



$N = 5$

$N = 4$

Optimal Solutions for various k:

Fundamental Theorems

Q: Given an optimized *k*-accessible network, SCC is *p*-Clan where *p* < *k*?

Q: What would be the diameter of an optimized *k*-accessible network?

Answer: 4 or 5

A Quadratic Integer Programming model to construct a minimal *P*-Clan digraph

Lemma: In a *p*-Clan digraph, the network optimization problem (minimizing the number of edges) ≡ maximizing the number of distances of length *P*.

$$\min \sum_i \sum_j x_{ij}^1,$$

s.t:

$$\sum_k \sum_{r=1}^{l-1} x_{ik}^r x_{kj}^{l-r} \geq (l-1) \times x_{ij}^l \quad \forall i \neq j, 2 \leq l \leq p,$$

$$\sum_{l=1}^{p} x_{ij}^l = 1 \quad \forall i \neq j,$$

$$x_{ij}^l \in \{0,1\};\ x_{ii}^l = 0 \ \ \forall i, l.$$

To minimize the number of edges

- $x_{ij}^l = 1$ means j is reachable by i through $(l-1)$ intermediary vertices
- Several paths of same length may exist between the pair of vertices (i,j)
- avoiding sub-tours

$x_{ij}^l = 1$; if the distance between pair vertices i and j equals l; $(1 \leq l \leq N-1)$; otherwise $x_{ij}^l = 0$.

Integer Relaxation to study KKT Conditions for optimality:

$$\min \sum_i \sum_j x_{ij}^1 + \beta \sum_i \sum_j \sum_l x_{ij}^l (1 - x_{ij}^l),$$

s.t:

$$\sum_k \sum_{r=1}^{l-1} x_{ik}^r x_{kj}^{l-r} \geq (l-1) \times x_{ij}^l \quad \forall i \neq j, 2 \leq l \leq p,$$

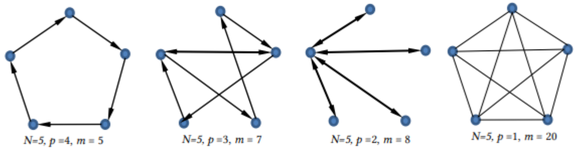
$$\sum_{l=1}^{p} x_{ij}^l = 1 \quad \forall i \neq j,$$

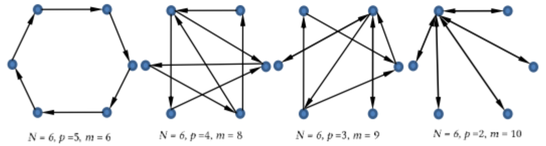
$$0 \leq x_{ij}^l \leq 1;\ x_{ii}^l = 0 \ \ \forall i, l.$$

$$\min \sum_i \sum_j x_{ij}^1 \equiv \max \sum_i \sum_{j \neq i} x_{ij}^p.$$

Example of minimal *p*-Clan digraphs (local optima using B&B)

↓N p→	1	2	3	4	5	6	7	8	9
3	6	3							
4	12	6	4						
5	20	8	7	5					
6	30	10	9	8	6				
7	42	12	11	9	9	7			
8	56	14	13	11	10	10	8		
9	72	16	16	12	12	11	11	9	
10	90	18	18	14	13	13	12	12	10





Other Business Impacts…

- Faster Transaction monitoring & decision making (from weeks to hours).
- Saving in man-hours (+200K per year)
- Visibility on interbank relationships (a portion or entire CB network can be shown over different layers, e.g., geographical, counterparty or risk level).
- Satisfying regulatory 1st Line behavioural monitoring
- Rapid response to new risks identified in the network
- **>200** Vostro accounts have been closed since Jan 2020.

Thank you

A Money Laundering Real Case

A charter private airline company and its owner are in the news in connection with a drug cartel. The airline company is allegedly supplying airplanes to, and profiting from, the drug trade.

With the company under investigation, the Airline Owner is looking to protect as much of the profits from the drug trade as they can by converting them from the local currency into US dollar (USD). The Airline Owner's contact in the drug cartel recommends speaking with an advisor with Plata Brokerage Group. The contact assures the Owner that the Advisor can be trusted and will not question where the money is coming from.

The Plata Brokerage Group Advisor sets up the shell company and contacts a Broker with a Brokerage Firm that they often use for these kinds of transactions.

The Broker contacts Leviathan, a local bank, which they have not traded with in over six months and uses the full amount the Airline Owner is looking to convert to buy a local government bond over the counter (OTC). The bonds are highly liquid and although this is a very large trade for the Broker, nothing else is suspicious.

The trade is accepted by Leviathan and is settled via a custodian network.

Simultaneously, the Broker sells an identical quantity of the same bond to Leviathan's US branch in exchange for USD.

The Broker has a long-standing relationship with the US branch and this trade is within its normal activity. However, the Junior Sales Advisor who answers the Broker's call is not familiar with the Broker or their trading activities and asks some additional questions regarding the purpose of the trade. The Broker immediately becomes impatient and advises there is no time to answer all his questions because of the urgency of the trade.

The request is escalated to a senior Sales Advisor who jumps on the line and agrees to execute the trade due to its urgency.

The trade is also settled via the custodian network, and the USD funds are credited to a custodian account belonging to the Brokerage Firm.

The Broker then transfers the USD funds to an offshore company - the Shell Company set up for the Airline Owner by the Plata Group Advisor.

The Junior Sales Advisor identifies this as a potential unusual activity for the Broker.