

Stress Testing SPEI: Policy Recommendations about the Mexican Payment System Simulating Distressed Liquidity Scenarios

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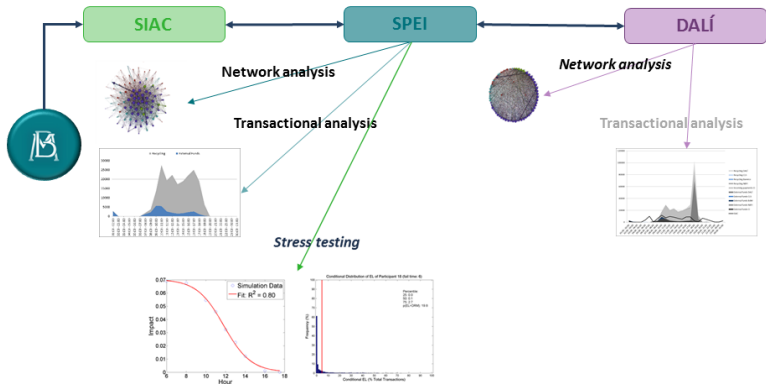
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Conceptual Framework

This work is part of a campaign promoted by Bank of Mexico with the purpose of achieving a more thorough knowledge of the country's financial structure.



Why Stress Testing?

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- While a full comprehension of **causes** of crises is unlikely to be achieved, the way in which they **unwind** is easier to be understood.
- Knowing in advance the effects of potential disruptions can help to **prevent** those disruptions from happening.
- Knowing in advance the effects of potential disruptions can help to **intervene** promptly in case those disruptions happen.
- A more thorough knowledge of the System can help to **assess** the current policies.

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- Many have analysed the **topology** of Payment System networks. The study about SPEI revealed a **tiered**, highly **clustered**, and highly **interconnected** structure [1].
- Few have access to **real data** and thus rely on **data simulators** [2]. SPEI keeps track of every transaction with its timestamp attached.
- When simulating disruptions in a Payment System, we want to estimate the amount of **additional liquidity** that participants will need. Some proposed to calculate an **Upper** and **Lower Bound** [3].

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- Liquidity flows analysis in SPEI has highlighted the importance of the **timing** of payments.
- It has also detected **recycling** tendency of the participants that generally manage to efficiently exploit incoming payments as a source of liquidity.

- **Simulation** of the operational failure of each participant of the system at different hours in order to calculate the **extra funds** needed by every other institution.
- Construction of the **distributions** of Extraordinary Liquidity.
- Analysis of the **time-dependence** of the **Systemic Impact**.

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Structure of the connection between Mexican FMIs

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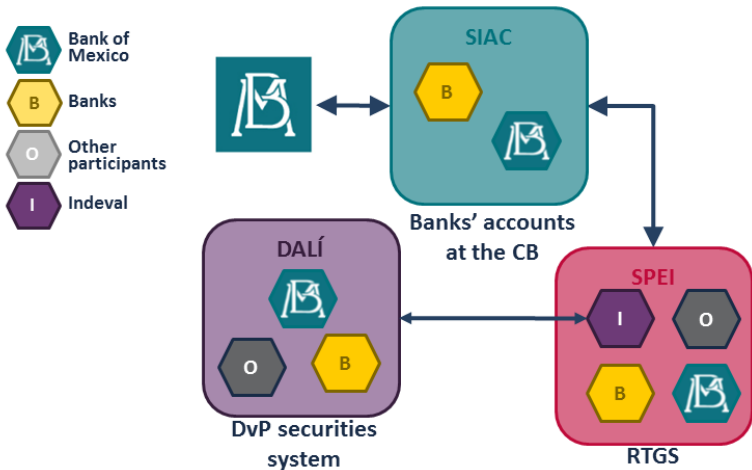
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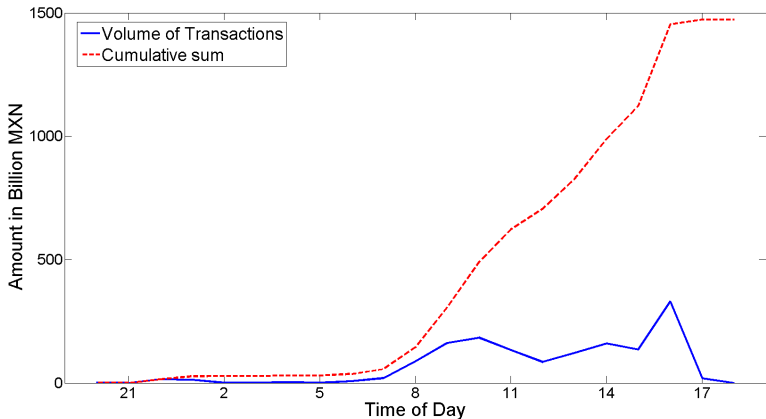
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SPEI is particular **RTGS** that settles both **Large** and **Low** value transactions while operating on a Settlement Cycles basis.

Distribution of Payments

Previous studies showed that the distribution of payments is **inhomogeneous**. The bulk of transactions is spread between 8 a.m. and 4 p.m.



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① Hypotheses:

- Exogenous Shocks
- No Recovery
- No Reaction
- Unlimited Liquidity

② Calculate Ordinary Liquidity⁴

③ Select hour

④ Remove payments

⑤ Calculate Extraordinary Liquidity⁴

⁴The algorithm used to calculate Ordinary and and Extraordinary Liquidity is the same.

1 Hypotheses:

- Accounts start at zero
- There are only two sources of liquidity
- Payments within a Settlement Cycle are offset

- 2 Let P_{it}^r and P_{it}^s be namely the total amount received and sent by participant i during cycle t , then the **net amount received**, A_{it} , the **liquidity reserve**, S_{it} , and the **liquidity borrowed**, F_{it} , are defined as follows:

$$\begin{cases} A_{it} = P_{it}^r - P_{it}^s \\ F_{it} = F_{it-1} - \min\{0; S_{it-1} + A_{it}\}. \\ S_{it} = \max\{0; S_{it-1} + A_{it}\} \end{cases}$$

- 3 Provided that $\forall i, A_{i0} = S_{i0} = F_{i0} = 0$, F_{iT} is the **Ordinary Liquidity**, NL_i .
- 4 **Extraordinary Liquidity** is therefore $EL_i = F_{iT} - NL_i$

Distributions of EL - Core

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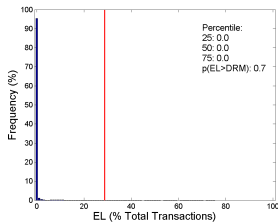
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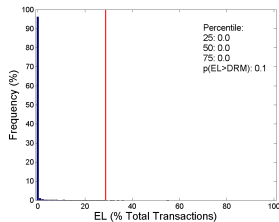
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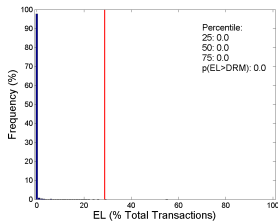
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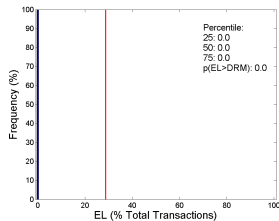
(a) 6:00 am



(b) 10:00 am



(c) 2:00 pm



(d) 5:30 pm

Distribution of EL - Periphery

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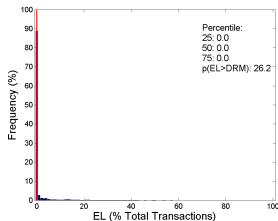
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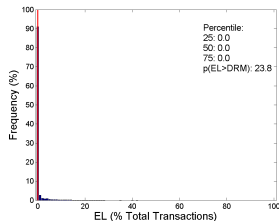
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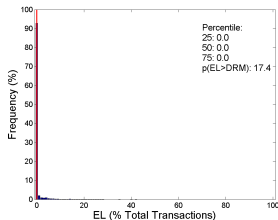
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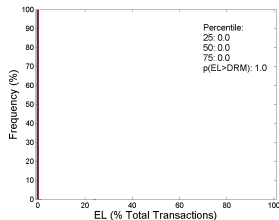
(e) 6:00 am



(f) 10:00 am



(g) 2:00 pm



(h) 5:30 pm

Distribution of EL - Core - Periphery

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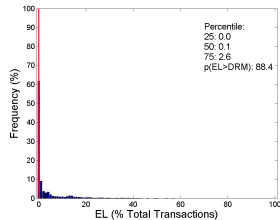
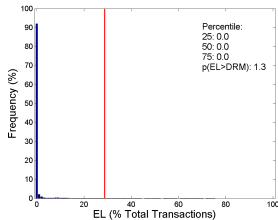
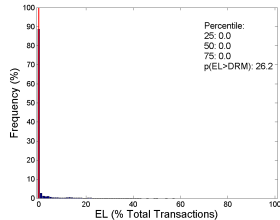
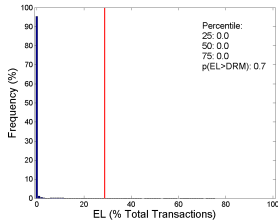
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(k) core

(l) periphery

Distribution of EL - Periphery - NBF1

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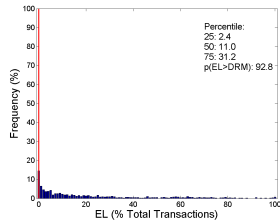
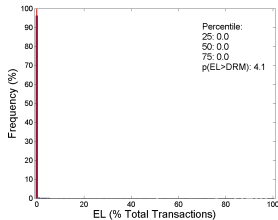
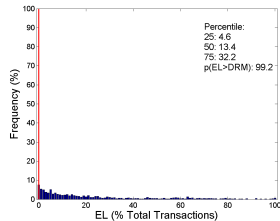
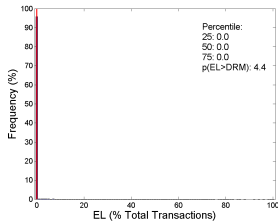
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(o) unconditional

(p) conditional

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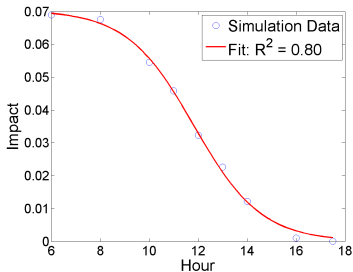
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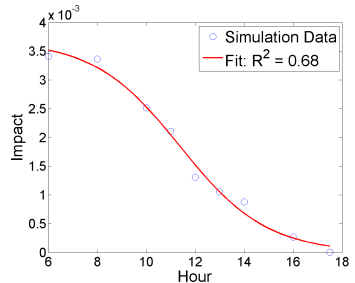
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The **Systemic Impact** is defined as the sum of the Extraordinary Liquidity triggered onto the other participants by an event.



(q) core



(r) periphery

Fit using a *logistic function*: $S(h) = \frac{K}{1+qe^{-rh}}$

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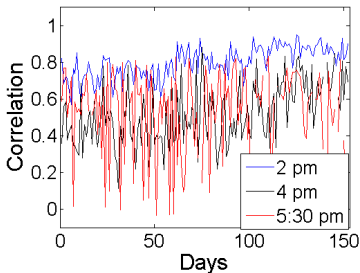
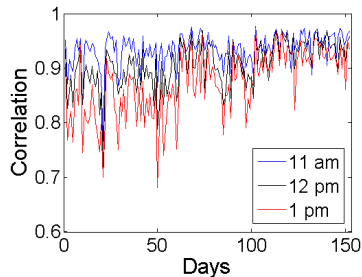
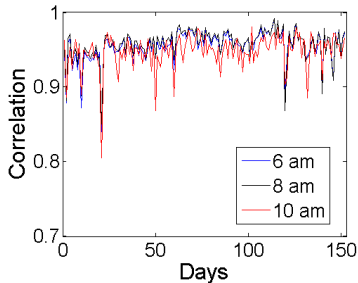
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- ① The system as a whole will **unlikely be severely impacted** by a failure.
 - ① **Core Banks:** hardly require extra funds and trigger the most severe consequences;
 - ② **Periphery Banks:** likely not to require any fund, but if they do, the amount can be significant (maximum ranges from 40% to 100%);
 - ③ **Periphery NBFIs:** extra funds required in the majority of the cases. If their counterparts fails, they are turned from *perfect recycler* to *free rider*.
- ② The Systemic Impact shows a trend that can be accurately fitted with a logistic curve. Obtaining a a sound understanding of the underlying mechanism is key to be able to make forecasts.

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Thank you for your attention!