The dawn of a mobile payment scheme: The case of Movii

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Disclaimer

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Take home messages

- **Mobile wallets replicate a physical wallet on a mobile device**, in which users can store different payment instruments (e.g., cards, transfers) to make mobile payments. Thus, mobile wallets can promote and encourage the provision of payment services.
- Movii was the first fintech firm in Colombia operating under a financial non-banking license for electronic deposits and payments—known as a Sedpe license.
- Movii aims at mobile payment solutions (a paytech) with a mobile wallet under the same brand.
- **We study the evolution of Movii's mobile wallet as a network of transfers among its users**.
- Besides the anticipated increase in the number of users and the value of transactions, **the visual and quantitative complexity of the network of transfers increases over time**.
- **This increase in complexity is likely to be linked to the adoption of Movii's mobile wallet**, which results in users finding **new ways to use mobile payments beyond person-to-person (P2P) transfers**.
- Results are valuable for **better understanding, monitoring, regulating, supervising, overseeing, and developing retail payment systems**.

Contents

Introduction

- **Mobile wallets replicate a physical wallet on a mobile device**, in which users can store different payment instruments (e.g., cards, transfers) to make mobile payments.
- **Mobile payments can promote and encourage the provision of payment services, especially P2P transfers**, but also government-to-person (G2P) transfers, online and offline purchases of goods and services (i.e., P2B, person-to-business transfers), and the payment of bills and fees (see Bezhovski, 2016, Iman, 2018).
- Mobile payments and mobile wallets are considered **beneficial to (unbanked) upper-middle and lower-class population, and a tool amid disaster recovery and emergency responses** (see Iman, 2018, Surtikanti & Mustofa, 2019).
- To the best of our knowledge, **there are no research works that study the evolution of mobile wallets from the users' transactional perspective**. That is, the lack of the users' perspective in payments (see Singh, 1999, Unger, et al., 2020).

Introduction

- **Movii was the first fintech firm in Colombia operating under a financial non-banking license for electronic deposits and payments (a Sedpe)**. As of Q3-2020, Movii has about 85 percent of the value of electronic deposits and about 94 percent of the market by number of clients.
- Movii aims at mobile payment solutions with **a mobile wallet under the same brand**.
- We study the evolution of **Movii's mobile wallet as a network of transfers among its users**. We use network analysis—to **build, visualize and analyze the mobile payments networks**.
- **A unique dataset**: bilateral transactions between Movii users from Nov.18, 2017 to Nov.25, 2020.
- Besides the anticipated increase in the number of users and the value of transactions, **the visual and quantitative complexity of the network of transfers increases over time**.
- This increase in complexity is **likely to be linked to the adoption of Movii's mobile wallet**, which results in users finding new ways to use mobile payments beyond P2P transfers, i.e., P2B.
- The emergence of **P2B mobile payments \may expose the limitations faced by small vendors to accept non-cash payment instruments**.

Introduction

- Also, the government's decision to disburse **transfers to low-income population through mobile wallets parallels with a remarkable increase in the number of users and the total value of transfers during 2020**.
- Results…
  - Show that **people do not just use mobile money services**: they innovate, and they subvert, they become designers and innovators in mobile money (Maurer, 2012).
  - Are **useful for financial authorities in their quest for understanding, monitoring, regulating, supervising, and overseeing** retail payment systems.
  - May help to enhance poverty reduction programs and disaster recovery and emergency responses by **studying how G2P transfers are dispersed and used**.
  - May help **to understand the limitations faced by small vendors to accept non-cash payment instruments**.
  - For market participants, they may help **to understand how a payment scheme evolves**.

Contents

Literature review

- Fintech is growing where the current financial system is not meeting demand for financial services; in the case of **Latin America and Southeast Asia, unmet demand for basic banking, payments, and money transfer services is likely the key factor behind the rapid growth of paytech firms** (Frost, 2020).
- Paytech firms take advantage of technological progress; demographic trends; regulatory changes; changes in socio-cultural, economic and political environment; and their simpler organizational structures to deploy new payment technologies faster than traditional banks (Polasik, et al., 2020).
- **Mobile wallets are digital wallets based on a mobile device** (e.g., smartphone, tablet), which enable users to make mobile payments in the form of transfers between transaction accounts, and online and offline purchases (see Bezhovski, 2016, FSB, 2017, Kaur, et al., 2020, Mumtaza, et al., 2020).
- About the importance of mobile wallets and mobile payments…
  - They enable **the delivery of financial services to unbanked populations** (Iman, 2018).
  - They have added a **new and more versatile way of processing payments** through the internet (Kaur, et al., 2020).
  - They can be the future of a cashless system because of its **ease and positive impact on non-cash transactions** (Mumtaza, et al., 2020).

Literature review

- About the **factors behind the usage of mobile wallets and mobile payments**…
  - Ten key technological, personal, and environmental factors: ease of use, perceived usefulness, perceived trust, perceived risk, social influence, perceived security, effort expectancy, attitude, performance expectancy, and facilitating condition (Karsen, et al., 2019). See also Mumtaza, et al. (2020).
  - Swiftness, ease of use, efficiency, effectiveness, transparency, and accessibility (Kaur, et al., 2020)
  - The lack of alternatives to cash, lack of access to banking products, poorly developed infrastructure, and high fees for money transfer services, that make mobile payments and mobile wallets attractive (Iman, 2018).
- About their adoption:
  - Mobile wallets have gained much attention in emerging markets, but **adoption is still low and uneven** (Kaur, et al., 2020, Mumtaza, et al., 2020).
  - **Where deployed, they were mostly used for P2P transfers**, but also to purchase goods or services, and to pay bills and fees. Also, **enabled G2P payments** in disaster and emergency responses (Iman, 2018).
  - During the Covid-19 pandemic, mobile wallets and other paytech solutions **enabled governments to transfer funds to bottom-of-the-pyramid unbanked population in the form of subsidies** (Cantú & Ulloa, 2020).

Literature review

- There is a long-lived **shortcoming in payments literature: the users' perspective**.
  - The available **payments data focus on the volume and value of payment instruments rather than users' use** (Singh, 1999).
  - Literature on the use of mobile wallets focuses on the volume and value of transactions, the number of users, or the intention to use or to recommend, either from reported data, surveys or interviews (e.g., Iman, 2018, Surtikanti & Mustofa, 2019, Mumtaza, et al., 2020).
  - There is a **deficiency of research that tracks changes in behaviors within payment platforms over time** (Unger, et al., 2020).
- A noteworthy exception: the case of Venmo (Zhang, et al., 2017, Acker & Murthy, 2020, Unger, et al., 2020).
  - A mobile wallet that is also a social payment system, with payments and comments publicly available in a social media feed.
  - It has enabled **the first large-scale analysis of financial transactions networks on person-to-person mobile payments**.
  - Unger, et al. (2020) **focus on the evolution of Venmo's transactional network** to study the changes in behavior of its users.
- Our work is inspired by Singh (1999): **the users' perspective is needed to better understand payment systems and money.**
- Our work is strongly related to Zhang, et al. (2017) and Unger, et al. (2020), who study Venmo's transactional network.
- But **we focus on the evolution of mobile wallet usage, daily, from day 1**; that is, we focus on how the visual and quantitative complexity of the transfers network evolves over time as a proxy of users' adoption.

Contents

The dataset

- Data provided by Movii, in edge list format.
  - 461,749 rows, comprising transactions since Nov.18, 2017 to Nov. 25, 2020 (983 days).
  - 178,750 users (transfers between Movii users only, a closed system).

	COP$	US$
Mean	93,991.00	27.12
Median	40,000.00	11.54
Mode	160,000.00	46.16
Standard deviation	149,030.00	43.00
Min	100.00	0.03
Max	11,900,000.00	3,433.20
Skewness	7.66	7.66
Kurtosis	224.87	224.87

Table 1. Descriptive statistics of the transactional dataset. Calculated on daily transactions between users. Conversion from COP$ to US$ is based on December 2020's average official exchange rate (US$/COP$ 3466.13).

The dataset

- The value of transactions is not evenly distributed among the users: **a few users greatly contribute to the total value of transactions**, whereas most users contribute marginally.

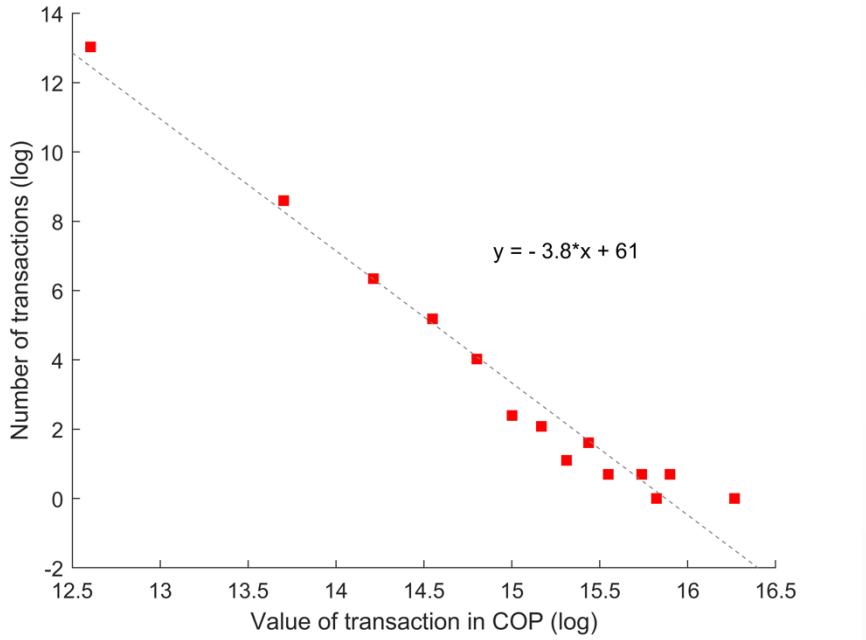


Figure 1. Distribution of transactions by value. In COP$, in double-log plot.

The dataset

- The activity ratio suggests that **most users are sporadic**: About 34.22 percent of users are of the "one-and-done" type.

$$y = \frac{\langle t_{last}, t_{first} \rangle}{t_{end} - t_{first} + 1}$$

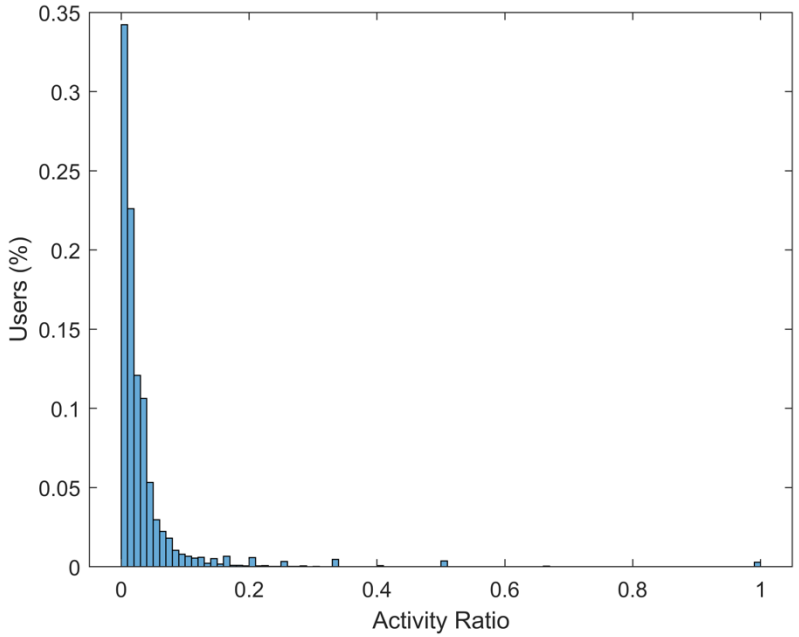


Figure 2. Histogram of the activity ratio.

Contents

The methodology

- Networks are **a natural representation of complex systems** (Caldarelli, 2020).
- Network analysis is dedicated to **describing and understanding an underlying system, focused on capturing its structure** (Börner, et al., 2007).
- As we represent Movii's scheme as a network, its **users are represented as nodes that interconnect when they send or receive a transfer** from other users.

$$W = \begin{bmatrix} 0 & w_{1,2,t} & \dots & w_{1,n,t} \\ w_{2,1,t} & 0 & & w_{2,n,t} \\ \vdots & & \ddots & \vdots \\ w_{n,1,t} & w_{n,2,t} & \cdots & 0 \end{bmatrix}$$

- From the network representation, we calculate several network statistics. These statistics aim at measuring the adoption of the mobile wallet and the mobile payments from the users' perspective.

The methodology

- We calculate a selected set of network statistics for each day, namely
  - The size of the network (the number of connected users);
  - The total value of transfers (the total value of transfers);
  - The density (the fraction of potential nodes that are observed);
  - The average number of connections per node;
  - The reciprocity (the fraction of connections that are reciprocated, i.e., two-way connections);
  - The transitivity (the fraction of triads that are fully connected);
  - The number of connected components (the number of subnetworks in the network);
  - The number of components with two and more than two nodes (the number of subnetworks with 2 or >2 users);
  - The size of the largest component (the number of users in the largest subnetwork in the network);
  - The degree structure entropy of the network (a measure of the structural complexity of the networks).

The methodology

- Additionally, we employ network visualization to examine the complexity of the system over time.
- As put forward by Lima (2011), network visualization is a potential visual decoder of complexity—a remarkable discovery tool, able to translate structural complexity into visual insights.
- **Network visualization will enable us to track the evolution of the system of transfers** among Movii users, focusing on the increase in size and the **emergence of intricate transactional patterns in the network**, such as stars, chains, loops, etc.

Contents

Main results

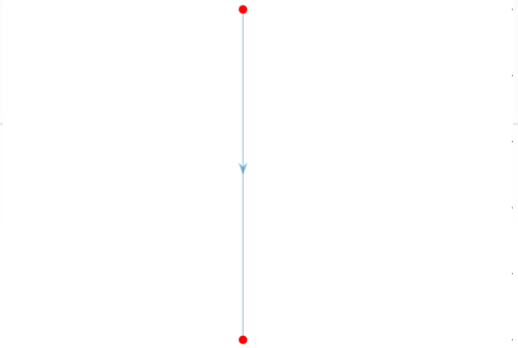
- Network visualization
- Network statistics

Network visualization

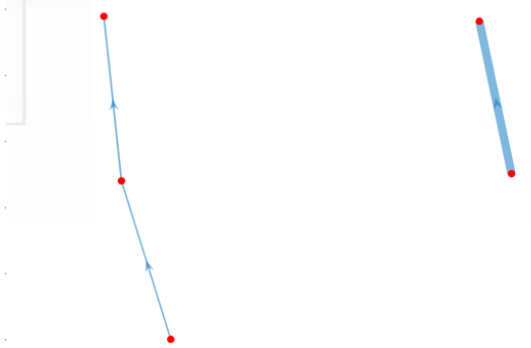
- Graphs are the most suitable method for the depiction of networks due to their intrinsic organization based on nodes and connections (Lima, 2011).
- For visualization purposes,
  - Nodes represent users; all nodes in a graph have the same size.
  - Directed connections represent transfers between them, pointing from the payer to the payee, where their width corresponds to the value of the transfer.
  - We employ a force layout to arrange the nodes, which attracts adjacent nodes and repulse distant nodes.
  - To enhance the visualization as the network becomes large, we impose a gravity layout that spreads components radially and we uniformly reduce the size of the nodes for graphs with n>100.
  - Time is one of the hardest variables to map in any complex system, yet it is also one of the richest (Lima, 2011).
  - Yet, displaying all 983 networks is unfeasible… thus, we select 8 graphs representative of the evolution of the network.

Network visualization

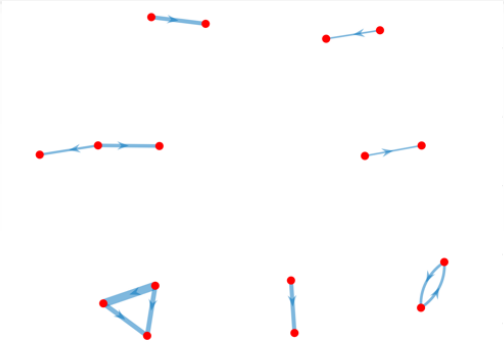
a. November 18, 2017



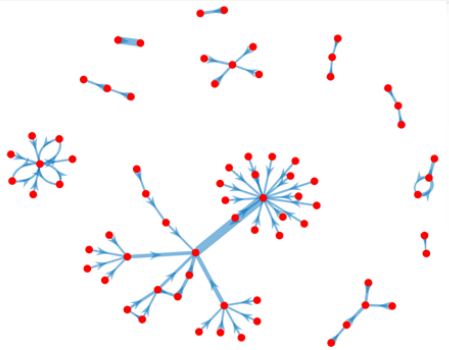
b. April 16, 2018



c. August 17, 2018

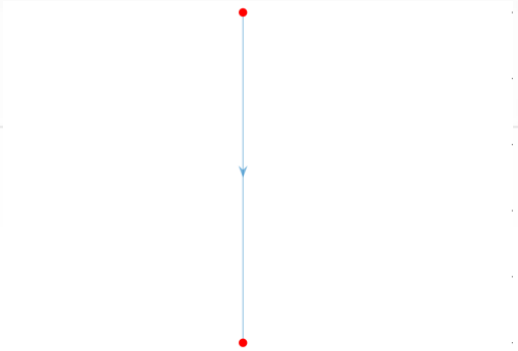


d. January 25, 2019

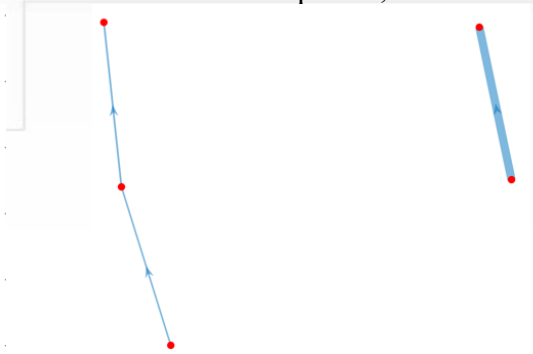


Network visualization

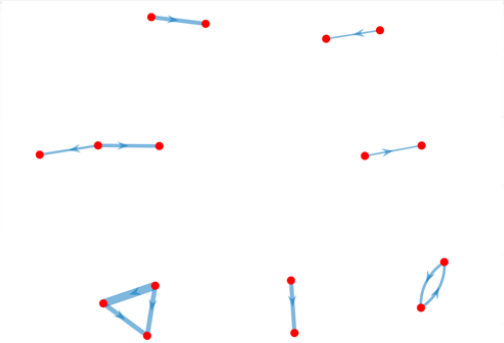
a. November 18, 2017



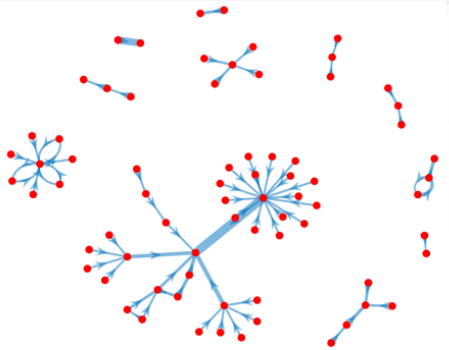
b. April 16, 2018



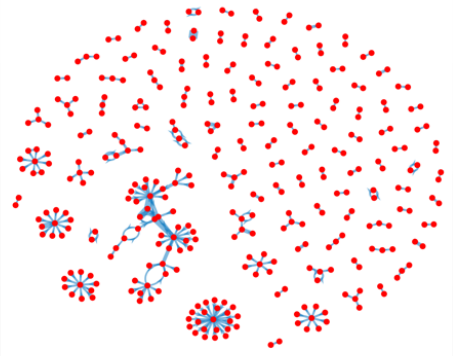
c. August 17, 2018



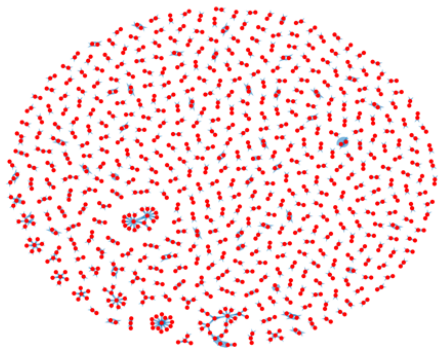
d. January 25, 2019



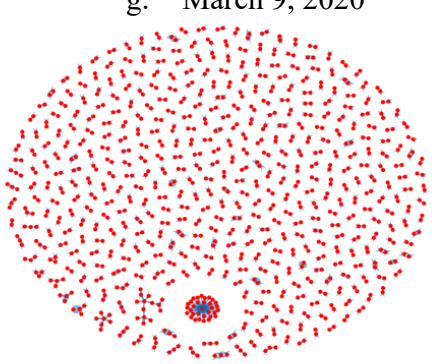
e. June 29, 2019



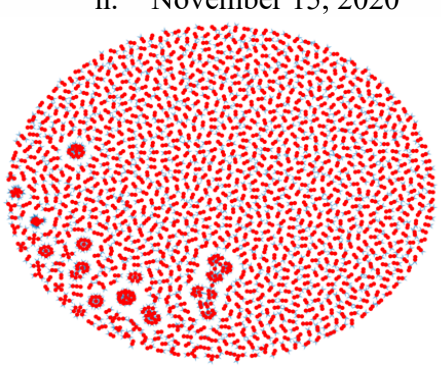
f. October 28, 2019



g. March 9, 2020



h. November 15, 2020



Network visualization

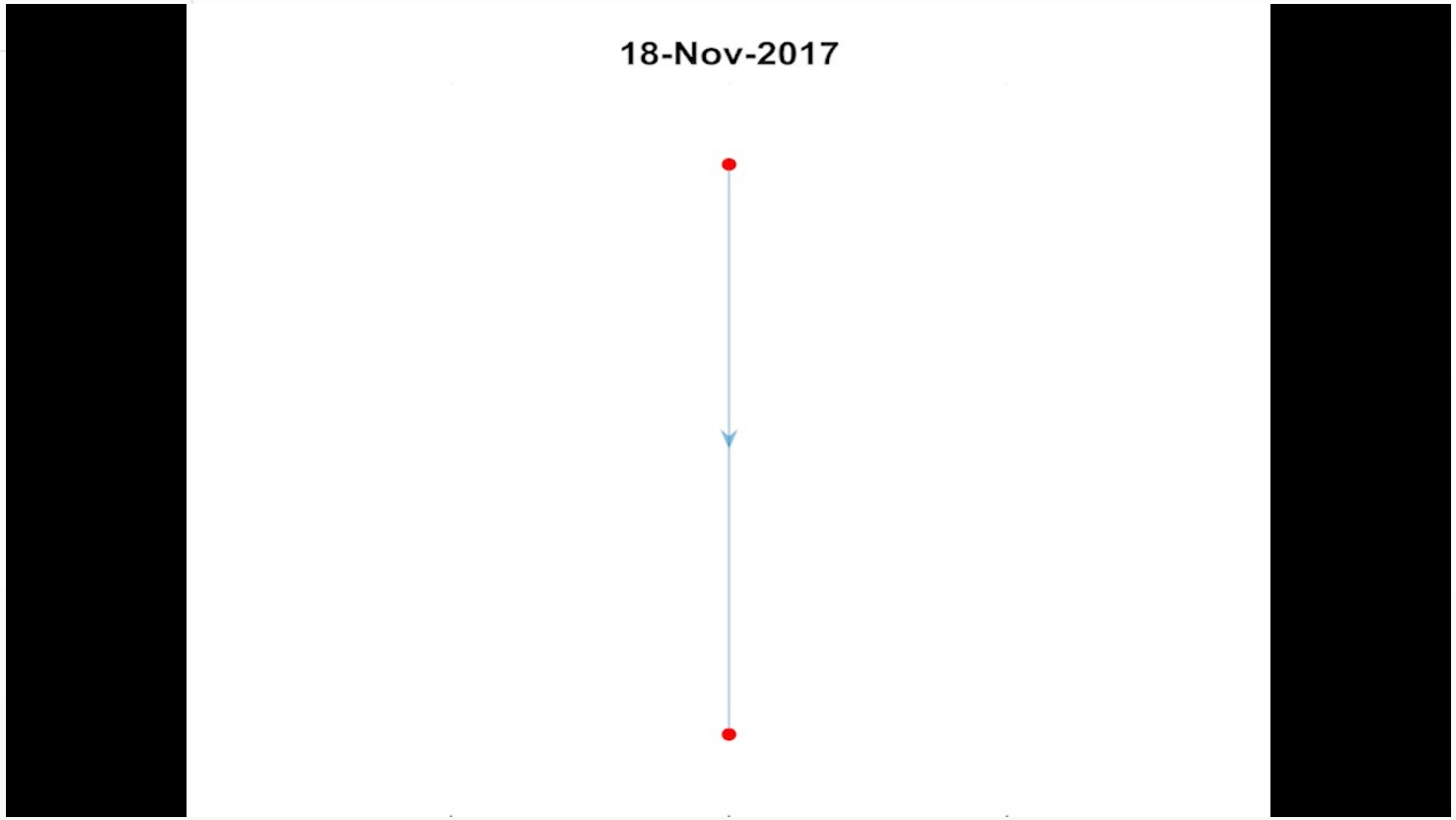
- Some insights:
  - **It starts with a rather simple network with a few users displaying simple connective patterns**.
  - **It evolves** to several tens, several hundred, and almost two thousand users, displaying **both simple and intricate connective patterns**.
  - **Most transactions are simple transfers** between two otherwise isolated users.
  - **But new transactional patterns emerge in the form of stars, chains, and loops**.
  - **Components with a non-small number of users** emerge.
  - The largest components from 2019 onward display a common feature: they are **star networks or a collection of interconnected star networks**.
  - Most of **those star networks consist of surrounding nodes that transfer funds to the central node only**; there are no transfers between peripheral nodes or from the central node to peripheral nodes. This is **likely the footprint of a vendor of goods and services that receives payments from his customers**.

Network visualization

- The following video presents the daily evolution of the graphs, from November 18, 2017 to November 25, 2020.
- It shows…
  - How **a small and simple network of transfers evolves to a larger and more intricate network.**
  - The **size and visual complexity of the network increased remarkably during 2020**—parallel to the Covid-19 pandemic.
  - There are **several abrupt increases in the size of the network during 2020, which concur with the availability of funds transferred by the government amid the Covid-19 pandemic**.

Network visualization

- The following video presents the daily evolution of the graphs, from November 18, 2017 to November 25, 2020.

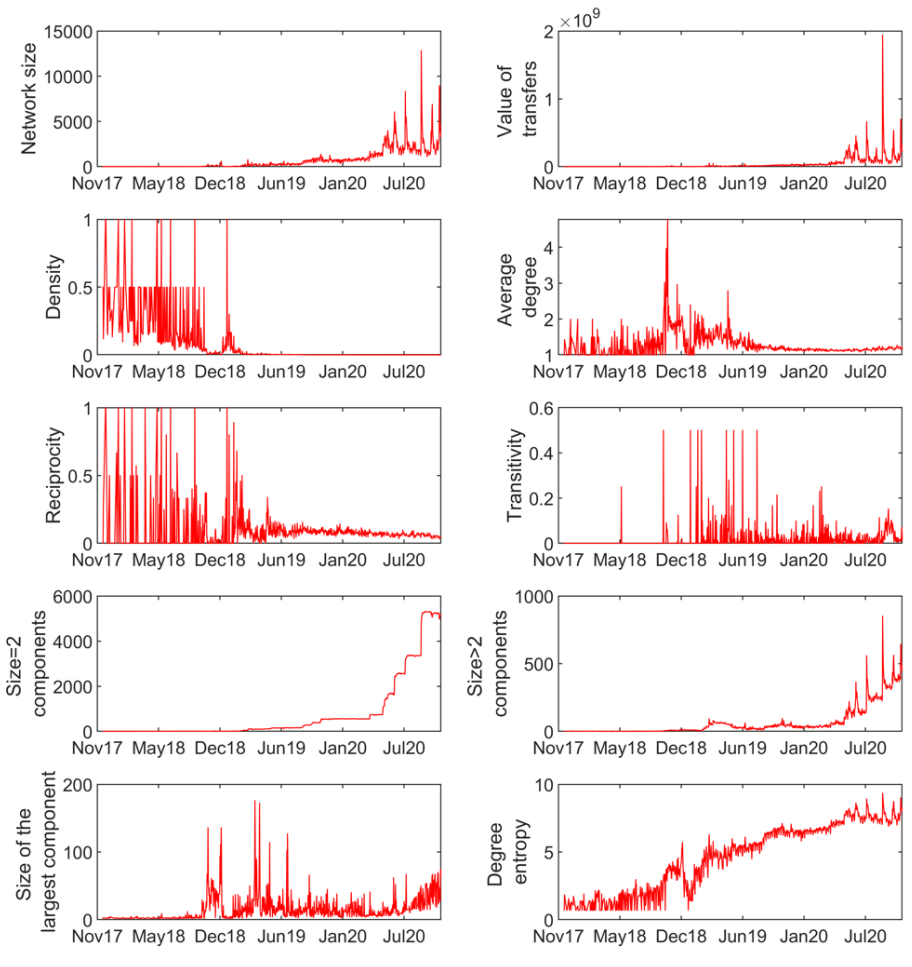


https://youtu.be/D_BTDplRxA4

Main results

- Network visualization
- Network statistics

Network statistics



- The number of users and the value of transfers increased troughout the period.
- Remarkable increase during 2020, parallel lo Covid-19 government-to-person transfers.

- The number of counterparties remained low, i.e., about less than 2 per user.
- As the number of users increased, the density dropped—akin to financial networks levels.

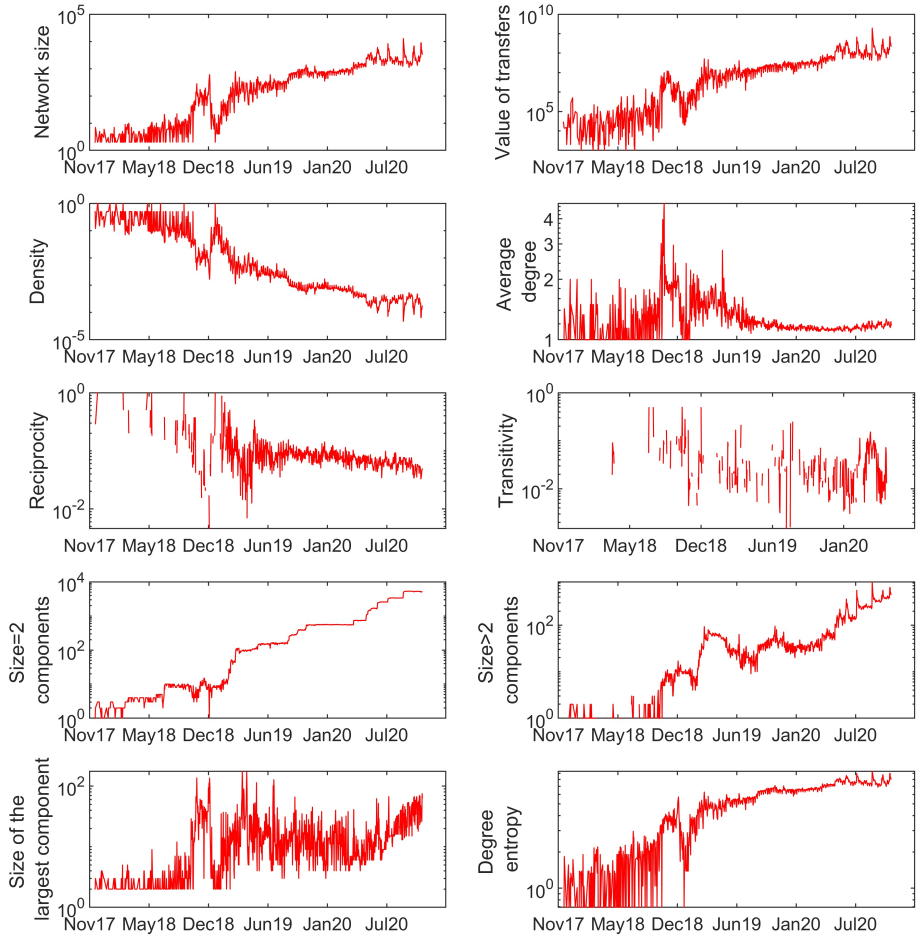
- Reciprocity shows a clear decreasing trend; in the last 100 days, averaging 5.83%.
- From 2019 onwards, transitive relations become noticeable but still infrequent.

- Components with two nodes are prevalent and clearly increasing—reaching > 4000.
- Components with more than two nodes show an increasing trend too.

- The size of the largest component increases.
- The degree structure entropy shows a clear increasing trend; this means that complexity factors, such as connectedness, cycles, etc. increase over time.

Network statistics

Log-scale



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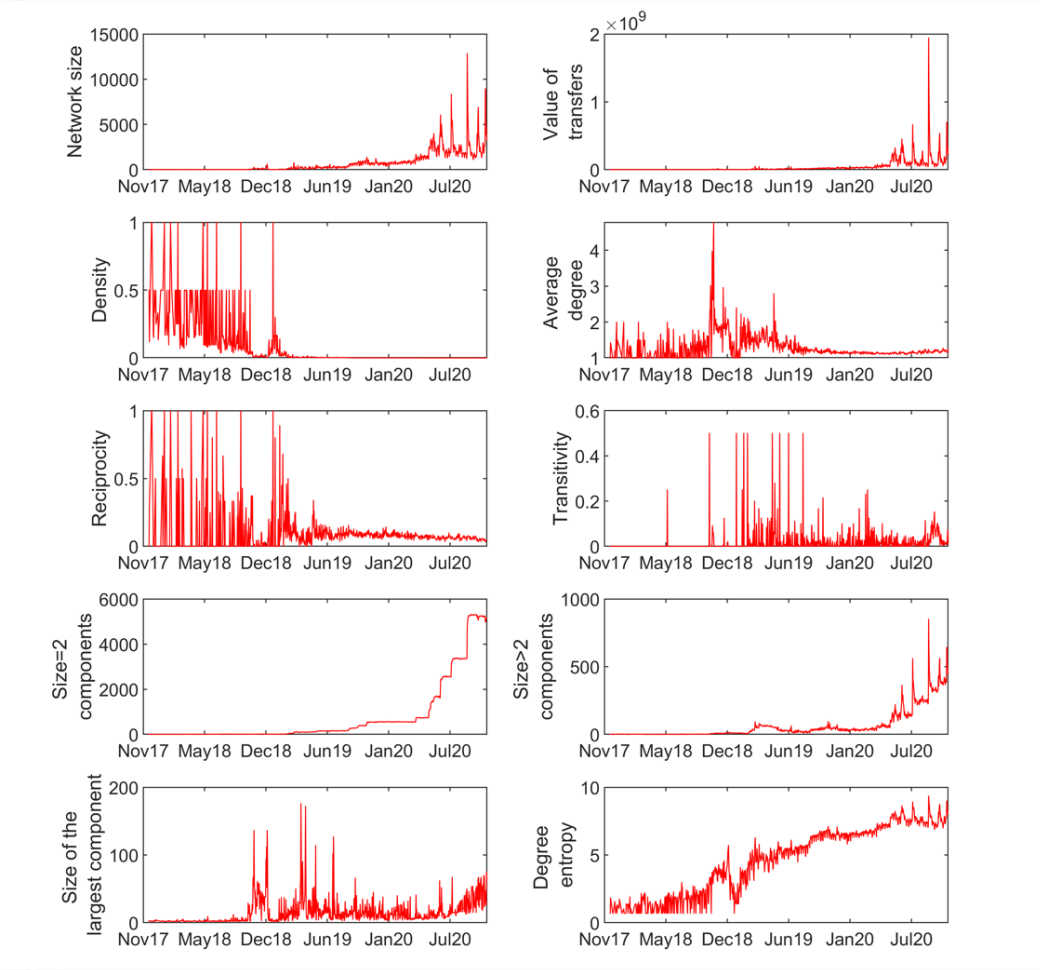
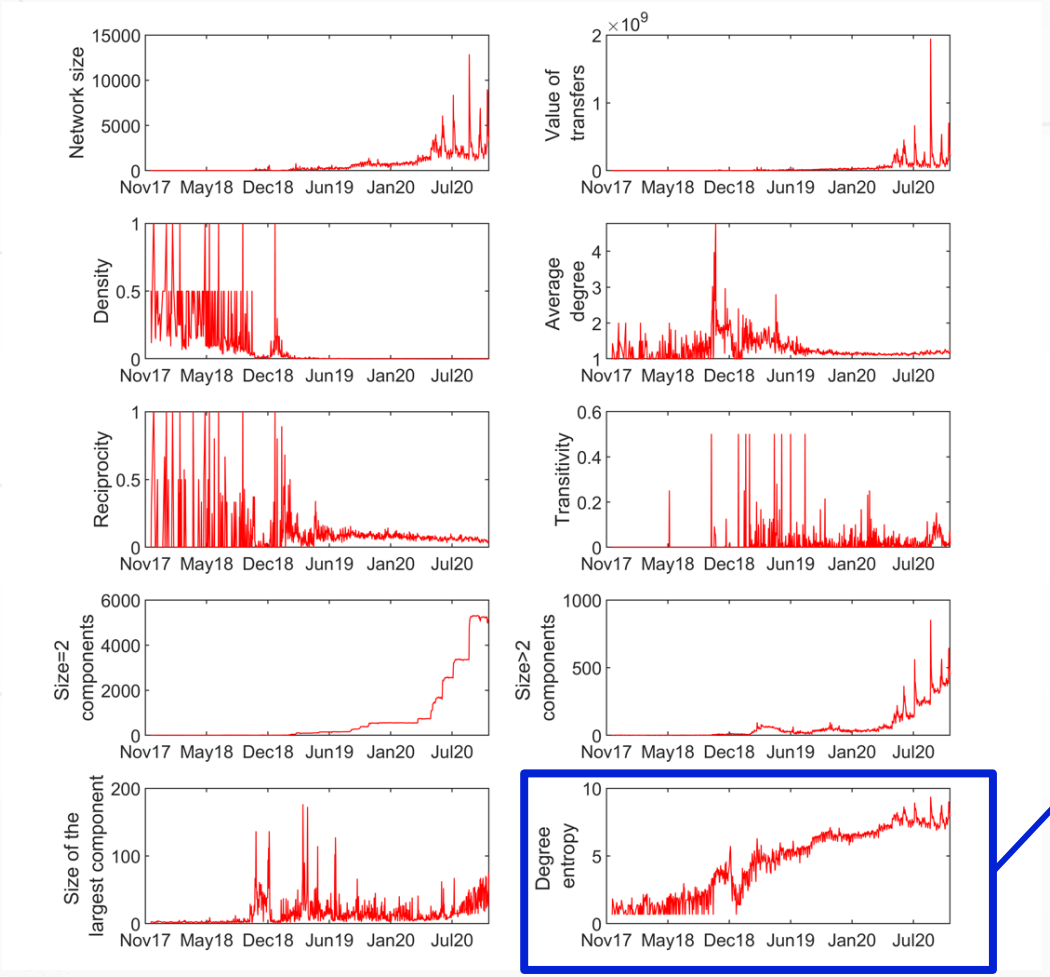
Network statistics



Log-scale

Not only the number of users and the value of transactions increase manifestly as a customary token of adoption, but also the emerging intricate and multifaceted patterns of connections correspond to users—advertently or inadvertently—discovering new uses beyond the simple bilateral transfer of funds.

Network statistics



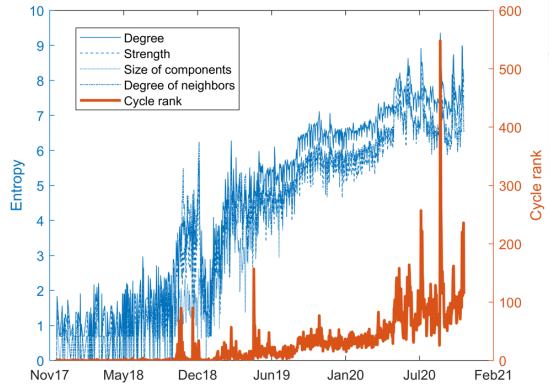


Figure A3. Comparison of entropy on selected probability schemes and cycle rank (November 17, 2017, to November 25, 2020). Degree corresponds to the probability scheme based on nodes' degree (see Figure 5). Strength corresponds to the probability scheme based on the contribution of each node to the total value of transfers. The size of components corresponds to the probability scheme based on the number of nodes in each component. The degree of neighbors corresponds to the probability scheme based on the average number of connections of each node's neighbors. Cycle rank corresponds to the number of linkages that must be removed to get a minimal spanning tree, i.e., the simplest graph covering all nodes but containing no cycles or loops.

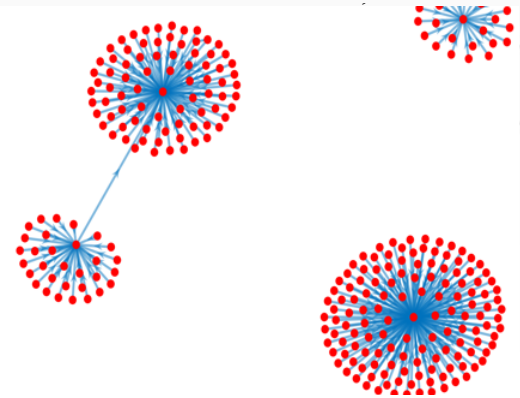
	I	II	III	IV	V
I. Degree					
II. Strength	.99				
III. Size of components	.99	.98			
IV. Degree of neighbors	.99	.98	.95		
V. Cycle rank	.69	.73	.70	.66	

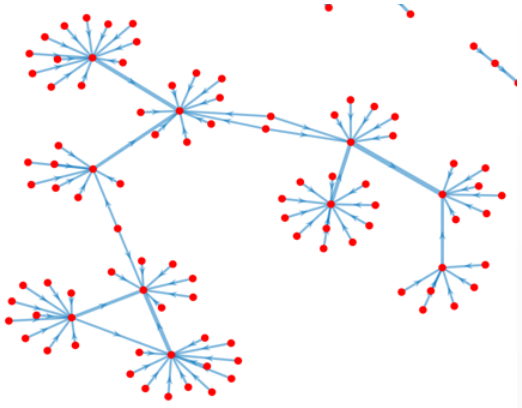
Table A1. Correlation matrix of entropy on selected probability schemes and cycle rank.

Contents

Discussion

- Together, the visualization of the networks and the selected set of network statistics suggest that **the adoption of Movii increases throughout the period** under study.
- Following Maurer (2012), these **emerging connective patterns are a footprint of mobile money users** acting as everyday designers and innovators in mobile money.
- Components in the form of **star networks, with a central node exclusively receiving transfers from peripheral users that are not connected among them**, is an obvious hallmark of P2B transactions.
- P2B transactions materialize as small vendors are unable to accept other non-cash payment instruments (e.g., credit and debit cards, checks); that is, Movii enables small vendors to accept mobile payments in exchange for their goods and services.
- Unfortunately, the anonymity of users impedes the verification of our suggestion. Therefore, we discuss how the reported connective patterns and network statistics could further support our conjecture…

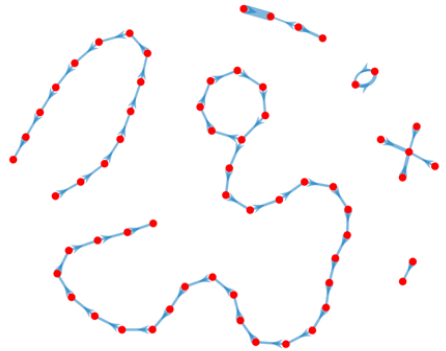




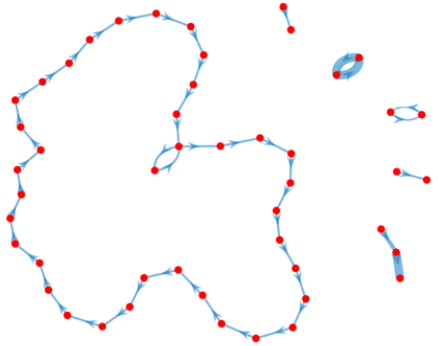
Discussion

- Other connective patterns that emerge as the network evolves are interesting as well, namely the lengthy loops and chains. These connective patterns **require further study to provide a plausible explanation**.

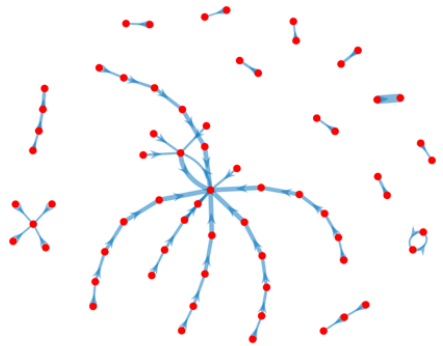
a. January 18, 2019



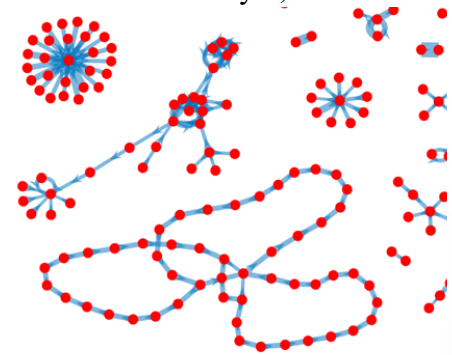
b. February 3, 2019



c. February 9, 2019



d. May 8, 2019



Contents

Final remarks

- **Mobile wallets and mobile payments have become a recurrent topic worldwide**, with particular traction in developing countries—where the demand for basic banking, payments, and money transfer services is unmet.
- However, **research about how the users adopt mobile wallets and mobile payments is scarce**. Existing research focuses on the volume and value of mobile payments but neglects the users' behavior as they adopt mobile payments.
- **We study the networks that emerge from the transfers between users of Movii**—the mobile wallet of the first fintech firm in Colombia operating under a financial non-banking license for electronic deposits and payments.
- **We find that the anticipated rise in the number of users and the value of transactions is accompanied by an increase in the visual and quantitative complexity of the network**.

Final remarks

- We suggest that **this increase in complexity is likely to be linked to the adoption of Movii, which results in users finding new ways to use mobile payments beyond P2P, including P2B**.
- As the anonymity of users impedes the verification of our suggestion, we discuss how the reported connective patterns and network statistics could further support our explanations.
- Results…
  - show that **people do not just use mobile money services: they innovate, and they subvert, they become designers and innovators in mobile money** (Maurer, 2012).
  - are **useful for financial authorities** in their quest for understanding, monitoring, regulating, supervising, and overseeing retail payment systems.
  - may help to enhance poverty reduction programs and disaster recovery and emergency responses by **studying how G2P transfers are dispersed and used**.
  - may help **to understand the limitations faced by small vendors to accept non-cash payment instruments**.
  - for market participants, they may help **to understand how a payment scheme evolves**.

Final remarks

- Pending issues and challenges…
  - **We are working on an isolated system**. We know that this system interacts with other systems (e.g., banking accounts and other electronic deposits) and services (e.g., cash in and cash out, debit card purchases).
  - **Studying other mobile wallets**—in Colombia and abroad—will contribute to determine whether our findings are stylized facts of their evolution.
  - Our findings suggest that the **connective patterns in the transfer networks may reveal the type of nodes and relations** in the scheme…
    - The network importance (i.e., the centrality) of nodes may reveal which nodes correspond to users selling goods and services, and which relations correspond to person-to-business transfers.
    - The connective patterns may help to identify unusual transfers worth scrutinizing.
  - **Adding users' features to the dataset** (e.g., gender, age, geolocation, income, economic activity, mobile device) may open new dimensions to the analysis of the networks.

The dawn of a mobile payment scheme: The case of Movii