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RÉSUMÉ OF THE PH.D. THESIS

Pollák, Zoltán

LIQUIDITY MANAGEMENT AND INTERMEDIATION IN UNSECURED CREDIT MARKETS

Ph.D. dissertation

Supervisors:

Berlinger, Edina Ph.D.
Dömötör, Barbara Ph.D.

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Department of Finance

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1. The aim of the dissertation and the relevance of the topic

The bankruptcy of Lehman Brothers in 2008 and the ensuing lightning-fast knock-on effects leading to a global financial crisis highlighted the importance of understanding interbank networks and, through them, the importance of systemic risk management. Central banks, which had used micro-prudential instruments until then almost exclusively, recognised the importance of macro-prudential regulation, and it became a key factor to identify the so-called Systemically Important Financial Institutions (SIFIs) and to rethink regulations governing them.

The Basel Committee on Banking Supervision (BCBS), the body shaping the regulatory framework for the banking sector on a global level, published its methodology for the assessment of systemically important banks in 2011 *(BCBS [2011])*, by updating it in 2013 *(BCBS [2013b])*. In its recommendation, the Committee included five characteristics to be used for the identification of systemically important banks, namely the size of an institution, its substitutability, its complexity, the global scope of its activities, and its interconnection with other market participants within the financial system.

Owing to that latter interconnection, network science was officially included in regulatory processes, a fact creating regulatory support for its application, in addition to a demand arisen for it before. As academic literature suggests, this gradually growing demand has led to an extremely rapid advancement of network science in the field of finance over the past decade.

My research on the Hungarian unsecured interbank deposit market and intermediation activities is carried out at three levels built on each other.

At the first level, a descriptive research is conducted to examine, from several angles, a significant segment of the interbank market: the unsecured interbank deposit market. In the spirit of this, my thesis starts with a general academic literature review. In addition to describing the domestic interbank market, I also cover similarities and differences observed between interbank markets of some countries in the CEE region.

After that, a detailed database of transactions (received for research purposes) is used to examine certain dimensions characterizing the interbank unsecured deposit market network in the period of 2012-2015 and to analyse how stable the examined parameters were over time. This examination aims (1) to provide a general picture of the market, presenting magnitudes of volumes and typical maturities of transactions; (2) to compare my results with previous studies

found in academic literature to draw interesting conclusions about processes observed in the period analysed; and (3) to examine the stability of the network over time, subject to different dimensions, an effort definitely worthwhile to make, as a sufficiently stable network structure is essential for drawing robust conclusions and exploring causal relationships.

The next chapter presents three essential network models (necessary in order to analyse and develop a deeper understanding of financial networks): random, scale-free, and hierarchical networks. A special type of this latter, hierarchical network model is discussed in detail: the core-periphery structure, which is typical of interbank networks. The discrete and continuous versions of the core-periphery model found in the academic literature are described, together with the coreness measure that can be calculated in connection with the continuous version. One of the main scientific results of my thesis is a methodological innovation (a modified alternative to the coreness measure published in academic literature), enabling a more accurate classification of core and periphery participants.

At this point, building on the descriptive part, I move on to the next level of research, where deeper connections and causal relationships are examined. The key to the above-mentioned core-periphery network structure is intermediation. Core participants act as intermediaries between periphery banks, in addition to managing their own liquidity.

Then, an examination is carried out to explain why even financial intermediaries need intermediaries in such markets. As the academic literature suggests, intermediaries perform five main functions: they (1) provide liquidity and facilitate a more efficient allocation of funds; (2) alleviate information asymmetry; (3) reduce transaction costs in the market; (4) take advantage of economies of scale and scope; and (5) allow for a higher degree of risk sharing. Intermediaries perform beneficial activities that tend to increase the efficiency of operations in interbank deposit markets and reduce market failure attributable to the factors listed above.

Therefore, simple economic arguments are sufficient to present why markets need intermediaries. But, from the other side, what motivates intermediaries when stepping in between two periphery participants? Based on business logic and academic literature, an assumption is used: core banks provide such intermediation services for making profits.

Using the detailed transaction database analysed previously, an estimate is provided of the volume of intermediation activities in the Hungarian interbank market and their significance is examined. Then a weighted average estimate and an upper estimate is provided of the annual

profits made by intermediation activities. To the best of my knowledge, no other authors have attempted to quantify the amount of profits made by intermediaries in the interbank market; so this part is the next major research result of my thesis.

After that, building on the results of a joint research with my co-authors, I present the network of interpersonal loans made by the Roma majority population of an underdeveloped small Hungarian village; and compare that network with the unsecured interbank deposit market. These two – seemingly distant – markets have not been compared before by any other authors; so the results achieved here can be considered as a novelty that expands our current knowledge.

As shown by a comparison between them in terms of their structural characteristics, basic network indicators, degree distributions, and clustering coefficients, the two credit markets are similar in many respects. This allows us to conclude that similar processes work in the background, and essentially the same problems have to be solved by players in both markets, which creates similar patterns.

After that, the chapter seeks answers to the questions whether intermediation activities are present in interpersonal lending markets and what is the primary motivation for granting loans.

Finally, after exploring causal relationships, I move to the third, normative level of my research, formulating proposals and policy recommendations and summarizing possibilities for utilizing my research results in relation to interpersonal loans and then the interbank deposit market.

2. Methods applied

I examine a total of seven hypotheses in my thesis. In the following, I describe these together with the methods used for their analysis.

H1: **The distribution of overnight and longer-term unsecured interbank transactions significantly differ.**

The relevance of my first hypothesis lies in the fact that if the overnight and longer-term transactions of the unsecured interbank deposit market significantly differ, their joint analysis would lead to distortions. The appropriate selection of the circle of transactions to be analysed is a cardinal question concerning what follows.

These distributions were compared through histograms, box diagrams, a Q-Q graph, as well as a homogeneity analysis.

According to the null hypothesis of the test for homogeneity, the distribution of one variable (size of the transaction in this case) in two populations (overnight and longer-term transactions) is identical. In contrast, the alternative hypothesis states that the two examined distributions are not identical.

H2: **The concentration of borrowing is significantly higher than the concentration of lending, both in terms of volume and the number of transactions.**

An unsecured and significant exposure brings to the fore counterparty risk in the interbank market. The actors constantly monitor and rate each other. If a bank perceives that a counterparty has an increased default risk, it can respond by raising the interest rate (price adjustment) and reducing the amount of loan available (quantity adjustment) *(Berlinger [2017])*.

In the interbank market, quantity adjustment clearly dominated the market, and the participants responded to the increased risk by cutting back on lending.

The concentration analysis for my second hypothesis aims to shed light on the structure of the quantity adjustment, and its relevance lies in the concentration-related connections published in the academic literature.

According to my second hypothesis, in terms of the volumes and the number of transactions, the borrowing transactions show a significantly higher concentration than the lending

transactions. It means that proportionally more market participants finance fewer market participants.

This assumption can be tested with a two-sample z-test for comparing expected values. According to our alternative hypothesis, the average concentration of borrowing *(B)* (μ_B) is larger than the average concentration of lending *(L)* (μ_L), and according to our null hypothesis, the expected value of the HHI index of lending is minimum the size of that of borrowing, in other words, formally:

$$\begin{aligned} &H_0: \quad \mu_B - \mu_L \leq 0 \\ &H_1: \quad \mu_B - \mu_L > 0 \end{aligned} \tag{1}$$

H3: **A coreness measure adjusted by a concave weight function allows for a better and more robust classification than before.**

Whereas, in testing this hypothesis, I use the results of our joint research performed together with Edina Berlinger and Barbara Dömötör so that I will switch to first-person plural in the wording.

In the majority of the interbank networks, a so-called core-periphery structure is present. The core-periphery structure consists of two distinct groups of nodes (in this case, banks). The first group is the core, which forms a complete graph; that is, any two vertices are connected by an edge. The other group, the periphery, is a set of isolated nodes not connected at all *(Borgatti–Everett [2000])*.

To move from the discrete core-periphery model to a continuous one, where coreness is no longer measured by a binary variable 0 or 1 but by a so-called coreness measure that can assume any real number between 0 and 1. The higher the value of this coreness measure, the more the given node is assigned to the core. We can determine freely the cutoff value above which the nodes are put into the core. Thus, in a continuous core-periphery model, the issue of coreness is not black and white, but different shades of grey also appear. And the analyst can decide the critical value of the coreness measure for separating the core and periphery actors. *Boyd et al. [2010]* propose the MINRES method described by *Comrey [1962]* and *Harman [1967]* for the transition to a continuous model.

To improve the *Boyd et al. [2010]* coreness measure, we first defined four properties that a properly functioning coreness measure must fulfil. These requirements were formulated

everywhere at the level of economic intuition, starting from the original definition of a core-periphery structure.

We presented some simple – and, by definition, perfect – core-periphery networks and subject to the optimization process used in academic literature, where coreness measure does not fulfil at least one of the four defined properties.

As a solution, we recommend determining M_{ij} modifiers (or weight functions) between the actors i and j of the network which give great weight to the transactions of similar actors (core-core or peripheral-periphery), while the transactions between highly different (core and peripheral) actors are given low weights within the sum of the squares of differences.

$$\sum_i \sum_{j \neq i} M_{ij} \left(A_{ij} - w_i w_j\right)^2 \qquad (2)$$

Where $\boldsymbol{A}$ is the $N \times N$ adjacency matrix (elements are 1 if there is an edge between points i and j, and 0 if there is no connection), $\boldsymbol{w}$ is the N-element column vector containing the coreness measures, and $\boldsymbol{w^T}$ is its transpose.[1]

In the optimization, we first take an N-element vector $\boldsymbol{w}$ with arbitrary initial values between 0 and 1 and form the structure matrix as the dyadic product of $\boldsymbol{w}$ by itself. The sum of squares of the deviations of the elements of this structure matrix and matrix $\boldsymbol{A}$ gives an error term, which we can minimize by modifying the elements of $\boldsymbol{w}$. A necessary restriction is that the elements of the $\boldsymbol{w}$ can only fall between 0 and 1.

Formula 2 differs in the modification factor M_{ij} from formula widespread in the literature *(Boyd et al. [2010])*. The anomalies of the widely *(Langfield–Liu–Ota [2014], Fricke–Lux [2015], León–Machado–Sarmiento [2018])* used coreness measure can be handled by introducing a modification factor M_{ij} which gives more weight to the relationship A_{ij} when two core players (both w_i and w_j are large, close to 1) or two peripheral actors (both w_i and w_j are low, close to 0) meet. This can be technically solved if M_{ij} is a monotonically decreasing function representing the distance in the coreness measures of w_i and w_j.

A concave weight function is best able to fulfil the function that relatively similar (core-core or peripheral-periphery) connections are given high weight, and the more significant the difference in the coreness measure of two nodes, the less the algorithm will take their relationship into

[1] So, $\boldsymbol{ww^T}$ is the dyadic product of an N-element column vector by an N-element row vector.

account in optimization. (i.e., underweight the core-peripheral and peripheral-core connections).

We examined the robustness of the unweighted coreness measure described by *Boyd et al. [2010]* and the new coreness measure we have introduced. We did this by adding a certain amount of noise to the examined adjacency matrix and examining how much the weighted methodology changes the coreness measure of each node relative to the original (unweighted) case. We consider it to be a more robust coreness measure, in which case a small amount of noise changes the order of the network actors ranked according to the coreness measure less.

According to the Basel principles laid down in 2013 *(BCBS [2013b])*, the Financial Stability Board designates Global Systemically Important Banks (G-SIBs) on an annual basis. The designation process is based on a multi-dimensional scoring system and, at the end of that process, the 30 credit institutions having the highest scores are classified into the G-SIB category. Due to the designation logic (n banks with the highest score are selected by the Financial Stability Board), it is essential for the indicators determining the central players in an interbank market (such as the coreness measure) that random noise should influence the ranking of players as little as possible. This is why the criterion of robustness is defined based on the variability of sequence.

The change in order we quantified by Spearman's rank correlation coefficient. In terms of robustness testing, it is also essential to clarify precisely the "noise" mentioned earlier. We apply the following algorithm: each element of the adjacency matrix (in an independent manner) is changed with a certain probability q. Where there was previously a connection between two actors, there is a probability that this connection will disappear, and where there was no edge between two vertices, it will be there. This probability q is from now on referred to as the noise level.

We performed simulations for stylized and real networks and looked at the rank correlations between the $\boldsymbol{w}$ coreness measures vectors obtained during the simulation for 1000-1000 modified (“noisy”) relationship matrices at different noise levels between 0 and 1. Finally, we took the arithmetic mean of the 1000 rank correlation coefficients and repeated it for different noise levels.

After that, using a hypothesis test concerning the difference between two population means, we examined the extent to which differences between average rank correlations obtained at different noise levels are considered significant. Thus, we tested the statement that the average

rank correlation is significantly higher in the case of the new modified type of measure (μ_M) than in the original unweighted case (μ_U).[2] The null hypothesis states that the average rank correlation obtained with the original measure is at least as high as in the new case calculating with the modification factor.

H4: **Intermediation activities in the Hungarian unsecured interbank deposit market are of significant volume.**

The essence of the core-periphery model presented in the previous chapter is intermediation, where core banks provide a kind of intermediation service between peripheral participants who do not transact directly with each other.

I examined the question of how much of the credit volumes observed in the market can be linked to intermediation activities. I performed the analysis on the previously used database of transactions, by focusing again on interbank transactions concluded solely for liquidity management purposes, i.e. overnight loans, which account for 91% of unsecured interbank deposit market transactions. A significant difference compared to previous methods is that data is now aggregated on an annual rather than a monthly basis.

Let $L_{i,t}$ denote the face value of bank i lending and $B_{i,t}$ the face value of bank i borrowing on day t. The volume of intermediation for bank i ($I_{i,t}$) – being overnight transactions – is the minimum amount taken or given, on every single day t. This amount is supposed not to serve the institution's daily liquidity management directly.

$$I_{i,t} = min(L_{i,t}; B_{i,t}) \tag{3}$$

$I_{i,t}$ is the amount that the bank i merely flows through itself on day t, the net liquidity position at the end of the day would remain unchanged without this common part of borrowing and lending. In this way, I determined the volume of intermediation activities.

H5: **In the Hungarian unsecured interbank deposit market, the main motivation of intermediation activity is to make profits.**

Generalizing the method mentioned above, the calculation of the intermediary profit (π) for bank i on day t is

$$\pi_{i,t} = I_{i,t} \cdot \frac{r^L{}_{i,t} - r^B{}_{i,t}}{360} \tag{4}$$

[2] This will be the alternative hypothesis.

where $r^{L}{}_{i,t}$ and $r^{B}{}_{i,t}$ are the weighted average (annual) lending and borrowing rates, respectively, and $I_{i,t}$ stands for the volume of intermediation of bank i on day t. I rescaled the annual interest rate into daily return by dividing by 360, as the money market ISDA standard suggests *(ISDA [1998])*.

The calculation with a weighted average interest rate is a possible estimation method; it is impossible to determine the exact intermediary profit. However, from the detailed transaction data, the upper limit of the intermediary profit can be calculated too.

All we have to do is sort the transactions in descending order of interest rate on the lending side and in ascending order on the borrowing side for a given day and for a given market participant, so we assume the most favourable conditions for the intermediary's profit. In this way, I got an upper estimate for profits from intermediation. Based on the magnitude of the profits realized, I made logical conclusions about the main motivation for intermediation activities.

H6: **The network of the examined interpersonal loan market differs significantly from the Hungarian unsecured interbank deposit market network.**

In comparing with the interpersonal loan market, I again use first-person plural, as I build on the results of our joint research performed together with Edina Berlinger, Márton Gosztonyi and Dániel Havran.

A significant part of the households living in underdeveloped settlements do not even have bank accounts; therefore, they are completely excluded from the formal bank services. In his PhD thesis titled "Jugglers of Money: Financial Surviving Strategy of Low-income Families and a Story of a Participatory Action Research" *(Gosztonyi [2018])*, Márton Gosztonyi presented how these families living in extreme poverty manage their finances. We took the findings and database of this study, to which a series of interviews was added as our starting point. Building on *Gosztonyi [2018]* research and interviews, we compared the interpersonal lending market and the Hungarian unsecured interbank deposit market.

H7: **The main motivation for transactions in the interpersonal loan market is selfless, philanthropic assistance provided by the rich to the poor.**

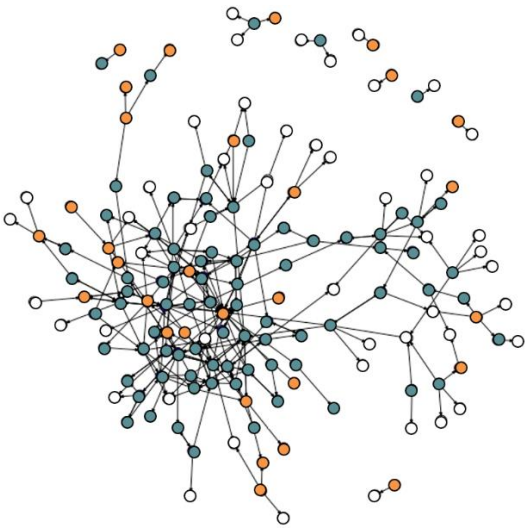
Examining information available on households that make up the nodes of the interpersonal network, we came to the conclusion that one of the most important differentiators of households in terms of lending is their income situation.

We divided households into poor households and richer ones[3]. For this, the per capita income for each household was calculated according to OECD guidelines *(OECD [1982])*, by assigning different weight factors to each family member (a weight factor of 1 to the primary bread-earner adult; 0.7 to any additional employed family member; and 0.5 to any unemployed adult or child in the family).

The relative poverty threshold in Hungary in 2015 was approximately HUF 70,000. Households with a per capita income below this relative poverty threshold were classified as poor, and those with higher incomes were considered (relatively) rich. In the village examined, 75% of households fell into the former group, and only 25% lived above the poverty threshold, which illustrated the extremely disadvantageous situation of those living there.

Figure 1:

Network of interpersonal loans of households, broken down into poor households (blue), rich ones (orange), and those with unknown income (empty circles)



Source: own edition.

Figure 1 shows the positions of poor households (blue) and rich ones (orange) in the interpersonal lending market (no information was available on the income situation for households marked with empty circles).

The graph shows that central participants with many contacts in the network typically live below the relative poverty threshold (except for the central participant who has the most

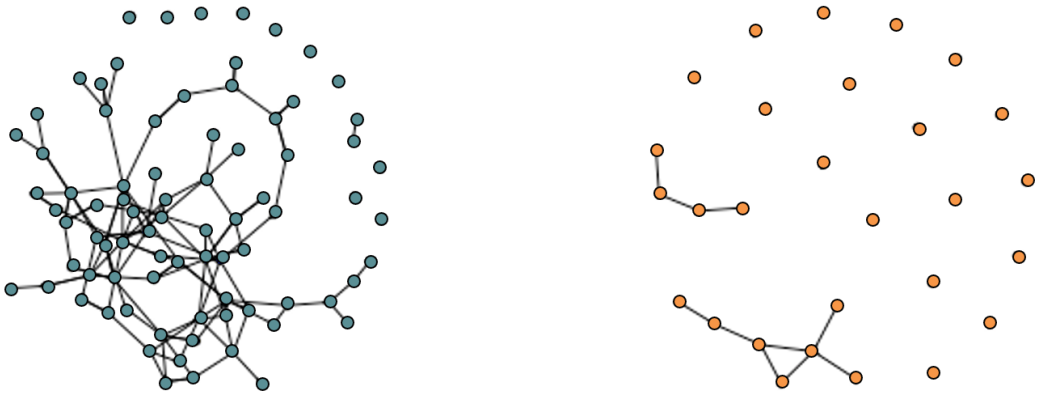
[3] It is worth noting here that the category "rich" refers to the fact that a given household has an income above the relative poverty threshold.

contacts, who is the mayor of the village). These – mostly poor – central households maintain a much denser network of contacts than the richer ones.

In Figure 2, in order to illustrate the phenomenon more clearly, lending relations between the poor (left graph) are separated from those between the rich (right graph).

Figure 2:

Sub-networks of poor households (blue) and rich ones (orange)



Source: own edition.

Thus, it can be established that, while lending activities are low among richer households, low-income families develop a dense system of informal lending relationships, helping each other in dealing with liquidity shocks. Central participants carrying out intermediation activities are typically those with incomes below the relative poverty threshold, and poor households provide the majority of loans to each other. The main motivation for transactions was logically inferred, as described in the next chapter.

3. Results of the thesis

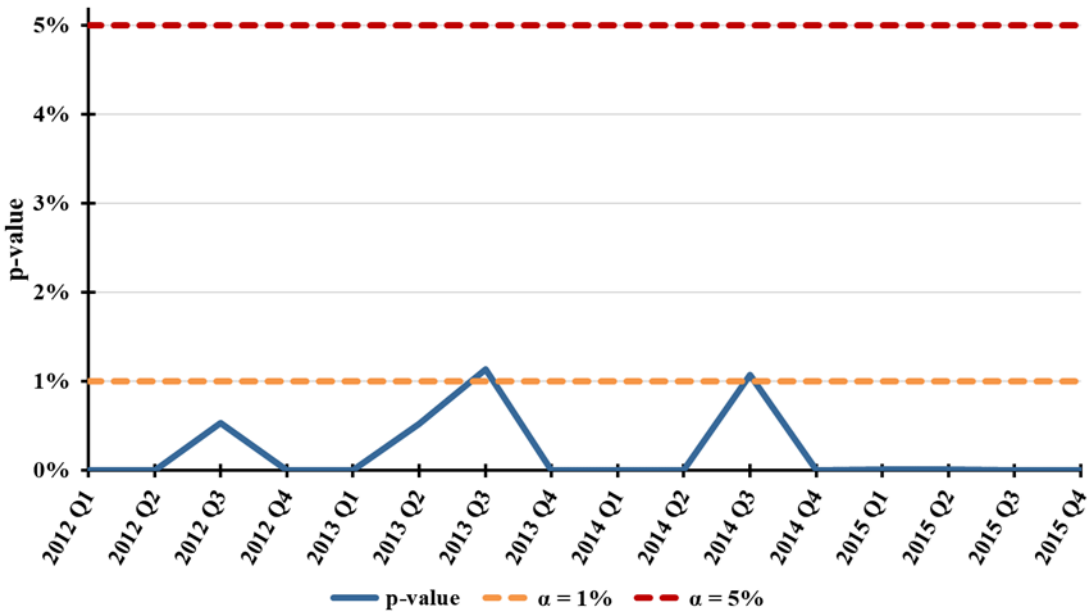
3.1. The distribution of overnight and longer-term unsecured interbank transactions significantly differ

In connection with my first hypothesis, I compared the distribution of overnight and longer-term interbank unsecured HUF loans through histograms, box diagrams, a Q-Q graph, as well as a homogeneity analysis.

The p-value of the test for homogeneity was 1.36×10^{-40}, which means that the homogeneity of the distribution of O/N credit amounts with the distribution of longer-term loans can be rejected at any generally used significance level. In addition to the histograms and box diagrams, I also established with a formal test that the distributions of the amount of O/N and longer-term transactions differ.

Figure 3:

Stability of the heterogeneity between the O/N and longer-term transactions over time



Source: Own editing based on MNB data.

In addition to the static test, I also examined the difference of the overnight and longer-term transactions dynamically for each quarter at 1% and 5% significance levels generally used for hypothesis tests. It can be established at a 95% confidence level (broken red line in Figure 3) in every quarter that the distribution of the overnight and longer-term unsecured interbank transactions differed from each other significantly. The two distributions can be deemed

homogeneous at a higher, 99% confidence level only in two quarters, in the third quarters of 2013 and 2014, but even in these quarters, the p-value of the test for homogeneity (continuous blue line) exceeded the 1% threshold (orange straight broken line) only in minimum extent.[4]

Overall, it can be established that the distributions of the overnight transactions and transactions with maturity longer than one day differed from each other significantly, and this difference was stable over time in the period between 2012 and 2015, by which I confirmed my *H1* hypothesis.

3.2. The concentration of borrowing is significantly higher than the concentration of lending, both in terms of volume and the number of transactions

The table below shows the results of the two-sample z-test for comparing expected values (presented in the previous chapter).

Table 1:
Examination of the average HHI difference of borrowing and lending with two-sample z-test

	Volume	Number of transactions
Test statistic (*z*)	**14.3331**	**28.4172**
Upper critical value	**2.3263**	**2.3263**
p-value	**0.0000**	**0.0000**

Source: Own editing based on MNB data.

Based on the calculations of Table 1, the value of the test statistic is much higher than the upper critical value both in terms of the volumes and the number of transactions. It is in the critical (or rejection) range, therefore the null hypothesis can be rejected at a 99% confidence level, which means that the average concentration of the borrowing transactions was significantly higher than that of the lending transactions. The p-value is extremely close to 0, so the null hypothesis can be rejected not only at a 1% significance level but also at any generally used significance level. Thereby, hypothesis *H2* is successfully proven through a formal test.

The more even distribution of the lending transactions can be explained by the fact that structural liquidity surplus was typically experienced on the Hungarian interbank market in the past one and a half decades. The high concentration of the borrowing transactions derives from the partner limits and the quantity adjustment being stronger on the interbank market.

[4] The p-value was 0.0113 in 2013 Q3 and 0.0108 in 2014 Q4.

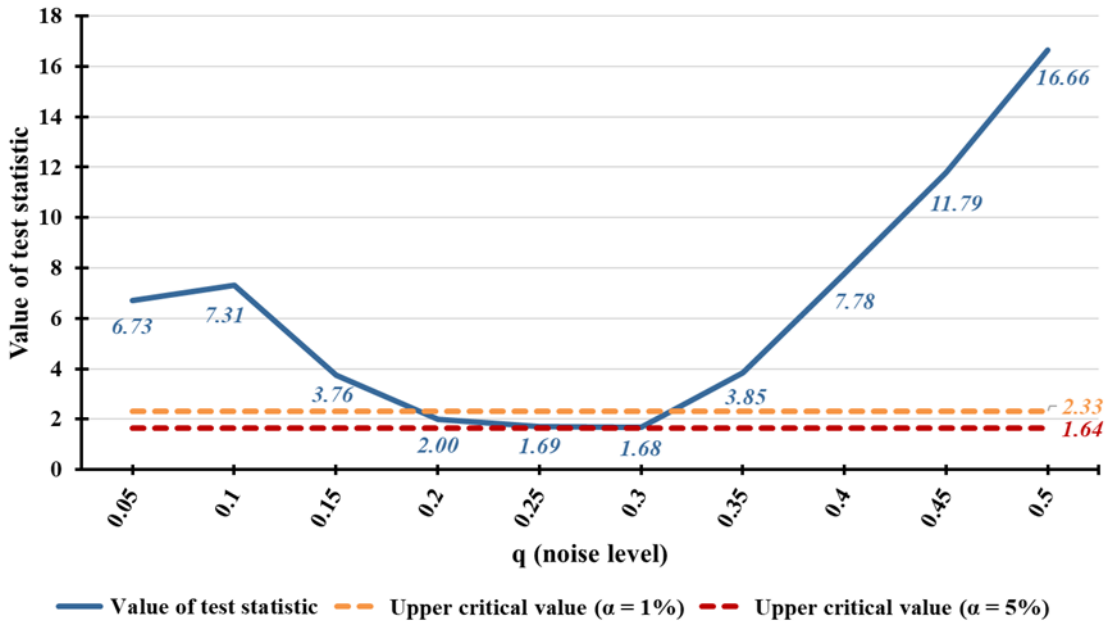
3.3. A coreness measure adjusted by a concave weight function allows for a better and more robust classification than before

In my thesis, I have shown through examples that the new weighted algorithm presented is able to more sharply separate core actors from the periphery. It appears that the new weighted algorithm we introduced is able to separate core actors from the periphery more sharply. Clearly, core actors get a value of 1, and pure peripheral nodes get a coreness value of 0. We only get a value between 0 and 1 where actors can really be considered "transitional".

In addition to stylised examples, we carried out a formal test concerning the difference between two population means for the real interbank network in order to examine whether the average rank correlations calculated from results obtained by using the new type of modified measure are higher than previously at the commonly applied confidence level of 95% and 99%.

Figure 4:

Values of the test statistic of the hypothesis test for the differences of average rank correlations at different noise levels in the case of a real interbank network



Source: own edition.

At a significance level of 5% (red dashed line in Figure 4), the new weighted coreness measure we introduced produces higher average rank correlations than previously at all noise levels. Also, at a significance level of 1% (orange dashed line), it is true that, at the really important, low-level of noise, the new modified measure is more robust than the unmodified one, and only

at noise levels of 0.2-0.3 was it observed that the value of the test statistic (solid blue line) was slightly lower than the upper critical value, 2.33, corresponding to $\alpha = 1\%$.

In summary, in addition to eliminating the anomalies of the original Boyd coreness measure, the new type of weighted core-periphery measure presented by us appears to be significantly more robust than the unweighted measure for both the examined stylized core-periphery structures and the real interbank network. The latter result is also of key importance because core-periphery indicators' main function is to identify systemically important banks, which requires the greatest possible stability of the ranking established by the measure.

At this point, however, it should be noted that, in the real (already noisy) network examined, although the new weighted indicator is significantly more robust in statistical terms, the deviation from Boyd's original coreness measure is much smaller than what was observed in case of pure or nearly pure core-periphery structures.

3.4. Intermediation activities in the Hungarian unsecured interbank deposit market are of significant volume

Table 2 shows the total volume of the lending amount and the volume of intermediation calculated as described in the previous chapter during the period examined.

Table 2:

Intermediation in the Hungarian unsecured interbank deposit market (2012-2015)

Year	Total volume of lending amount (million HUF)	Total volume of intermediation (million HUF)	Rate of intermediation
2012	27,625,252	3,835,564	13.88%
2013	27,602,445	5,308,237	19.23%
2014	30,203,019	6,984,471	23.13%
2015	33,762,722	8,513,659	25.22%
2012-2015	**119,193,438**	**24,641,931**	**20.67%**

Source: Own editing based on MNB data.

The table shows that the intermediation activity was significant in the market and grew dynamically during the investigated period: the intermediated volume increased from 13.88% in 2012 to double in the next three years, to 25.22%, as a percentage of total loan volume. We can also see a very significant intermediation activity of over 20% (20.67%) in the average of the examined 4 years. With this, hypothesis *H4* (as formulated in relation to the volume of intermediation activities in the previous chapter) is confirmed.

3.5. In the Hungarian unsecured interbank deposit market, the main motivation of intermediation activity is risk sharing

Table 3 shows the maximums of potentially available intermediary profit in each period. The maximum intermediary profit achieved by one bank for one year was only HUF 18,322,149 in the period under review, which was achieved by bank number 10 in 2015.[5] This amount is very low and – presumably – not sufficient even to cover the direct costs of the activity (dealers' salaries, provision of necessary IT infrastructure).

Table 3:

Maximum of intermediary profit per year of the 5 most profitable banks (in HUF, 2012-2015)

Code of the bank	2012
14	7,104,979
8	1,595,672
17	1,501,493
9	1,455,364
6	1,017,924

Code of the bank	2013
14	11,518,968
8	3,513,793
10	3,349,139
5	2,606,725
4	2,031,664

Code of the bank	2014
10	13,241,457
14	12,348,553
5	2,533,435
27	2,494,583
8	1,758,547

Code of the bank	2015
10	18,322,149
14	11,966,128
8	3,889,060
17	2,703,278
224	1,756,806

Code of the bank	2012-2015
14	42,938,628
10	34,912,745
8	10,757,072
17	7,580,785
5	6,742,121

Source: Own editing based on MNB data.

Interesting results – contradictory to academic literature – are achieved because HUF 18 million in profits from intermediation is far from the order of magnitude that could significantly increase the size of bank number 10 (presumably a core bank).

This means that the market participants do not perform intermediation activity (which is additional to their own liquidity management) to achieve profit. However, if they do not do it for money, what rational explanation can there be for "free" daily services amounting to billions or even tens of billions of forints?

According to literature, there are basically three possible motivations behind intermediation activities: (1) making profits through intermediation *(Matthews–Thompson [2005], Veld–Leij–*

[5] It is notable that the highest annual intermediary profit of 18.3 million HUF (~60,000 EUR) was barely 0.0005% of the HUF 4,035 billion unsecured exposure of the bank No. 10 as a lender.

Hommes [2020]); (2) selfless, philanthropic assistance *(Caudell–Rotolo–Grima [2015])*; or (3) risk sharing based on reciprocity *(Laczó [2015])*.

As shown above, the main motivation for intermediaries in the interbank market is not profit-making. As a huge risk is posed by the unsecured nature, as characteristic to interbank markets, therefore, selfless, philanthropic assistance cannot be the primary driver either, and altruism is mainly a feature of social networks *(Caudell–Rotolo–Grima [2015])*.

By process of elimination, we can assume that the main motivation of intermediaries in the unsecured interbank deposit market is risk sharing. Risk sharing, in this case, means that one bank makes a loan to another so that when it encounters a lack of liquidity later, the previously assisted partner should reciprocate it. Individual liquidity shocks affect individual market participants at different times and to different degrees, allowing participants in the interbank market to operate such an insurance scheme based on reciprocity. Intermediaries, therefore, do not carry out their activities for making profits but for the "security" they can enjoy by belonging to the community of the interbank market. With this, hypothesis *H5* about the main motivation of intermediation is rejected.

3.6. The Hungarian unsecured interbank deposit market network is similar to the structure of an interpersonal loan market in many respects

I have shown that, when examining the markets as a whole, we can, apart from differences in the characteristics of players and transactions, find only similarities almost exclusively. For example, there is a strong presence of information asymmetry in both markets, so that participants, either informally or through their formal systems, continuously rate and monitor each other and apply partner limits. The risks managed are asymmetric in the sense that satisfying the lack of liquidity is the more pressing problem, and the placement of surplus funds is a less important aspect. The main driver of transactions in both markets is liquidity management, the efficient operation of which intermediaries contribute significantly.

A concentration analysis made for each of the two markets showed that, while few lenders lend funds to many borrowers in the interpersonal network, the opposite is true for the interbank market. A possible explanation for this phenomenon is that structural liquidity shortage is typical for the interpersonal lending market, while systemic excess liquidity is typical for the Hungarian unsecured interbank deposit market.

Both networks have a hierarchical structure, but interestingly, a higher degree of hierarchy can be observed in the interpersonal network. The interpersonal network consists of several

interconnected sub-networks (cousins, grandparents, wider kinship), which usually communicate with each other through their central participants. In other words, central players (bridges) in the interpersonal network connect otherwise separated network parts, which phenomenon may explain the high level of hierarchy in the interpersonal lending market. Thus, I demonstrated the similarity of the examined unsecured credit markets along several dimensions, and thereby, I rejected hypothesis *H6*.

3.7. As in the interbank unsecured deposit market, the main motivation for transactions in the interpersonal lending market is risk sharing

Based on Figure 2 presented in the previous chapter, we found that, while lending activities are low among richer households, poor families develop a dense system of informal lending relationships, helping each other in dealing with liquidity shocks. Loans from the rich to the poor are rare; so it can be stated that the main motivation for mediation is not selfless, philanthropic assistance, but – like in the interbank market – risk sharing.[6] Households in the most difficult situations operate an insurance scheme based on reciprocal assistance. As part of the community, they are willing to lend, knowing that, should they find themselves in a difficult financial situation later, they can count on the support of their peers. Thus, interesting results are obtained, contradicting the academic literature *(Caudell – Rotolo – Grima [2015])*, on the basis of which the last hypothesis, *H7* is rejected.

[6] Making profits is not even a possible motivation, as credits in the interpersonal loan market are interest-free.

4. Possibilities for utilizing research findings

As I analysed networks of markets systematically, from a bird's eye view in my thesis, the results presented could be most beneficial for regulatory authorities. I examined two separate, yet in many respects similar, networks: the unsecured interbank deposit market and the interpersonal loan market of disadvantaged households. Accordingly, I formulate my recommendations in relation to these two groups in this section.

4.1. Recommendations in connection with the interpersonal loan market

In my thesis, I presented in detail the results of a European study involving disadvantaged individuals to complement the results discussed above on interpersonal lending markets, thus providing an opportunity to formulate some relevant policy recommendations.

In 2011, a project called SIMS *(Social Innovation and Mutual Learning on Micro-Saving in Europe)* was launched with the support, among others, of the European Commission, aimed at encouraging disadvantaged low-income individuals to make savings and to improve their financial awareness *(Guisse–Gilles [2013])*.

Social capital is more valuable than the most promising individual savings product

Based on the SIMS experiment, two important recommendations can be made. One of them is that, among the disadvantaged Roma, belonging to the community is more important than individual interest. If someone saves money, they prefer to lend it to an acquaintance, thus contributing to the operation of the previously mentioned reciprocal insurance scheme, because in this way they can, as part of the community, count on the help of the community, should a subsequent liquidity shock arise. This "financial safety net" is more valuable to most poor people than an individual savings product with a risk-free return of more than 100% per annum. In other words, it may not be worthwhile to strongly encourage people living in deep poverty to save individually; the effectiveness of programs aiming for that is likely to be low *(Berlinger [2020])*.

Disadvantaged people can successfully manage liquidity shocks they encounter, so the path leading to their rise is not primarily through the development of their financial awareness

Another recommendation that is worth considering is related to financial awareness. One of the most common development paths in lagging regions is to improve the financial awareness of those living in deep poverty, to show them the importance of savings and to increase their financial literacy *(Klapper–Lusardi–van Oudheusden [2015]; Grohmann–Klühs–Menkhoff*

[2018]). *Gosztonyi [2018]* describes the poor as " jugglers of money" who masterfully manage their liquidity shocks and operate their versatile informal risk management systems in a very conscious way. In other words, the reason for their disadvantaged status is not to be found primarily in their lack of financial knowledge; it would be worthwhile for policy makers to take this into account when formulating development paths.

4.2. Recommendations concerning the interbank market

Interbank market regulations are sharply separated (in academic literature and also by regulatory authorities) into a macro-prudential (systemic) and a micro-prudential approach (related to individual credit institutions, separately). In connection with the former, lightning-fast contagion following the bankruptcy of Lehman Brothers in 2008 and the ensuing global financial crisis highlighted the importance of managing systemic risk.

The new type of weighted coreness measure allows a better and more robust classification of core and peripheral banks than earlier

The Basel III regulation – by requiring the identification of systemically important financial institutions – officially made systemic risk part of international banking regulations. Systemically important players are selected based on various measures, of which coreness measure is discussed in detail in my thesis. My first recommendation is that, in light of the deficiencies of the current coreness measure, it is worth considering the application of its modified version presented in the context of hypothesis *H3* to identify central (core) banks. Using the new weighted coreness measure, a better classification of core and peripheral banks can be achieved than earlier.

Strict individual liquidity requirements for credit institutions may result in a less resilient interbank market

Examining the micro-prudential side of banking regulations, the new system of requirements having been introduced since the global crisis of 2008 raises the issue of over-regulation. Since the entry into force of Basel III, banks have been facing very strict liquidity rules, obliging players to maintain their own liquidity positions flawlessly. One of the most important elements of the new rules is the *Liquidity Coverage Ratio* (LCR), which requires institutions to have sufficient liquid assets of high quality to cover a 30-day outflow of funds following a severe stress situation *(BCBS [2013a])*. Thereby, regulators oblige each bank individually to manage its liquidity continuously and rigorously.

As a result of current micro-prudential regulations, which are stricter than the previous ones, banks are turning inwards and primarily focus on their own liquidity positions, having less room for manoeuvre in providing temporary support to other partner banks, a fact deteriorating the efficiency of the interbank market. Individual-level (micro-prudential) regulations may therefore be at odds with ensuring systemic (macro-prudential) liquidity *(Berlinger [2020])*. My second recommendation is that the current regulation, which has a strong focus on liquidity management at the individual level, should be reviewed from that aspect in order to balance micro- and macro-prudential interests.

The introduction of G-SIB scores restricts globally significant core banks in their intermediation activities, a fact that severely weakens the efficiency of interbank markets

Another new element of Basel III is the inclusion of the macro-prudential approach in banking regulations, which requires that systemically important banks, the failure of which could cause serious damage to financial markets, must receive special treatment. According to the Basel principles laid down in 2013, the Financial Stability Board designates *Global Systemically Important Banks (G-SIBs)* annually, facing additional prudential requirements and rigorous supervision *(BCBS [2013b])*.

Efforts made under Basel III to reduce systemic risk prompted global systemically important banks to manage their G-SIB scores continuously *(Pozsár [2019])*. The interbank market (normally) is an insurance scheme based on reciprocity between participants and helps manage liquidity shocks affecting the banking system. The system as a whole – owing, in part, to the beneficial activities of intermediaries – is able to absorb external shocks more effectively than in a situation where it is up to individual participants to solve it alone.

However, due to the recently introduced rigid micro-prudential rules, banks are turning inwards and focusing primarily on their own liquidity positions, having less room for manoeuvre in providing temporary support to other partner banks, a fact deteriorating the efficiency of the interbank market. In light of this, my third recommendation is that it would be worthwhile to formulate more flexible liquidity requirements for credit institutions. I consider systemic risk management to be very important, but tying the hands of key banks may lead to significant distortions and may reduce the efficiency of the market in eliminating liquidity shocks.

The problem is made worse by the fact that, as a result of the single G-SIB scoring system, market events and external shocks, such as stock market fluctuations, induce major market

participants to enter into transactions in the same direction, a situation that could lead to the amplification of shocks affecting the interbank market and the disappearance of intermediaries.

Attractive monetary policy instruments tend to reduce the efficiency of the interbank market

In the case of a wide interest rate corridor and less attractive monetary policy instruments, interbank interest rate volatility generally increases, which is undesirable for the efficiency of monetary transmission, but at the same time encourages market participants to be more active in the interbank market. In this way, the reciprocal insurance scheme of the interbank market can operate more efficiently.

The last decade of Hungarian monetary policy has been characterized by the fact that, in the event of major market shocks, the central bank almost immediately "switched the interbank market to manual control" with the help of a favourable interest rate central bank instrument. This happened most recently in connection with the coronavirus crisis when on 1 April 2020, the MNB decided to announce tenders for one-week deposits at the base rate regularly *(MNB [2020])*. The purpose of this move was to place the banking system's liquidity into deposits at the base rate. In the lack of detailed data, I cannot judge whether such a step was necessary, but it is certain that, thereby, the central bank temporarily weakened the efficiency and smooth operation of the interbank market.

My fourth suggestion is that it is worthwhile to use particularly attractive monetary policy instruments temporarily and for a short period only because, if this becomes the primary tool for managing market participants' liquidity on a permanent basis, it could cause significant long-term damage to the operation of the interbank market. In a turbulent global macro environment, a well-functioning, active interbank market is critical to eliminate liquidity shocks, and monetary policy must consider this when reshaping its toolbox.

The key to a well-functioning interbank market is: trust

As a fifth suggestion, I would also like to draw attention to the importance of reducing uncertainty in the interbank market. In order for reciprocity-based insurance schemes of interbank markets to work efficiently and for intermediaries, who are core players, to be willing to stand between two peripheral participants in addition to managing their own liquidity needs, in the absence of physical collateral, trust is crucially important. Therefore, any action that strengthens confidence also helps the risk sharing system to function properly.

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