Bank selection decisions: Fitness and topology

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Abstract
The article models the determinants of bank selection decisions. The relative importance of the fitness of banks and the topology of financial transactions in the bank selection decision is assessed, an issue never addressed in the literature before. The decision-making process is examined on a weighted and directed network of corporate clients linked by financial transactions. Although the dynamic process implied by the rational decision of companies results in multiple equilibria, the statistical properties of the equilibria show similarities. The authors show that if the fitness of the banks is the only driving factor in the decision-making process, the market share of the largest bank equals the fitness of the most talented bank. Contrary to the expectations, the market share of the largest bank increases steadily as the role of the topology is becoming more and more important in the bank selection decision, and reaches its maximum just before the case, when the topology of the financial network plays exclusive role in the decision-making process. The authors argue that this counterintuitive phenomenon might be explained by the presence of stable clusters, opinion-leading companies and dominant corporations. When the topology of the transactions is the only factor in selecting financial provider, then the market shares of banks equalise. The speed of convergence towards the market equilibrium is slower if the value of the topology parameter is higher. The results of this study have important implications for banking experts. On the one hand, marketers should consciously manage the topology of financial transactions in their customer portfolio, while acquiring new customers. On the other hand, marketers should devote special attention to stable clusters and opinion-leading companies in retention campaigns.

Keywords: network of corporate clients, bank choice decision, fitness, topology of financial transactions

JEL classification: C15; C62; D53; D85; G21; L14

1. Introduction

Network theory is widely used in many sciences, and it has a long tradition in social sciences, as well. With regard to commercial banks, network theory has been applied
to analyse the position of banks in the network of directorate interlocks [1] and to map the actual topologies observed in the financial system [2, 3, 4]. Our previous study addresses the phenomenon of customer attrition at commercial banks [5]. The application of network theory might deliver additional value to today’s financial institutions. Network theory might function as an important value driver in the fields of bank selection decision making, customer attrition, customer retention, customer acquisition and the diffusion of various banking products.

The present article put exclusive emphasis on the phenomenon of bank selection decisions, a key issue in banking and finance. With rapid change and more sophisticated customers, it has become very important that financial institutions determine the factors which are pertinent to the customers’ selection process. A review of the literature reveals that much has been written about the choice criteria in the financial services area. The studies mostly focus on the choice of retail banks as service providers. For example, Anderson et al. [6] reveal that the five key selection criteria include friends’ recommendations, reputation of the bank, availability of credit, friendliness of staff and service charges on accounts. Several authors inform that convenience is the most important factor in the choice of banks [7, 8]. Martenson [9] suggests that, next to locational convenience, parental influence is also of major importance in bank choice. Recommendations by parents and friends are also found to be crucial [10]. Some authors argue that the quality of the service is the most important factor in bank selection decisions [11, 12]. Elliot et al. [13] identify price, speed and access to be particularly important in bank selection process. In contrast, some other authors find that customer service appears to be more important than price, and that consumers use additional criteria beyond price, speed and access to evaluate and choose between banks [14]. Dick [15] emphasizes that consumer demand responds favorably to the staffing and geographic density of local branches, as well as to the banks’ age, size and geographic diversification. As a summary of the previous literature, Devlin and Gerrard [16] list the following choice criteria: (1) image and reputation, (2) branch opening hours, (3) competitive interest rate paid, (4) low fees/overdraft charges, (5) location (near home), (6) location (near work), (7) product range, (8) service expectation, (9) recommendation of third parties, (10) family relationship, (11) home banking option and (12) incentive offered. The authors conclude that choosing a bank near home, on the basis of family relationship, taking note of the recommendation of others and choosing a bank near a place of work are the most important factors in choosing both main and secondary banks.

In this article, the role of two main factors is investigated: the fitness of banks and the topology of financial transactions. The fitness encompasses all those factors that are considered important in the bank selection process in the literature. Therefore, the concept of fitness includes, for example, the accessibility and geographic location of the branches, the number of branches and ATMs, the reputation of the bank and the quality of the banking service. The fitness might be considered a single parameter reflecting all external factors driving the bank selection decision made by companies. Put another way, the fitness of banks refers to the capability of banks to attract new customers and to retain old ones. The fitness might also be captured as a probability that an influential economic actor is satisfied with the banking service and can convince other economic actors to join the same bank.

Aside from the fitness of banks, the topology of financial transactions might be another important factor in the bank selection process. Due to lower transaction costs and
quicker fund transfers, corporate clients prefer intrabank transfers to interbank transfers. The role of pricing, and thus implicitly the role of the topology, are supported, for example, by the findings of Khazeh and Decker [17]. The authors argue that the bank’s service charge policy is the most important factor in explaining how consumers choose their bank. Javalgi et al. [18] also report pricing as a crucial factor in the bank selection process. Similarly, by studying differences in choice criteria with respect to the level of customer financial knowledge, Devlin [19] informs that customers with a high level of knowledge (e.g., sophisticated corporate clients) are more likely to take account of "intrinsic" service attributes, such as service features, rates of return and low fees, when making their choice. In line with the importance of pricing and the topology, we argue that among the competing banks, companies choose the one to whom the majority of their outgoing payments are directed. In this way, companies can minimise their banking costs.

To highlight the advantage of intrabank transfers to interbank transfers, the transfer delay and the price differences are quantified. According to the Hungarian legislation in force, the average transfer delay is one day for both electronic and paper-based transactions. (Electronic intrabank transfers are instant, whereas electronic interbank transfers are executed on the day following the initiation of the transaction. Paper-based transactions are executed in both cases one day later than the electronic transactions.) Quantifying the difference in the transfer fees is not as straightforward as measuring the average transfer delay. The transfer fees generally have two components: a lump sum and a certain percentage of the money transferred. Additionally, the transfer fee might have lower and upper limits. Therefore, measuring the price difference between intrabank and interbank transfers is hard, as both components vary greatly across banks, across accounts and even across the type of the submission. A quick market survey, however, reveals that interbank transactions cost on average 20-90% more than intrabank transactions. For example, K&H, the market leader of the Hungarian corporate segment, charges 0.11% for intrabank transactions initiated from its customer services but 0.14% for interbank transactions [20]. In Hungary, the international player Citibank charges 0.05% for intrabank transactions but 0.08% for interbank transactions in its CitiBusiness package for transactions initiated online [21]. (Note that in the retail segment, the Hungarian Financial Supervisory Authority carries out a comprehensive comparison of bank accounts, but no similar comparison is prepared for the corporate segment [22].)

Although it is hard to judge exactly how much companies base their decision on comparing interbank and intrabank transaction fees, in the following paragraphs, we show that transaction fees indeed represent an important factor in bank selection decisions. In the banking industry, a number of banks offer faster and cheaper banking transactions. The avowed goal of the banks with these packages is obviously to attract customers to the bank. A marketing strategy emphasising the faster and cheaper intrabank transactions is followed by, for example, OTP Bank, which is the largest bank in the Central and Eastern-European region by asset size. On the English version of its home page, OTP uses the following advertisement targeted at corporations: "By choosing OTP Bank, your company can also benefit from OTP Bank’s wide range of clientele, as your business partners are very likely to keep their accounts with OTP Bank. Therefore, intrabank account transactions will save you costs [23]." In general, a number of banks offer companies group-based account and cash management services. To satisfy the needs of their community-conscious customers, OTP targets, for example, its ELEC-
TRA account-keeping service at them [24], whereas K&H Bank offers corporations its K&H Aktiv business package account [20]. An important element of these high-quality community-based packages is that intrabank transaction fees are much lower than usual (for paper-based payment orders) or are even equal to zero (for electronic payment orders).

Banks target their group-based account services at closely connected companies, that is, at companies who trade, cooperate or transact with each other frequently. Companies that actively manage their banking costs are also possible candidates. Consolidated subsidiaries and affiliated companies are, however, the most prominent examples of companies that choose the same bank as the parent company [25]. The obvious reason for this behaviour is to lower the transaction costs of the subsidiaries and thus to lower the cost of banking at the holding level. Generally, parent companies select the main bank and then prescribe the subsidiary the usage of the same bank.

The importance of the network topology in selecting a bank is also supported by anecdotal evidence with relation to churn. According to banking experts, from time to time, an apparently insignificant company leaves the bank, after which 200-250 other corporate clients of the bank do the same. Note that banks carefully hide their mass churn events occurring in the past from the public (most importantly, from current and potential customers and competitors). As information on churn waves is extremely confidential, despite its obvious existence and anecdotal evidence, it has been shown to be impossible to find reference papers or other citable evidence.

After highlighting that transaction fees constitute an important factor in bank selection decisions, it is important to emphasise that this is only one factor in the complex decision-making process. It might happen easily that the majority of the companies assign the topology parameter a fairly low weight. Additionally, in reality, the role of the topology parameter varies between companies. Large companies most probably assign the topology parameter a weight close to zero, as they have strong negotiation power and are usually able to make special deals with the banks. For example, large companies might pay a lump sum for all the transactions they initiate and lower their transaction fees substantially in this way. Thus, large companies choose the most talented bank (more precisely, the one who targets the highest discount and a full range of additional services at them), and base their bank selection decisions almost exclusively on the fitness of the banks. In contrast, small and medium enterprises (SMEs) might put a relatively higher emphasis on the topology parameter in their bank selection decisions. SMEs are more exposed to the terms and conditions dictated by the banks. The SMEs that transfer a relatively large amount of money to certain number of firms at a high frequency might make significant efforts to lower their banking fees. To do so, they might pay special attention to the fee structure applied by banks and might opt for a bank at which the majority of their outgoing payments are directed. As the model setup allows for correlating the weight of the topology in the bank selection decisions with the size of the company, in some simulations we will differentiate among the behaviour of large and small enterprises and control for its impact.

In this article, the determinants of bank selection decisions, namely, the role of the fitness and the topology, are modelled by means of network theory. The relative importance of these two parameters has never been assessed in the literature before. Unfortunately, data on the bank selection decisions of companies are not available, whereas data on the topology of the banks’ corporate client portfolio are strictly confidential. In the absence
of citable data sets, the directed and weighted network of corporate clients linked by financial transactions relies on stylised facts. In addition, the decision-making process of companies regarding the choice of a bank also needs to be modelled. We then examined the characteristics of the equilibrium as the function of the network topology of financial transactions. The most important research questions include the following: Is there a unique, stable equilibrium? Which statistical properties characterise the equilibrium? How fast is the convergence towards the equilibrium state? How significantly is the market share of banks affected if more emphasis is put either on the role of the fitness or on the impact of the network topology? Does the fitness or the topology drive the system? Special attention is devoted to analysing whether the banks should improve their fitness or focus on the network topology of their corporate client portfolio. Having the Erdős–Rényi and the Barabási–Albert networks as benchmarks, the role of the underlying network structure is also investigated.

The article is organised as follows. Section 2 introduces the model of the corporate client network. The principles on the basis of which companies select their main bank are described in detail in Section 2.1. Section 3 summarises the main results. In Section 3.1, we analyse whether a unique equilibrium exists. In Section 3.2, the speed of convergence towards a market equilibrium is measured. Section 3.3 investigates the market share of the largest banks in equilibrium by assigning different weights to the topology and the fitness of banks in the bank selection decision. In Section 3.4, we control for differentiated corporate behaviour. Section 4 provides a conclusion.

2. The model

A detailed description of the network generation model is provided in [5]. In that article, the motivation of the model setup, the network generation algorithm and the method of assigning directions and weights to the links are presented step by step. In the following, only the basic idea of the model is highlighted; the technical details can be found in [5].

The network of companies was modelled on the basis of [26] and [27]. In addition to growth and preferential attachment, from the network-generation model of [26], the idea was adopted that the agents only had information about a limited number of existing nodes. The information about the existing network was costly, so agents must have optimised their utility under budget constraints. Therefore, the model operated with a limited amount of information and utility maximisation subject to an available set of information. Additionally, in line with [27], newcomers were attached with some kind of a local nature. The key feature of the network generation model was that the neighbours of newcomers were also located close to one another. This local nature of the growth process contributed to the formation of communities.

The most important topological features of the generated network included (1) scale-free degree distribution, (2) high degree of clustering, (3) communities with dense internal connections and (4) small-world property. In [5], the authors argue that the network of companies linked by financial transactions exhibits all of the above-listed properties.

In the network of corporate clients, the direction of the links was determined on the basis of the direction of net money flow, whereas the weights of the links corresponded to the value of funds transferred. The direction of the links incorporated several stylised
facts, whereas the weights of the links relied on real sales data. The fact that the number of firms is normally distributed as the function of the logarithm of the sales revenues was shown in [28] more than 50 years ago, and later on, for example, in [29] and [30]. Sales data analysis of 287,821 Hungarian companies also verified the lognormal distribution of the firm size empirically. The underlying data were collected by the APEH Sztádium (IT and Tax Settlement Office of the Hungarian Tax and Financial Control Administration) and included the sales data of companies with double-entry bookkeeping in year 2004. The majority of the companies were limited partnerships, limited liability companies or public companies; sole proprietors were excluded from the dataset. Based on the lognormal distribution of sales, the model assumed that the value of transactions is also log-normally distributed.

2.1. Dynamics: Decision-making process of joining a bank

The dynamics of the model is different from the one presented in [5]. In this model, corporate clients choose their main bank on a rational basis, taking two factors into account. On the one hand, the decision is driven by the fitness of banks, which reflect the ability of banks to attract new customers and to retain old ones. The fitness encompasses all the specific characteristics of banks (e.g., price and quality of the service, number and location of branches) that are important when companies decide which bank to choose. On the other hand, the bank selection decision is driven by the topology of financial transactions. Due to lower transaction costs and quicker fund transfers, corporate clients prefer intrabank transfers to interbank transfers. In line with this, companies bias their decision towards the bank to which the majority of their outgoing payments are directed. Initially, each company chooses a bank with uniform randomness, and then this choice is reviewed. Note that the model setup shows similarities to the random Potts model with three components, without antiferromagnetic interactions. The role of the topology parameter is similar to the function of the temperature, whereas the fitness parameters might be considered external magnetic fields.

Let \( a \) denote the weight of the topology, and let \( b \) denote the importance of fitness in the bank selection decision. Assume that \( a + b = 1 \). If \( a = 1 \), then companies choose their main bank solely on the basis of the topology and the related cost implications. If \( b = 1 \), then the bank selection decision is exclusively driven by the fitness of banks. In between the two extremes, the decision is driven by both forces.

Let \( w_{i,j} \) denote the weight of the link directed from node \( i \) to node \( j \). Indicate with Greek symbols the banks; \( B \) corresponds to the set of banks. The algorithm describing the decision-making process of companies includes the following steps:

1. Assign a certain parameter value to \( a \) and \( b \), by taking the constraint of \( a + b = 1 \) into account.
2. Determine the fitness of banks, \( f_\alpha \) exogenously. Assume that the fitness of a bank can only be improved by lowering the fitness of a competitor bank, that is, \( \sum_{\beta \in B} f_\alpha = 1 \).
3. Index the links directed from node \( i \) to companies belonging to bank \( \alpha \):
   \[ I_{i,\alpha} = \{(i, j) \mid w_{i,j} \neq 0, \text{ node } j \text{ belongs to bank } \alpha \} \]
Take the set of indices obtained in this way.

4. Calculate company \( i \)'s proportion of transactions directed to companies belonging to bank \( \alpha \):

\[
 w_{i,\alpha} = \frac{\sum_{(i,j) \in I_{i,\alpha}} w_{i,j}}{\sum_{\beta \in B} \sum_{(i,j) \in I_{i,\beta}} w_{i,j}} \tag{1}
\]

5. Find \( w_{i,\alpha_{\text{max}}} = \max_{\alpha \in B} \{w_{i,\alpha}\} \).

6. Company \( i \) chooses \( \alpha_{\text{max}} \) with probability \( p_{i,\alpha} \):

\[
p_{i,\alpha} = a \cdot w_{i,\alpha_{\text{max}}} + b \cdot f_{\alpha} \tag{2}
\]

Company \( i \) chooses its original bank \( \beta \) with probability \( p_{i,\beta} \):

\[
p_{i,\beta} = a \cdot (1 - w_{i,\alpha_{\text{max}}}) + b \cdot f_{\beta} \tag{3}
\]

Company \( i \) chooses the remaining banks (e.g., bank \( \gamma \)) with probability \( p_{i,\gamma} \):

\[
p_{i,\gamma} = b \cdot f_{\gamma}. \tag{4}
\]

Let us demonstrate the decision-making process of companies by examples. Assume that \( a = 0.3 \), and \( b = 0.7 \), that is, that bank selection decisions are driven to a greater extent (70%) by the fitness of banks and to a lesser extent (30%) by the underlying topology of financial transactions. In addition, let us assume that in the case of three banks, the fitness of the banks is as follows: \( f_{\alpha} = 0.15 \), \( f_{\beta} = 0.20 \) and \( f_{\gamma} = 0.65 \). As a next step assume that 55% of the outgoing payments of company \( i \) is directed to companies belonging to bank \( \alpha \) (\( w_{\alpha} = 0.55 \)). The rest of the outgoing payments are directed at two other banks: \( w_{\beta} = 0.30 \) and \( w_{\gamma} = 0.15 \). Therefore, \( w_{\alpha} \) is the maximum. If company \( i \)'s original bank was \( \beta \), than the company chooses bank \( \alpha \) with probability \( p_{i,\alpha} = 0.55 \) and bank \( \beta \) with probability \( p_{i,\beta} = 1 - 0.55 = 0.45 \). The probability of choosing bank \( \gamma \) equals 0 (\( p_{i,\gamma} = 0 \)).

If \( a = 1 \), then company \( i \) chooses bank \( \alpha \) with probability \( p_{\alpha} = 0.55 \) and bank \( \beta \) with probability \( p_{\beta} = 1 - 0.55 = 0.45 \). The probability of choosing bank \( \gamma \) equals 0 (\( p_{\gamma} = 0 \)). If \( a = 0 \), (and thus \( b = 1 \)), then company \( i \), similarly to all other companies, chooses bank \( \alpha \) with probability \( p_{\alpha} = 0.15 \), bank \( \beta \) with probability \( p_{\beta} = 0.20 \), and bank \( \gamma \) with probability \( p_{\gamma} = 0.65 \). This kind of model setup reflects the companies’ rigidity regarding switching banks. As switching to another bank is costly, if there are no significant benefits (cost-savings), companies hesitate to do so.
3. Results

3.1. Market equilibrium

This section addresses the question of whether a unique equilibrium exists by assuming that companies choose their main bank on a fully rational basis. For the sake of simplicity, an economy with three homogeneous banks is assumed. The algorithm of reaching market equilibrium is described as follows:

1. Assign each company a bank with uniform randomness.
2. Select a node (company) randomly. The company joins a bank according to the decision-making process described in Section 2.1.
3. Repeat step (2) three times for the relaxation time. (For a definition of the relaxation time, see Section 3.2.) The state reached in this way is denoted as an equilibrium state.

Although the update is asynchronous in the model, company \(i\)'s choice affects the decision of company \(j\) when it is its turn to decide which bank to choose. Higher values of parameter \(a\) and the proportion of company \(j\)'s payments directed to company \(i\) indicate a stronger feedback effect.

Figure 1 displays one possible realisation of the equilibria in the network of corporate clients. The various colours imply that companies belong to one of the three distinct banks. As shown in Figure 1, the network is dominated by a single colour (white). The majority of the companies belong to bank \(\gamma\), whose fitness is the highest. The role of the topology is pushed into the background, companies of the same community do not necessarily choose the same bank.

In the simulations, the equilibrium was not unique. Nevertheless, as highlighted in Section 3.3, the large number of equilibria show similar statistical properties.

3.2. Convergence and relaxation times

Figure 2 displays the speed of convergence towards the market equilibrium for various parameters of \(a\). The market share of the largest bank is plotted as function of \(t/N\), where \(t\) equals the number of updates in the decision-making process. The market shares are averaged over 1,000 runs. Although the fluctuation of market shares is remarkable across the simulations, the amplitude of the fluctuations decreases as the size of the network increases. In equilibrium, the average market share of the largest bank increases as the value of parameter \(a\) increases, except for cases where the topology of the financial network plays exclusive role in the decision-making process of a bank \((a = 1)\). In this case, the market shares of the three banks equalise. If the fitness of the banks is the most important factor in the decision-making process \((a = 0)\), the market share of the largest bank equals the fitness of the most talented bank \((ms_{\gamma} \approx f_{\gamma} = 0.65)\). (A detailed explanation for the evolution of the average market shares of the largest banks in equilibrium as function of parameter \(a\) is provided in Section 3.3.)

Regarding the speed of convergence towards the market equilibrium, the simulations reveal that the convergence becomes slower as the role of the fitness decreases (and thus the value of parameter \(a\) increases). As shown in Figure 2, to reach the market equilibrium, we might select a company randomly for updating its decision 9 times on
average if $a = 0.75$ while selecting it 6 times on average if $a = 0.25$.

The speed of convergence towards the equilibrium is also measured by means of relaxation times. The relaxation time is defined as follows:

1. The market share of banks is calculated after each update in the decision-making process. The market share of bank $\alpha$ corresponds to the ratio of transactions (funds received and funds transferred) realised by the corporate clients belonging to bank $\alpha$ to the transactions executed by all the companies. The market share of bank $\alpha$ ($ms_\alpha$) can be written formally as

$$ms_\alpha = \frac{\sum_{i \in V} \sum_{j \in V} (w_{i,j} + w_{j,i})}{\sum_{i \in V} \sum_{j \in V} (w_{i,j} + w_{j,i})}$$  \hspace{1cm} (5)

If companies $i$ and $j$ do not trade with each other directly, then $w_{i,j} = 0$ and $w_{j,i} = 0$ in the denominator. Therefore, summing along $j$ is only performed for the direct neighbours of company $i$.

2. Exponential functions of the following form are fitted on the market share of the largest bank:

$$y = y_0 + A \cdot e^{-x/\tau}$$  \hspace{1cm} (6)

3. The relaxation time equals $\tau$ calculated on the basis of Equation 6.

Figure 3 shows the relaxation times as function of parameter $a$. In addition to the network of corporate clients, we also look for the properties of the equilibria in the Erdős and Rényi’s random graph model and in Barabási and Albert’s scale-free network. The relaxation times are the highest in the case of the Erdős-Rényi network; that is, the convergence towards the equilibrium is the slowest in this case. The relaxation times are the smallest in the case of the Barabási-Albert network, leading to the fastest convergence. Interestingly, in all cases, the convergence to the equilibrium becomes infinitely slow as the role of the topology is becoming more and more important. (The relaxation times for $a = 1$ are not plotted in Figure 3.)

In the simulations, a bank is assigned to each company with uniform randomness at the beginning of the computations; only this case is analysed. We do not aim to analyse the dependence on the initial assignment of banks or whether relaxation times change if one of the banks is pushed into the background.

3.3. Maximal market shares in equilibrium

As a next step, we examine the market share of the largest banks in equilibrium. The market shares in equilibria are not determined by the underlying properties of the companies (e.g., industry, size, profitability). In contrast, it is determined partly by the fitness of banks and partly by the position of corporate clients in the network.

Figure 4 shows the average market share of the largest banks in equilibrium as function of parameter $a$. As displayed in the figure, if $a = 0$ (indicating that the bank selection decision of companies is influenced exclusively by the fitness parameter), the market share of the largest bank equals the value of the largest fitness (0.65). If the decision is
exclusively driven by the topology of financial transactions \((a = 1)\), then, as was shown in \([5]\), the market share of the largest bank is around 0.33 in the network of corporate clients, and in the Erdős-Rényi network. In the network of corporate clients, the highly clustered network topology leads to the formation of stable corporate client base. As a result of the highly clustered structure, a bank can be trapped by the clusters, resulting in communities that are dominated by one of the three banks. Therefore, the strongly linked communities belonging to distinct banks serve as an explanation for the formation of a stable corporate client base for each bank \((a \text{ market share of } 1/3 \text{ for each})\). (Note that in the egalitarian network of Erdős and Rényi, none of the banks is able to acquire a significantly higher market share than the others. However, this can be explained by the lack of nodes with ledge number of links.) In contrast, in the equilibrium state of the Barabási-Albert scale-free network for \(a = 1\), one bank dominates the entire financial industry apart from a few, nonaccessible companies located in the periphery of the network. Therefore, in the Barabási-Albert network, the dynamics converges to one cluster and one bank can gain control over the entire economy through companies with high degrees. Interestingly, in between the two extremes, the market share increases as the function of parameter \(a\) and reaches its maximum just before \(a = 1\). Note that not only do the average market shares of the largest banks increase continuously as the function of parameter \(a\) but so do the relaxation times. The steadily increasing maximal market shares as the function of parameter \(a\) is surprising; we expected the market share to decrease if the bank selection decision is increasingly driven by the topology of financial transactions. This phenomenon might be explained by the following facts:

1. When the decision of companies is more and more driven by the topology of financial transactions, stable clusters of companies are formed, and these clusters choose the same bank with a higher probability.

2. There may be opinion-leading companies, that is, companies whose act of switching results in several other companies deciding to switch as well.

3. When companies also take the fitness of the banks in their decision-making process into account, even to a lesser extent, dominant companies might convince several other companies to choose the bank with the highest fitness. For example, if \(a = 0.9\) (the role of the topology in the decision-making process) and \(b = 0.1\) (role of fitness in the decision-making process), and a large company switches from bank \(\alpha\) to bank \(\beta\), then several other neighbouring companies might follow the behaviour of its large trading partner. When topology plays a more important role in the decision-making process, the intensity of the cascade of switching may increase. In contrast, if a small company switches from bank \(\alpha\) to bank \(\beta\), it most likely does not lead to a cascading effect. We might even expect the small company to switch back to bank \(\alpha\), as its neighbours also belong to that bank.

4. When the fitness has high importance in the decision-making process, there are no significant cascading effects in relation with the bank choice. Companies, both large and small, choose their main bank on a stand-alone basis, independently from others.

One of the counterintuitive features of the model lies in the large number of equilibria with similar statistical properties. In each run, companies were assigned to a bank with uniform randomness; therefore, the starting points were different. As a straightforward
consequence, there were large variations in the path of reaching the market equilibrium and in the possible realisations of the equilibria. Nevertheless, the statistical properties of the equilibria were similar. From this point of view, the behaviour of the model shows similarities to the spin glasses. The findings, being in line with the behaviour of many complex systems analysed by physicists, however, might be considered to be novel in the field of economics.

3.4. Differentiated corporate behaviour

In the previous simulations, the results are presented as the function of the topology parameter. The weight of the topology in the decision-making process varied across runs; however, the topology parameter did not vary across companies within a run. In the introduction, we argued that large companies might assign the topology parameter a weight close to zero, whereas small and medium enterprises (SMEs) might put relatively higher emphasis on the topology parameter in their bank selection decisions. By assuming a negative correlation between the size of the company and its topology parameter, we have controlled for this possibility.

When a linear correlation was assumed between the firm size and the weight of the topology in bank selection decision, due to the lognormal firm size distribution, only the decisions of the largest companies are driven by the fitness parameter. To put it another way, the value of the topology parameter is low for a small number of large companies with high degree. Nevertheless, the majority of the companies, mostly the SMEs, incorporate the financial consequences of the network topology to a larger extent (the value of the topology parameter is high for them). As a consequence, the speed of convergence towards the market equilibrium is rather low, similarly to the scenarios, when the weight of the topology in the bank selection decision was equally high for all the companies.

When exponential correlation was assumed, the distribution of the topology parameter was more uniform across companies. In this case, a much higher number of large and medium-sized companies selected banks on the basis of their fitness and disregarded the network effects (the topology parameter had a low value for a high number of firms). As a consequence, the speed of convergence towards the equilibrium became relatively fast, similarly to the scenarios, when all the companies assigned an equally low weight to the topology parameter.

In sum, the simulation results (relaxation times and market shares in equilibrium) remained unchanged, when large and small enterprises behaved distinctly. Building a model more in synch with reality and assuming a negative correlation between the size of the company and its topology parameter, the system behaved in a similar way as it would behave regardless of the effective topology parameter (the parameter being averaged across companies). The relaxation was slow, if the value of the topology parameter was on average high (close to 1), whereas the relaxation was quick if the mean was small (close to 0).

4. Conclusion

The paper models the phenomenon of bank selection decisions. In the banking sector, the price-benefit trade-off might be outweighed by complicated dynamics. In an attempt
to assess the determinants of bank selection decisions, we worked with a weighted and
directed network of corporate clients. The generated network reflected the most impor-
tant topological features of companies linked by financial transactions. The dynamics
on the network resulted from the decision-making process of the companies. The fitness
encompassed the specific characteristics of banks (e.g., price and quality of the service,
number and location of branches) that are important when companies decide which bank
to choose. The topology of financial transactions played an important role through the
pricing of services. That is, the price-sensitive companies took into account that intra-
bank transfers are cheaper and faster than interbank transfers.

In the model, the equilibrium was not unique. The dynamic process implied by
the rational decision of companies resulted in multiple equilibria with similar statistical
properties. Simulations showed that the speed of convergence towards the market equi-
librium is slower if the value of the fitness parameter is lower. In addition, by having
the Erdős–Rényi and the Barabási–Albert networks as benchmarks, simulations revealed
that in the case of networks of corporate clients, the relaxation times are similar to the
relaxation times in the Erdős–Rényi network. Interestingly, in all cases, the convergence
to the equilibrium becomes infinitely slow as the role of the topology is becoming more
and more important.

When the fitness of the banks was the only factor in selecting financial provider, then
the market share of the largest bank equalled the fitness of the most talented bank. On
the other extreme, if the topology was the only factor influencing the decision-making
process, the market share of banks equalised. Between the two extremes, by varying
the relative importance of the fitness of banks and the topology of financial transactions
in the bank selection decision, the simulations showed that by decreasing the role of
the fitness and increasing the role of the topology in the decision-making process, the
average market share of the largest bank increases steadily. Therefore, in line with the
obvious network effects within the corporate client portfolio, the network topology plays
an important role in determining the success of a bank. As a consequence, bankers not
only should focus on the intrinsic value of their banking services and improve the fitness
of the bank but also should devote attention to the topology of financial transactions.
This finding has important implications for the customer acquisition strategy of banks.
Bankers should consciously manage the topology of financial transactions in their cus-
tomer portfolio. From practical viewpoint, this means that marketers should target and
acquire those companies that are strongly linked to several companies in the portfolio of
the bank planning the marketing action.

The rigorous analysis of the market shares of the largest banks revealed a steadily
increasing maximal market share as the function of parameter $a$ (the topology param-
ter). This counterintuitive phenomenon might be explained by (1) the presence of stable
clusters choosing the same bank as the bank selection decisions are more and more driven
by the topology of financial transactions, (2) the presence of opinion-leading companies,
(3) the presence of dominant companies whose behaviour is followed by the neighbouring
companies and (4) by the lack of cascading effects if fitness plays an important role in
the decision-making process. This finding again has important implications for banking
experts. In retention campaigns and in targeted advertisements, marketers should
devote special attention to stable clusters, opinion-leading companies and dominant cor-
porations.
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Figure 1: Equilibrium of the network of corporate clients ($N = 1,000$). The model parameters include the following: $B = 3$, $a = 0.25$, $b = 0.75$, $f_\alpha = 0.15$, $f_\beta = 0.20$ and $f_\gamma = 0.65$. 
Figure 2: Convergence towards market equilibrium: the market share of the largest bank as function of \( t/N \) for \( a = 0 \), \( a = 0.25 \), \( a = 0.5 \), \( a = 0.75 \) and \( a = 1 \). Averaged over 1,000 runs. The size of the network equals \( N = 100,000 \).
Figure 3: Relaxation times as function of parameter $a$. 
Figure 4: Average of the maximal market shares in equilibrium as function of parameter \( a \). The curves are plotted on the basis of 100 runs (random allocation of banks) for 25 distinct networks generated by the corresponding algorithms. The impact of parameter \( a \) is measured at 25 discrete values with \( a \) being equally distributed between 0 and 1. In the model, there are 3 banks, and further model parameters include the following: \( N = 10,000 \), \( f_\alpha = 0.15 \), \( f_\beta = 0.20 \) and \( f_\gamma = 0.65 \).