STUDIES

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Regional Characteristics of Hungarian District Heating Companies Based on their 2009-2017 Financial Reports, with Special Regard to the Rate of Accounts Receivable and to the Energy Efficiency of Household Consumers

This study examines specificities in the asset structure of district heating companies in Hungary, with special regard to the accounts receivable. The author wants to find out whether geographical position and the socio-economic conditions of the household consumers have a significant effect on the companies' rate of accounts receivable. In addition, the paper examines how energy efficiency can be described in the case of household consumers of heat suppliers. Its methodology is the analysis of financial reports. Using the data derived from the reports of heat supply companies in Hungary, 72 companies in all, and the technical and economic information, data from 9 years (2009-2017) were examined. District-level LHDI was also calculated to describe the characteristics of household consumers.
Keywords: district heat supply, analysis of financial report, local (district level) HDI, accounts receivables, energy efficiency
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Introduction

Nowadays in Hungary, district heating is provided by 89 companies in 93 settlements, which supply more than 1.6 million people with heat. There are, however, differences in their ownership background, in the technical structure, in the activities carried out and in the number of supplied consumers of the district heat producers. The author hopes to reveal the characteristics that lead to the diverse assets, financial and profitability positions of these companies. In earlier research, factors were revealed that led to diverse assets, financial and profitability positions of these companies resulting from legal changes related to heat suppliers and from technical and economic characteristics. The current paper first focuses on the relationship between the socio-economic characteristics of household consumers and the asset structure of the district heat suppliers through the analysis of the share of accounts receivables to the total assets, as the economic and social positions of consumers has an effect on their solvency. The household fee payers' solvency can also determine the extent to which consumers can contribute to the development aiming at the improvement of energy efficiency(like the self-contribution for investments for the realization of a building renovation program or for the installation of heating metering). This leads to the second research question about testing the relationship between the socio-economic characteristics of household consumers and the efficient energy use of the population. To answer the outlined research questions, in the first part of the study the basic methodology is briefly summarized for the analysis of the asset structure and for the Hungarian situation of the heat suppliers, taking into account the regional differences in the consumers' socio-economic characteristics. Then, the results of the empirical research are described and discussed.

Toolkit necessary for analyzing current assets

In order to achieve and control a company's goal and its stakeholders'goals, information is needed (Mabberley 1999). Due to its fixed set of rules, accounting is suitable to realize communication among the various economic operators and to provide the requested information. Pál (2015, pp.14) says that "modern accounting is the language of business and the basic form of business communication as it forms a specific 'grammar'" that allows for the identical interpretation of economic processes by all actors.

Economic analysis can be considered as one of the basic methods of obtaining the necessary information. In the course of the analysis, we reveal relationships and factors influencing economic phenomena; therefore, the analysis can rightly be considered as a way of understanding, which not only facilitates but also ensures the acquisition of the necessary information(Kresalek 2011). The data presented in the reports provide an opportunity to get to know the company, as "financial indicators reflecting the realization of financial goals can be used to reveal the company's economic position and to understand the managerial, causal, market and other kinds of relationships"(Sinkovics 2010, pp. 125).

Examination of the balance sheet provides an opportunity to analyze the company's financial position. Depending on the depth and approach of the analysis, the comprehensive analysis of the balance sheet and a detailed examination of the individual/different balance sheet items can be distinguished (Pucsek 2011).

Table 1 includes calculation methods for a comprehensive asset analysis.

Table 1:
Calculation methods of asset structure indicators

Focus of the analysis / Indicator name		Calculation of the indicator	
		Numerator	Numerator
Indicators of asset structure	General way of calculating the indicator	Asset item	Asset group
	Examples	Fixed assets	Total assets
		Tangible asset	Total assets
		Current asset	Total assets

Source: Kardos et al. 2007; Siklósi-Veress 2016; Kresalek-Pucsek 2016, Musinszki 2015

In vertical analysis, we can understand the asset structure, the capital structure and their changes by calculating different distribution ratios (Molnár et al. 2018). The study tries to find the factors explaining the share of receivables rendered to clients. The term 'receivables rendered to clients' refers to the balance sheet item called 'Receivables from goods and service rendered to clients' specified in the Act on Accounting, accepting the legal definition that all the receivables performed by the entrepreneur, derived from goods and services that are not receivables from a related undertaking or from companies in other participating relations and that are not loans made in the long run shall be recognized here (Act C of 2000 on Accounting).

Importance of district heating

Consumers of Hungarian district heat suppliers

In Hungary, district heating has 677,000fee payers in 93 settlements, of which 657,000 are households and 20,000 are other fee payers. Figure 1 shows the evolution of the number of consumers between 2009 and 2017. In recent years, there has been no significant change for either households or other fee payers. Although there has been an increase in the construction of

new homes in recent years, its effect is only slightly reflected in the change of the number of fee payers. Research about district heat suppliers is relevant because of the high number of consumers and therefore the significant social involvement.

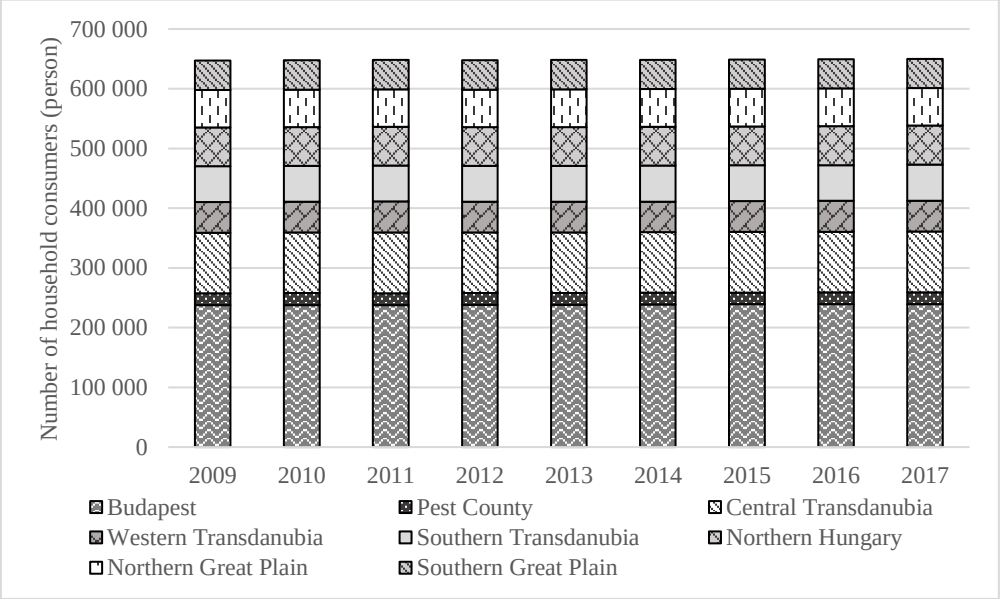

Figure 1: Number of household fee payers, 2009-2017
Source: Own edition based on HCSO data

There are regional disparities in the number and proportion of apartments supplied with district heating. Heat supply is widespread mainly in Budapest, in county seats and in settlements with more than 40,000 inhabitants (due to size management considerations). Differences can be observed not only in the number of district heat consumers, but also in the income conditions of household consumers, since social and economic inequalities at the regional level can be considered as a characteristic of the economies (Nemes Nagy, 1990). Just as geographical factors play a role in economic development (Benedek, 2019), the income conditions, the social status and employment conditions of household consumers using district heating can also affect the operation of district heating companies. Lower-income consumers are more likely to experience payment problems or delay payment of fees in the case of an unexpected problem and this can directly affect the profit, the profitability and the accounts receivable of service companies. There has been a shift towards lower-income consumers for household customers of heat suppliers. The distribution of households by type of heating per income deciles is shown in Figure 2. The income statistics of the Hungarian Central Statistical Office (HCSO) for 2017 highlight that district heating was present in an average of 16.9% of households in 2017 (compared to 15.9% in 2011). Figure 2 shows that a higher proportion of residents with higher income levels live in apartments with district heating than those with lower income levels.

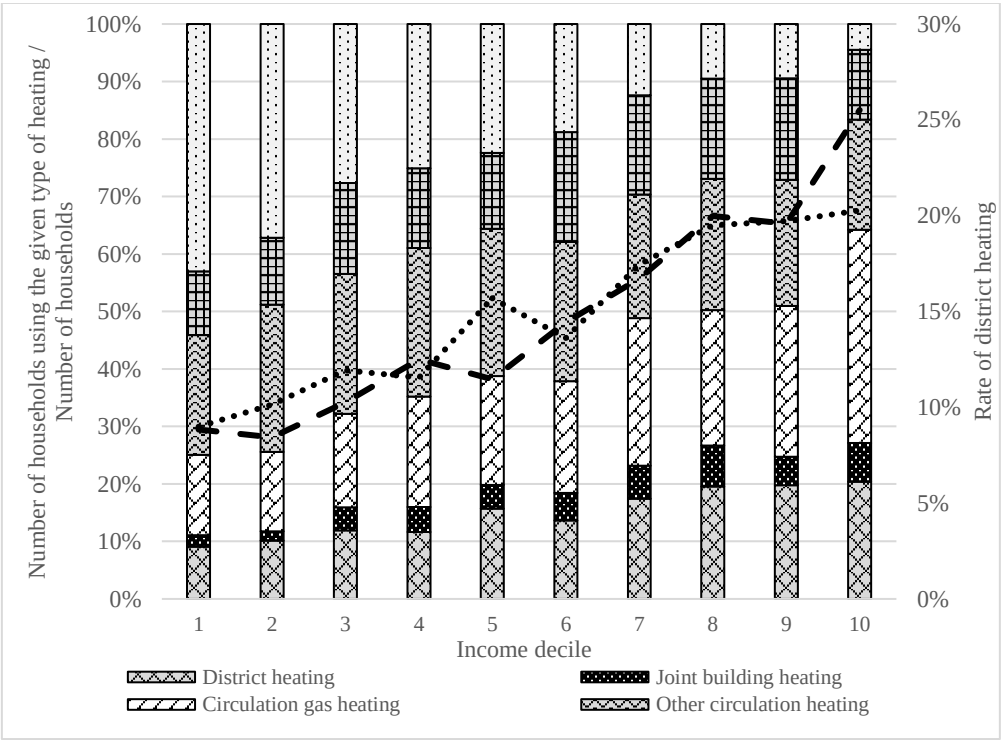

Figure 2: Distribution of households by type of heating by income deciles in 2017
Source: Own edition based on HCSO data

The two line graphs belonging to the secondary vertical axis highlight that there was some shift compared to 2011: the rate of district heating has decreased in the upper income decile, but the rate of consumers using district heating increased in four of the five lower deciles, which led to a decrease in the range and standard deviation of the rate of consumers in the different income deciles compared to 2011.

Another feature of district heating consumers is derived from spatial inequalities (Benedek and Kocziszky, 2017). To quantify and integrate them into a model, I downloaded district level data from the HCSO database for the period between 2009 and 2017 (there were several changes in the regional structure of Hungary; therefore, it was necessary for example to convert micro-regional level data to district level data). The variables describing household consumers were the following: Number of recipients of social support per capita, Number of jobseekers per capita, Per capita activity rate, Per capita personal income tax base.

When analyzing the performance of countries and regions (and of their inhabitants), besides economic factors, the use of other indicators (besides GDP-based mainstream analyses) is also justified. In order to properly describe the household consumers of district heat suppliers, I use a more complex indicator in addition to the simple variables described above and the economic characteristics of the consumers. Therefore I calculated a district-level Human Development Index (HDI)for 2011 and 2016. One such indicator is the LHDI (Local Human Development Index), which is based on the methodology and idea of the HDI. Szendi (2015) summarizes the emergence and development of the HDI as an indicator developed by the United Nations in 1990 and describes the development and evolution of the dimensions taken into account in its calculation over the past 30 years. She also describes the calculations made in recent years for territorial (regional, county, micro-regional) HDI calculations, including the cases of Brazil,

Russia, Portugal, Iran, Latvia, and Germany (Szendi, 2015). Similarly, my calculations applied the methodology of the 2013 United Nations Development Program (UNDP)elaborated for Poland (UNDP, 2013).

Based on these studies, I calculated the value of the LHDI for 2011 and 2016 as follows:

$$LHDI = \sqrt[3]{HI * EI * WI},$$

where LHDI is the local HDI of the given district, HI is the health component of the given district, EI is the education component of the given district, and WI is the welfare component of the given district.

In the calculation of HI (health component), life expectancy at birth was taken into account and the following relationship was used[1]:

$$HI = 1 + 99 * \frac{HI_i - HI_{min}}{HI_{max} - HI_{min}},$$

where HI_i is the value of life expectancy at birth in district, while HI_{max} and HI_{min} represent the maximum and minimum values of life expectancy at birth.

In the calculation of EI (education component), the geometric mean of two indicators were taken into account: the rate of residents having completed at least 8 grades of school among the population aged 15 and over and the rate of persons aged 25 and over with a tertiary education degree. Taking them into account, I used the following equation[2]:

$$EI = \sqrt[2]{(1 + 99 * \frac{LEI_i - LEI_{min}}{LEI_{max} - LEI_{min}}) * (1 + 99 * \frac{HI_i - HI_{min}}{HI_{max} - HI_{min}})},$$

where LEI_i is the proportion of residents having completed at least 8 grades of school among the population aged 15 and over, and LEI_{max} and LEI_{min} are the minimum and maximum rate of residents having completed at least 8 grades of school among the population aged 15, HI_i is the rate of persons aged 25 and over with tertiary education in district i, while HI_{max} and HI_{min} are the minimum and maximum rates of persons aged 25 and over with tertiary education in district i.

When calculating WI (welfare component), the calculations are based on the per capita personal income tax base and the following equation is applied[3]:

$$HI = 1 + 99 * \frac{WI_i - WI_{min}}{WI_{max} - WI_{min}},$$

where WI_i is the per capita personal income tax base in district i, while WI_{max} and WI_{min} represent the per capita personal income tax base in the districts.

The values of LHDI calculated for districts using this methodology are shown in Figure 3.

[1] Data for life expectancy at birth at the micro-regional level for 2011 was available from the 2010 Census. I used the 2016 data from the Microcensus data sources, which were collected at county level. In order to ensure that the data are comparable and could be used in the following analysis, two steps were needed: (1) I transformed the micro-region data for 2011 in accordance with the districts valid in 2016, since I deal with district heat suppliers at the district level, too, and (2) I transformed county-level data from 2016 to district level data, assuming that the change in the direction and the extent of life expectancy at birth in each district of a given county were the same as in that county.

[2] When calculating the two components of the education component, the data sources of the Census and the Microcensus were used, following similar steps as described above.

[3] I used TEIR (National Spatial Development and Spatial Information System) data to calculate the personal income tax base.

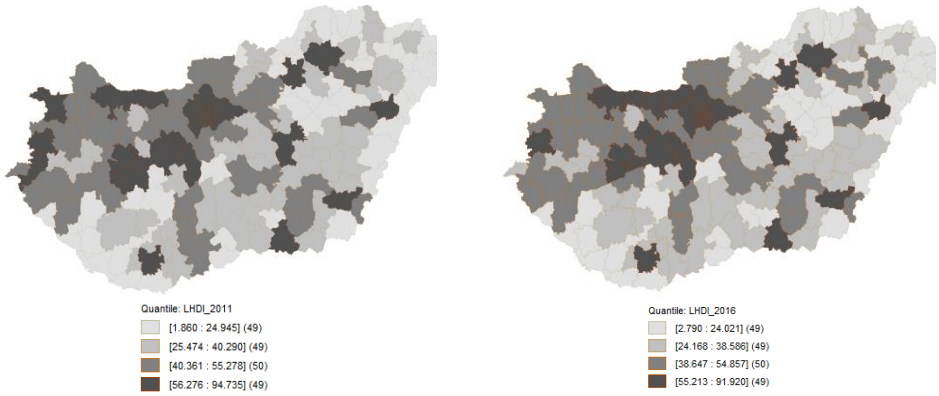

Figure 3: LHDI at the district level in 2011 and 2016
Source: Own edition based on HCSO data

The calculated data highlight that there are territorial disparities in LHDI values at the district level, with higher values in county seats and towns with county rank, and that territorial disparities did not decrease in the examined period (there were no significant change in the average and county level average values of LHDI and in their standard deviation). Moreover, it was the income component of LHDI that rose to the highest extent. The empirical part of the research examines the impact of the positive effects of the income and socio-economic situation of the population on the change in the rate of accounts receivables.

The role of district heat suppliers in energy policy

Energy is vital for life and used in many areas in our everyday lives, including heating, lighting, transport or industry. "Human well-being, industrial competitiveness and the functioning of the society as a whole depend on secure, reliable, sustainable and affordable energy" (European Committee, 2011). For this reason, proper management of energy sources is essential. The European Union Energy Strategy, elaborated based on these principles, set different targets for climate and energy policy for 2020, 2030 and 2050 (European Committee, 2012). Renewable energy sources play an important role in the energy strategy. The objective for 2020 is that 20% of the total energy will come from renewable energy sources. By 2030, the rate of renewable energy sources shall reach 32% and by 2050, it shall reach 55% (European Commission, 2018). The energy policy emphasizes sustainable, affordable, competitive and secure energy supply. Because of scarce resources, rational and efficient energy management can make its use sustainable. Achieving the targets will have a significant impact on applied technologies, as the rate of used resources will change fundamentally, and also because of the rising cost of fossil energy sources. These targets and the efforts made to achieve them can also be regarded as catalysts for the spread and development of technologies using renewable energy. Jensen (2019) states that low-temperature heat suppliers based on green and renewable energy sources play a key role in this. Djorup and Hvelplund (2016) point out their statement more categorically, arguing that a common European Energy System and efficient heat supply are essential to achieve the goals. If the targets are met, the benefits will be multiple: not only can carbon emissions be reduced, but new jobs can also be created and cost saving can be realized (European Committee, 2012).

It is worth noting how these principles are present in the law called Act XVIII of 2005on District Heating Services, the most important element of the regulation of district heat suppliers in Hungary. The objectives of the legislation are described as follows: "The Parliament makes the law to ensure objective, transparent and non-discriminatory regulations to ensure the safe, adequate and economical supply of district heating of customers, taking into account the

requirements of consumer protection, energy efficiency, energy saving and environmental protection' (Act XVIII of 2005 on District Heating Services).

The question arises as to which indicators can be used to measure the realization of energy efficiency and energy saving principles listed as aims of the law and what characteristics can be used to describe household consumers. This provides relevance to the second research question.

Material and method - Empirical study of district heat suppliers

Database of the analysis

The database used for the analysis includes the companies' annual reports from 2009 to 2017. Nowadays in Hungary, 89 companies provide district heating service in 93 settlements. Of these, 72 companies were included in the examined population.

The calculation of the indicators required the (annual) reports of the companies, which were considered the first type of data. The second type of the examined data was made up of technical and economic data provided annually by the companies under Annex 4 of Government Decree no. 157/2005 (August 15) [11] on the implementation of the Act XVIII of 2005 on district heating services. Since 2012, district heat suppliers have had the obligation to disclose these pieces of information to the public.

Act XVIII of 2005 on District Heating Services, Chapter 3, Article 18/A requires "that cogeneration shall be published broken down by premises, that district heat supply shall be published by settlements separately and that other activities shall be published in the supplement of the annual report as if they were carried out within the framework of an autonomous company." This implies that besides their regular balance sheet and profit and loss account, these companies have to prepare a balance sheet and a profit and loss account at the activity level (broken down by premises for district heat production and by settlements for district heat supply). Databases including the companies' annual reports were not relevant for my research because they do not include the data separated at the balance sheet group level or main group level. The tools of the analysis include the Excel program of the Microsoft Office 365 ProPlus package and SPSS 24 software.

Hypotheses and methods

In the study, two hypotheses are examined:

1. The largest part of the district heat suppliers' accounts receivable is the receivables rendered to clients. The rate of receivable rendered to clients is lower for companies whose household consumers are in a more favorable socio-economic situation.
2. Household consumers with a more favorable economic and social situation can be characterized by higher energy awareness.

The research questions, the variables (indicators) and the system of the performed calculations are included in Table 2.

Table 2:
Research questions, applied variables and statistical calculations

Hypothesis	Applied indicator	Calculation
1	Per capita personal income tax base (district level), Per capita number of job-seekers (district level), Per capita number of recipients of social support (district district), Local HDI (district level); Rate of receivables rendered to clients (based on the annual reports of district heating companies), Rate of receivables rendered to clients (based on reports separated from accounting point of view and typical for district heating)	Variance Analysis, Correlation Analysis
2	Local HDI (district level), Heat sold for heating purpose for one household consumer (corporate level), Number of household consumers accounted based on costs per one household consumer (corporate level), Average annual specific consumption of the upper annual heat consumption decile of household consumers (corporate level), Average annual specific consumption of the lower annual heat consumption decile of household consumers (corporate level)	Cluster Analysis, Logistic Regression

Source: Own edition

For later calculations, I consider it important to distinguish between district heat suppliers and companies providing district heating.

Act XVIII of 2005 on District Heating Services defines district heating as follows: "A commercial public service provided by the licensee, which supplies consumers with energy intended for heating or other heat utilization. The service is provided from a district heat producing facility through a district heating pipeline network". The Act and the related decrees do not prohibit companies providing these activities from engaging in other activities as well. Accordingly, besides district heating, the bulk of the 89 Hungarian district heat suppliers carry out other activities, including district heat production, electricity production, waste management, water utility supply and other activities related to urban management. The above-mentioned Article 18/A of the Act stipulates that the balance sheet and the profit and loss account have to be prepared at the activity level as well. This provided me with the opportunity to examine the rate of the total assets related to district heating and other activities and to examine what percentage of the net receipt of sales comes from performing district heat supplier activities. In the case of the examined population in 2017, the average rate of turnover from other (not district heating service) activities was 28%, while this rate was 33% for the assets. On this basis, I divided the district heat suppliers into two categories. Accordingly, reports of companies providing district heating subsequently refer to data from the whole set of annual reports while in the case of district heating reports, the base for calculations are the asset items necessary to provide district heating activity, after the separation from an accounting point of view.

Research results

To answer the first research question, the current asset structure of the companies needed to be analyzed.

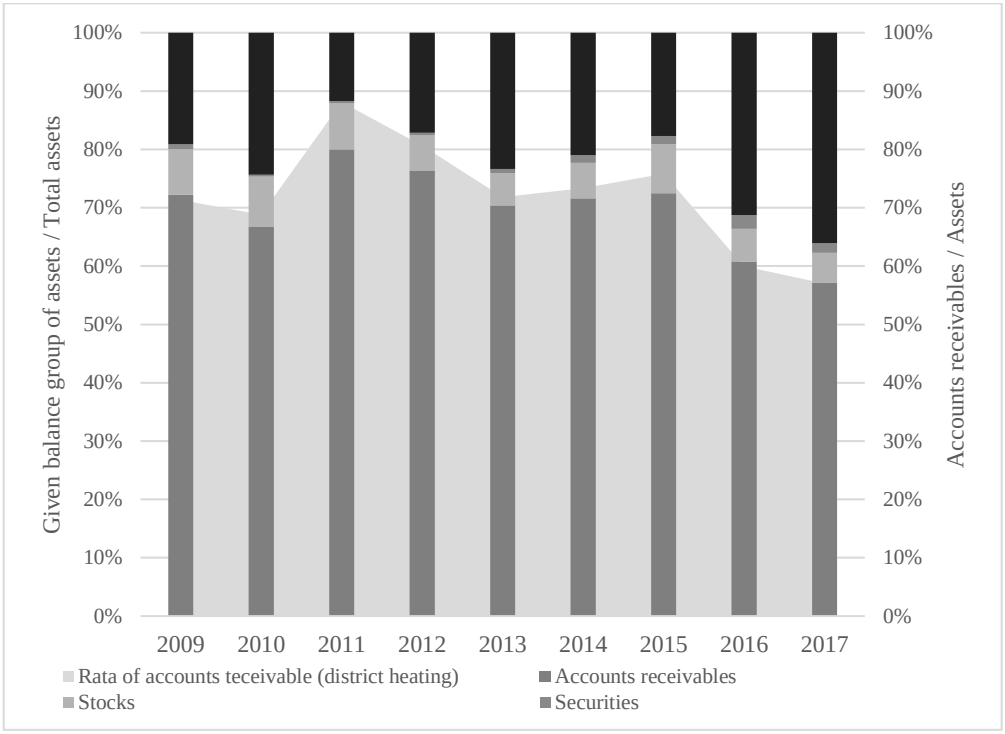

Figure 4: Distribution of current assets of companies providing district heating and the rate of accounts receivable based on the reports separated from accounting point of view (right-hand-side vertical axis) 2009-2017

Source: own compilation based on companies' reports

Figure 4 illustrates the specificities of district heat suppliers' management, which can be used to determine the following for the sector.(1) Due to their operational specificities, these companies have a negligible amount of securities (data from 2017 show that 85% of them belong to companies owned directly by municipalities and 15% belong to privately owned companies, while the rate was 0% for the two other groups in the whole period), and the rate of stocks was also low (below 10%) in the examined period for the whole sector. (2) Out of the short-term assets of the company, the rate of accounts receivable is determining and the amount of cash and cash equivalent is also remarkably high, the growth of which is demonstrable in absolute terms during the period under review. (3) Although the difference is not significant, it can be stated that if the data are treated separately, the examined companies were characterized by higher accounts receivable each year. It can be concluded that district heating is performed with a higher rate of accounts receivables than for companies which perform other activities as well.

In order to answer the second part of the first research question, the first step was to examine whether the location of the district heat supplier's site (including the residents living there(Síposné Nádori, 2016)) had any effect on the rate of receivables rendered to clients of district heat suppliers. To test it, Variance Analysis was conducted to examine to what extent

belonging to a given territorial unit (regional level) can be considered an appropriate grouping criterion. Table 3 summarizes the test results.

Table 3:
The strength of the relationship between the rate of receivables rendered to clients and region at the 5% significance level

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017
Eta	0.517	0.428	0.781	0.701	0.590	0.720	0.719	0.696	0.730
Eta (district heat)	0.868	0.635	0.869	0.778	0.651	0.754	0.772	0.755	0.765

Source: Own edition

The analysis revealed that at the 5% significance level, the region of the heat suppliers was an appropriate grouping criterion in each year, since different group averages of the rate of receivables rendered to clients can be observed both for the annual reports and for the reports separated from accounting point of view (the effect of grouping was stronger each year when the report separated from accounting point of view was examined, which implies that receivables rendered to clients of a district heating activity is determined by geographical region to a higher extent than the accounts receivables of the total corporate activity).

Subsequently, it was examined at a more detailed, district level, whether the socio-economic situation of the household consumers of the given district heat suppliers had an effect on the district heat suppliers'amount of debt. To do so, correlation analysis was carried out in the case of four selected and computed measures describing the social, income and economic positions and of a variable that examines the rate of receivables rendered to clients at three different levels. Results are summarized in Table 4.

Table 4:
Rate of significant relations between the independent and the dependent variables

Name	*	Clients / Assets	Clients / Current assets	Clients / Accounts receivable	(District heat) Clients / Assets	(District heat) Clients / Current assets	(District heat) Clients / Accounts receivable
Availability of the measure		9	9	9	5	5	5
JHDI 2011 and 2016	2	50%	50%	0	100%	0	0%
Per capita personal income tax base 2009-2017	9	56%	67%	33%	100%	80%	60%
Per capita number of job seekers 2009-2017	9	44%	33%	0	80%	20%	40%
Per capita number of recipients of social support 2009-2014	6	17%	50%	0	40%	20%	20%

Source: Own calculation

*Availability of the measure

There is a positive poor or medium strong relationship (Pearson Correlation) between per capita number of jobseekers, per capita number of recipients of social support, and the rate of receivables rendered to clients. There is a negative poor or medium strong relationship between the measures describing the socio-economic position (district level JHDI or per capita personal income tax base) and the measures of the rate of receivables rendered to clients. These results highlight that there is a relationship between the socio-economic status of household consumers and the rate of receivables rendered to clients. The district heat suppliers operating in areas

where the population has on average better social and economic conditions have on average lower debt amount.

The second research question is about the relationship between the energy efficiency of the household consumers and their socio-economic position. To quantify household energy efficiency, calculations started with data that companies have to disclose to the public yearly in connection with district heating. Accordingly, hierarchical cluster analysis was performed (Szilágyi et al. 2017) including the following variables: heat sold for heating purpose for one household consumer; number of household consumers accounted based on costs per one household consumer(corporate level); average annual specific consumption of the upper annual heat consumption decile of household users; and average annual specific consumption of the lower annual heat consumption decile of household users (corporate level).

With cluster analysis, two distinct clusters of energy use were created in different years. The results of the two clusters and the examined variables are shown in Table 5.

Table 5:

The two clusters created with hierarchical cluster analysis and the values of the variables

Report		**Variables**		
Ward Method		**V1**	**V2**	**V3**
Less energy efficient	Mean	100.72	277.61	0.26
	N	18	18	8
	Std. Deviation	52.69	62.80	0.13
Energy efficient	Mean	54.97	213.82	0.67
	N	20	20	20
	Std. Deviation	29.93	93.57	0.22
Total	Mean	76.64	244.04	0.48
	N	38	38	38
	Std. Deviation	47.66	85.73	0.27
1	Average annual specific consumption of the lower annual heat consumption decile of household users			
2	Average annual specific consumption of the upper annual heat consumption decile of household users			
3	Number of household users accounted based on costs per one household user			

Source: own edition

The available data made it possible to group 38 of the companies. The first group of companies is called‘less energy efficient’, where the annual specific consumption of the upper and lower annual heat consumption deciles of household consumers and also the rate of cost-sharing users (cost-sharing users are the users who can control the temperature of their apartment and thus control the price paid for the service) are lower. In the case of the energy efficient group of companies, the opposite of these trends was observed for the variables. From the research point of view, it was important to investigate whether there is an explanatory variable that can be used to characterize companies with consumers of average energy efficiency. Cross tables helped examine whether the ownership structure, sales size or the geographic position (district level) of district heat service were correlated with the two created clusters. The logistic regression was carried out with the aim of examining the effect of the

previously calculated LHDI describing the socio-economic background. For the Chi-square statistics used in the crosstab analyses, the critical significance level obtained for the spatial comparison was sig = 0.139, and for the other potential explanatory variables, significance levels were between 0.4 and 0.8. This highlights that there is no significant difference in terms of energy efficiency between companies with different ownership structures, with different sales sizes or with different geographical locations. The explanatory power of the function created with LHDI variable during the logistic regression calculation is extremely low (Nagelkerke R square = 0.09). LHDI can correctly identify companies with different energy efficiency only at 57%, which is hardly different from random classification (50-50%). Thus, the hypothesis that socioeconomic factors can influence energy efficiency has to be rejected. All analyses revealed independence; the listed variables cannot be used as grouping variables.

Summary

The study analyzed the asset structure of district heating companies along with two research questions by analyzing the annual reports of 72 companies for nine years. The statistical analyses highlighted that the socio-economic conditions of household consumers have an effect on the companies' accounts receivable and this effect can be shown for several indicators and for different levels of accounts receivable. Companies who operate in districts where residents have a more favorable economic and social background have on average a lower level of accounts receivables.

However, it is important to note that receivables rendered to clients is also determined by the clients and accounts receivables management practices included in the accounting policy of the companies, which include differences that determine how accounts receivable can be removed from the balance sheet, how they can be extinguished, and therefore their amount.

The second research question examined whether there is a relationship between the socio-economic characteristics of household consumers and the efficient energy use of the population or whether there are any criteria that could be used as explanatory variables. There was no proven link between the variables described above, which can be considered as a market for the company, as the potential for energy efficiency does not depend on the income position of the population and systems with higher energy efficiency also occur in less advantaged social areas.

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