REGIONAL DISPARITIES IN HUNGARIAN URBAN ENERGY CONSUMPTION

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RSA2018, LONDON

SZÉCHENYI 2020

HUNGARIAN GOVERNMENT

European Union
European Social Fund

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EFOP-3.6.2-16-2017-00007

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GLOBAL ENERGY TRENDS

- Role of urban areas in global energy use growth
- Decentralization process of energy systems
  - 2 approaches: the first one emphasizes technical issues, the second one is based on the (energy and regional) policy.
- New energy policy → moving towards regional level (and it should be more decentralized)
  - Issue of energy becomes a central question in regional policy
  - Global initiatives → Covenant of Mayors

SMART CITY CONCEPT

Many categories:

- smart city,
- eco city,
- sustainable city,
- low carbon city,
- green city,
- knowledge city,
- intelligent city,
- digital city,
- resilient city,
- ubiquitous city,
- information city,
- liveable city,
- hybrid city,
- creative city,
- humane city,
- learning city,
- wired city.

Smart Economy (competitiveness)

- Innovative spirit
- Entrepreneurship
- Economic image and trademarks
- Productivity
- Flexibility of labour market
- International embeddedness

Smart People (social and human capital)

- Level of qualification
- Affinity to life long learning
- Social and ethnic plurality
- Flexibility
- Creativity
- Cosmopolitanism/Open-mindedness
- Participation in public life

Smart Governance (participation)

- Participation in decision-making
- Public and social services
- Transparent governance

Smart Mobility (transport and ICT)

- Local Accessibility
- (Inter-)national accessibility
- Availability of ICT infrastructure
- Sustainable, innovative and safe transport systems

Smart Environment (natural resources)

- Attractivity of natural conditions
- Pollution
- Environmental protection
- Sustainable resource management

Smart Living (quality of life)

- Cultural facilities
- Health conditions
- Individual safety
- Housing quality
- Education Facilities
- Touristic attractivity
- Social cohesion

Source: own compilation based on Giffinger et al. (2007)

Components in Giffinger et al. (2007) and the group of adaptable indicators

DATA AND METHODOLOGY – DATA I.

- The analysis covers: 23 Hungarian towns with county rights and Budapest
  - 17 towns can be grouped into an „elite” category
- Time period: 2010-2015.
- Annual data as listed below are applied in the calculations collected from the Hungarian Central Statistical Office (KSH):
  - gross income (local currency unit LCU);
  - resident population at the end of the year (data calculated further from finalised data of the population census)
  - number of household electricity consumers;
  - volume of electricity supplied to households (thousand kWh);
  - total volume of electricity supplied (thousand kWh);
  - total volume of piped gas supplied (not recalculated) (thousand m^3);
  - of total volume of gas supplied, volume of gas supplied to households (not recalculated) (thousand m^3);
  - of household gas consumers, number of those using gas for heating.

DATA AND METHODOLOGY – DATA II.

- Based on these data we created the following indicators:
  - of total volume of gas supplied, volume of gas supplied to households (not recalculated) per the rate of household gas consumers number using gas for heating – hereinafter (simplified): *residential gas consumption per household (m^3).*
  - volume of electricity supplied to households per number of household electricity consumers – hereinafter (simplified): *residential electricity consumption per household (kWh);*
  - total volume of piped gas supplied (not recalculated) per capita – hereinafter (simplified): *natural gas consumption per capita (m^3)*;
  - total volume of electricity supplied per capita – hereinafter (simplified): *electricity consumption per capita (kWh)*;
  - gross income (LCU) per resident population at the end of the year (data calculated further from finalized data of the population census) - hereinafter (simplified): *income per capita (HUF).*

RESEARCH QUESTIONS

- What differences can be observed among the energy use of the examined cities and whether there is any connection between their success (meaning belonging to the elite category based on Rechnitzer et al. 2014) and their energy consumption patterns?
- Can the achieved level of energy efficiency and the decreasing energy use contribute to urban development or to success?
- Does the society of the more developed or more successful cities consume (natural) resources more efficiently and more consciously?

DATA AND METHODOLOGY – SIMPLE STATISTICAL METHODS

Indicator	*Definition*
range ratio	The range ratio is the ratio of the maximum and minimum values in the range.
range	The range is simply the difference between the highest and lowest observations.
relative range	The per cent relative range refers to the percentage ratio of the range to the average value in the set.
dual index	The dual index is defined as the ratio of mean income of those above the population income to those below the mean.
standard deviation	The standard deviation is a statistic that measures the dispersion of a dataset relative to its mean and is calculated as the square root of the variance. It is calculated as the square root of variance by determining the variation between each data point relative to the mean.
relative standard deviation	The relative standard deviation is a standardized measure of dispersion of a probability distribution or frequency distribution.
absolute average difference	The absolute average difference is the average distance between each data point and the mean.

Source: Nemes Nagy (2005) pp. 4-7

DATA AND METHODOLOGY – THEIL INDEX

$$T(I) = \sum_i y_i \ln\left(\frac{\bar{I}}{I_i}\right)$$

- where y_i is the gross income-share for city *i* for a given year; is average value of the measured (specific) energy data (considering the examined towns); I_i denotes the concerned indicator for city *i*. Similar to Zhang et al. (2011), in this study specific data (not total or absolute, but per capita or per household) are involved.

$$T(I) = T_B(I) + T_W(I)$$

- where $T_B(I)$ is the aggregate between-group variance component; $T_W(I)$ is the aggregate within-group component.

$$T_B(I) = \sum_g y_g * \ln\left(\frac{\bar{I}}{\bar{I}_g}\right)$$

- where y_g is the gross income share of group *g*; is the average of the cities in group *g* (related to the selected specific energy data).

$$T_W(I) = \sum_g \sum_i y_g * y_{i.g} * \ln\left(\frac{\bar{I}_g}{I_{i,g}}\right)$$

- where $y_{i,g}$ is the gross income share associated with city *i* in group *g*; $I_{i,g}$ denotes the concerned indicator for city *i* in group *g.*

DATA AND METHODOLOGY – AR-GINI INDEX

$$G = \frac{1}{2n^2\eta}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|y^i - y^j\right|$$

- where y^i and y^j are the incomes of the *i*th and *j*th household, η is the average income and n is the number of households. Adapting this formula to the calculation of AR-Gini, the explanation of the equation changes as well: y^i and y^j denote the average resource use in *i*th and *j*th area (in this study the resource use means the electricity consumption or natural gas use), η is the average resource use of each area, n is the number of output selected areas.

Comparison of AR-Gini and the original Gini index

	AR-Gini	Gini
calculation basis	calculated on an area basis	calculated on a per capita or household basis
object of calculation	calculated on a resource basis	income, wealth, expenditures (calculated on a monetary basis)

Source: own compilation based on Druckman and Jackson (2008)

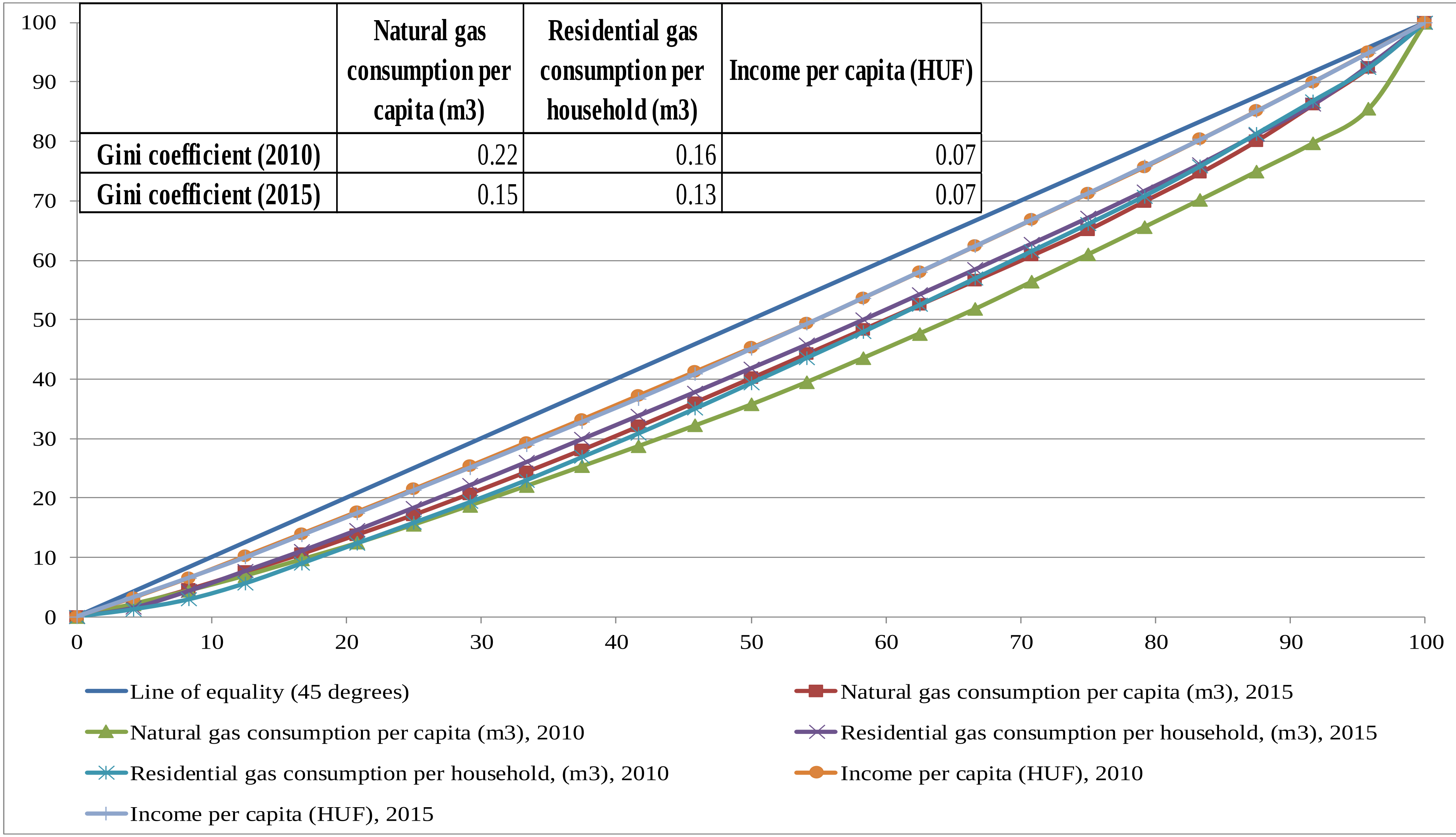
EMPIRICAL RESULTS OF SPATIAL POLARIZATION

	Residential electricity consumption per household (kWh)	Residential gas consumption per household (m^3)	Income per capita (HUF)	Electricity consumption per capita (kWh)	Natural gas consumption per capita (m^3)
2010					
max	3106.39	1631.85	1087438.94	20037.37	4103.86
min	1233.43	258.88	678824.00	2484.50	599.11
arithmetic mean	1886.01	892.73	898106.29	4410.04	1181.06
range ratio	2.52	6.30	1.60	8.06	6.85
range	1872.96	1372.96	408614.94	17552.87	3504.75
relative range	0.99	1.54	0.45	3.98	2.97
dual index	1.31	1.57	1.22	2.62	1.83
standard deviation	377.62	278.22	106824.73	3442.12	674.74
relative standard deviation	20.02	31.17	11.89	78.05	57.13
absolute average difference	247.37	194.10	87787.24	1564.01	350.99
2015					
max	3 209.85	1 527.40	1 323 747.90	23 995.81	1 621.59
min	1 292.70	306.06	839 022.91	2 495.43	421.90
arithmetic mean	1 801.89	881.21	1 081 828.14	4 773.38	881.12
range ratio	2.48	4.99	1.58	9.62	3.84
range	1 917.15	1 221.34	484 724.99	21 500.38	1 199.69
relative range	1.06	1.39	0.45	4.50	1.36
dual index	1.32	1.40	1.23	2.49	1.54
standard deviation	374.44	235.45	132 020.89	4 232.23	260.74
relative standard deviation	20.78	26.72	12.20	88.66	29.59
absolute average difference	239.77	147.64	109 082.97	1 945.39	178.12

Source: own calculations based on KSH (2018) database

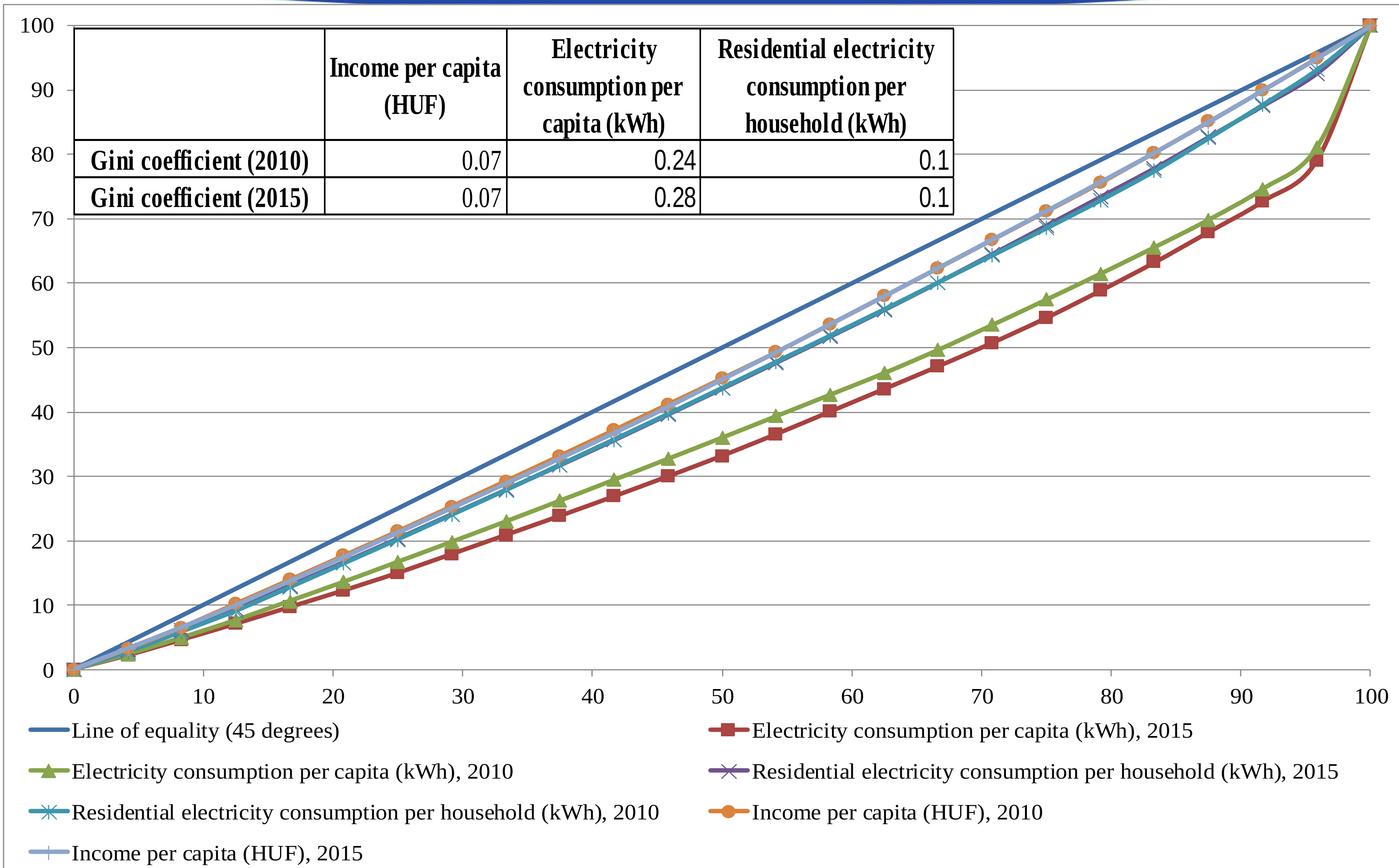
LORENZ CURVE BASED ON THE NATURAL GAS CONSUMPTION AND THE INCOME PER CAPITA, FOR BUDAPEST AND HUNGARIAN CITIES WITH COUNTY RIGHTS (2010, 2015)

	Natural gas consumption per capita (m3)	Residential gas consumption per household (m3)	Income per capita (HUF)
Gini coefficient (2010)	0.22	0.16	0.07
Gini coefficient (2015)	0.15	0.13	0.07



Source: own calculation

LORENZ CURVE BASED ON THE ELECTRICITY CONSUMPTION AND THE INCOME PER CAPITA, FOR BUDAPEST AND HUNGARIAN CITIES WITH COUNTY RIGHTS (2010, 2015)



	Income per capita (HUF)	Electricity consumption per capita (kWh)	Residential electricity consumption per household (kWh)
Gini coefficient (2010)	0.07	0.24	0.1
Gini coefficient (2015)	0.07	0.28	0.1

Source: own calculation

THEIL INDEX WITH REGARD TO ELECTRICITY AND NATURAL GAS CONSUMPTION FOR THE HUNGARIAN TOWNS WITH COUNTY RIGHTS AND BUDAPEST (2010, 2015)

Indicator	Year	Theil index	Between-group inequality component ($T_B(I)$)	Within-group inequality component ($T_W(I)$)
natural gas consumption per capita (m^3)	2010	0.097	-0.001	0.098
		100	-1	101
	2015	0.018	-0.018	0.036
		100	-96	196
residential gas consumption per household (m^3)	2010	0.104	0.037	0.068
		100	35	65
	2015	0.047	0.040	0.007
		100	84	16
electricity consumption per capita (kWh)	2010	0.111	-0.024	0.135
		100	-22	122
	2015	0.125	-0.030	0.155
		100	-24	124
residential electricity consumption per household (kWh)	2010	0.00	0.02	-0.02
	2015	0.00	0.01	-0.01

Source: own calculations

SUMMARY

- **Significant differences** between the rural and urban (23 Hungarian towns with county rights and Budapest) energy use **were not experienced**.
- In the case of the examined cities **significant inequalities and large spatial variances were not revealed** with regard to the indicators of **urban energy consumptio**n (i.e. residential electricity consumption per household, residential gas consumption per household, natural gas consumption per capita, electricity consumption per capita). Furthermore, the already small territorial differences typically decreased between 2010 and 2015.
  - Main reasons: rebound effect and high HDI level.
- The Theil index components call attention to the **differences in within-group inequality component** related to natural gas consumption and electricity use per capita. It is evident that within-group disparities are currently the most important factor explaining the level variance in these energy indicators across the 24 cities involved in the study.
- It was not found that the success (i.e. belonging to the “elite” category) causes significant changes in urban electricity and natural gas consumption patterns.
- There is a **strong positive correlation** between the electricity use per capita (kWh) and the income per capita, and between the natural gas consumption per capita (m^3) and the income per capita.

ACKNOWLEDGEMENT

This research was supported by the project nr. EFOP-3.6.2-16-2017-00007, titled *Aspects on the development of intelligent, sustainable and inclusive society: social, technological, innovation networks in employment and digital economy*.

The project has been supported by the European Union, co-financed by the European Social Fund and the budget of Hungary.

THANK YOU FOR YOUR ATTENTION!

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