DEMAND ADJUSTMENT IN HUNGARIAN NATURAL GAS CONSUMPTION: EFFECT OF PUNITIVE BLOCK TARIFFS?

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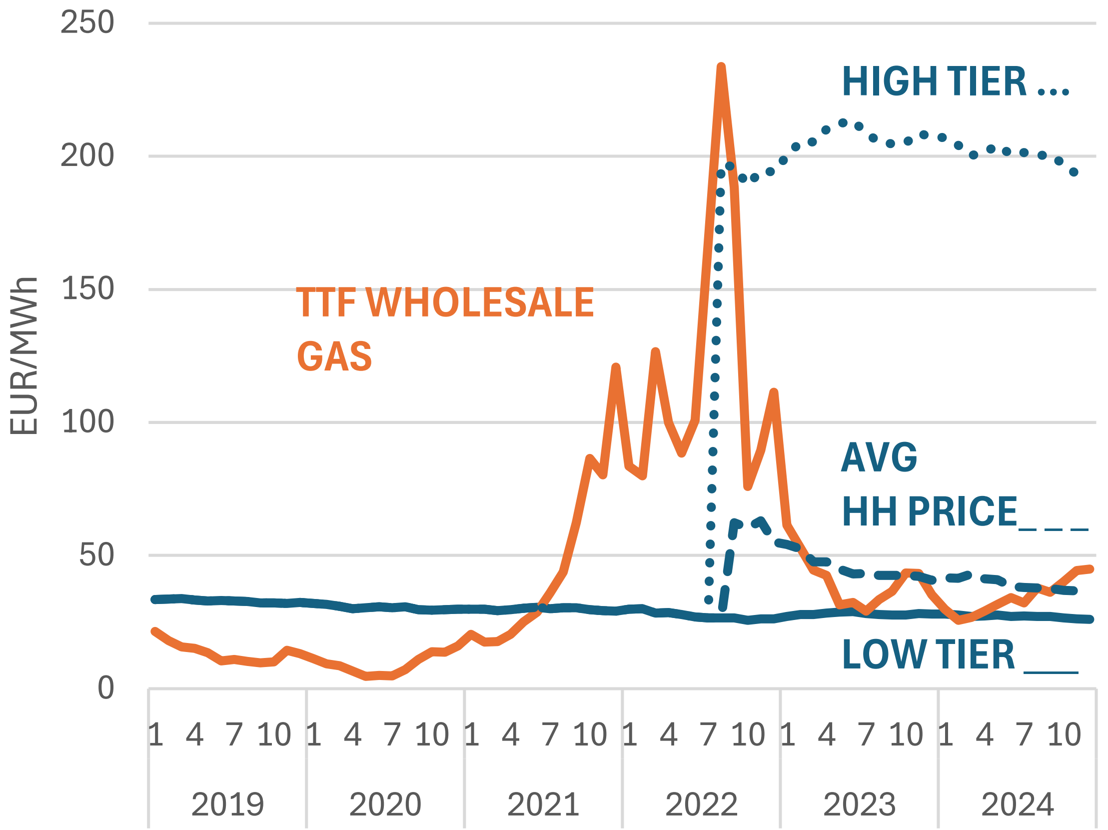
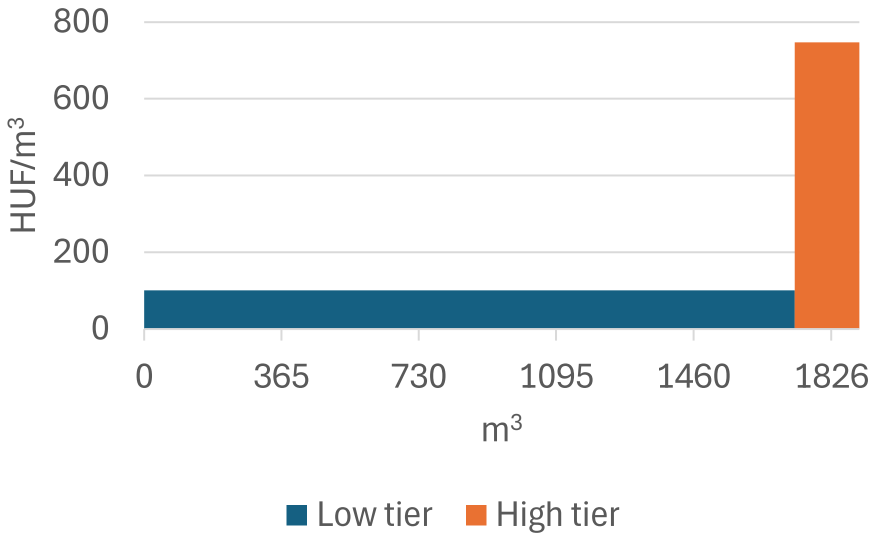
Background

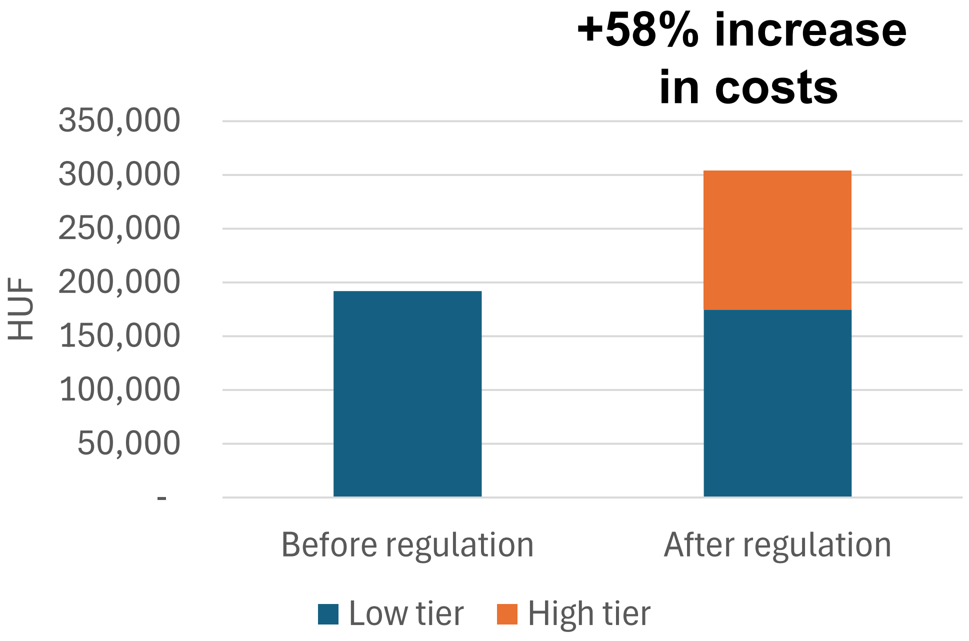
- Household (HH) end-user energy prices in Hungary have been regulated and fixed since 2012
- HH end-user prices include the cost of energy, network tariffs, taxes and levies and VAT
- HH gas provider company is state-owned, no other player supplies the consumers
- Due to the energy crisis, state budget could not finance the rising end user costs
- Regulation introduced a two-tier block tariff:
  - Low tier (unchanged) 101 HUF/m^3 ~ 33 EUR/MWh
  - High tier 747 HUF/m^3 ~210 EUR/MWh
  - For consumption below the average (1729 m^3/year), households pay the low tier
  - For consumption over the average, the high tier tariff is to be paid
- Demand dropped due to the new regulation
- Goal: quantify the effect of the regulation on consumption and price elasticity



Wholesale gas price,
High tier, *low tier* and *average household natural gas price*

Why are these tariffs „punitive?"

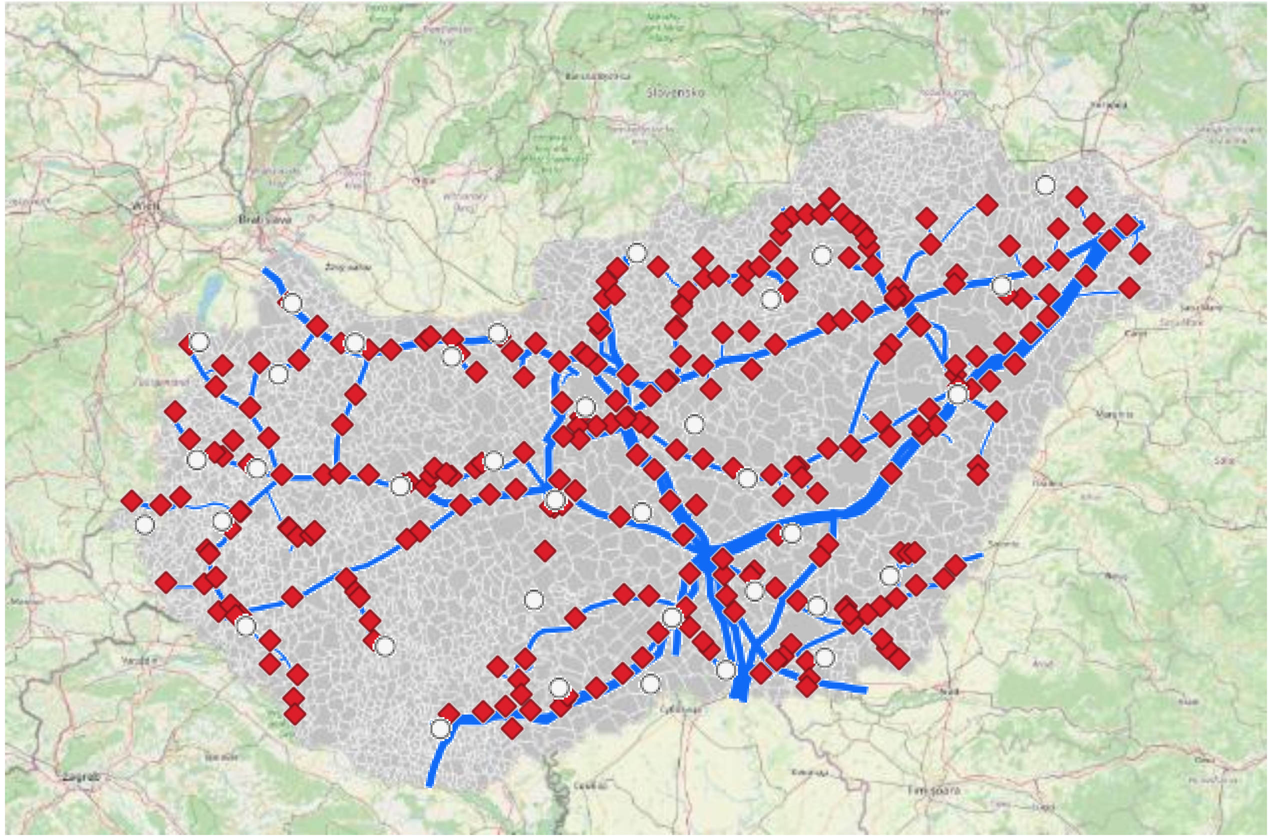




- Assume that the consumption of the household is 10% above the average set by regulation
- HH pays the
  - low tier tariff for 90% of its consumption and
  - high tier tariff for 10% of its consumption
- The regulation caused a ~58% increase in the annual gas costs of the household

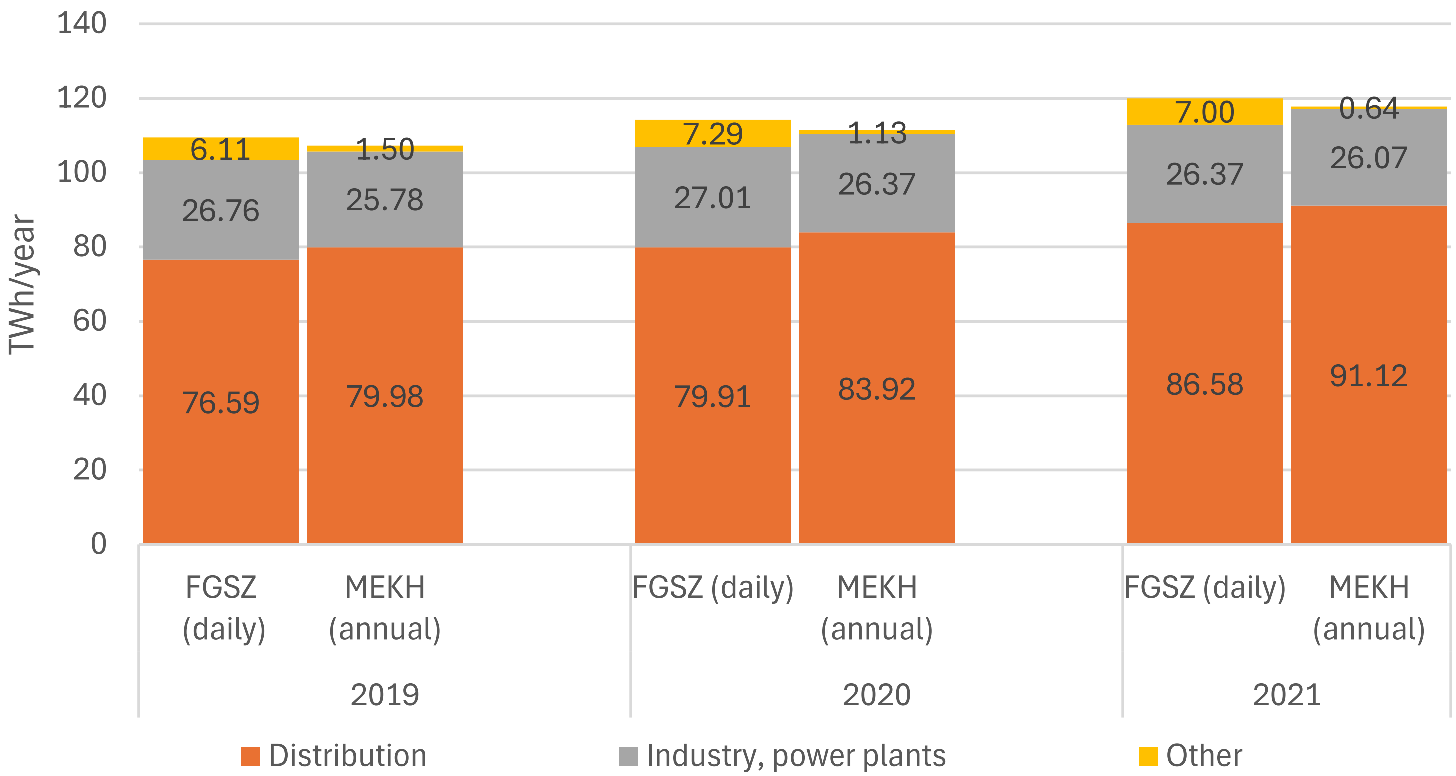
Data

- **Independent variable:** HDD / daily mean temperature by meteorological station ○
- **Dependent variable:** daily physical exit flow from natural gas transmission system to distribution system, 268 exit points **(daily consumption)** ◆
- 37 meteorologic stations are linked to the nearby TSO exit points
- **Period analysed: 01.10.2018. -31.12.2024.**



High pressure gas transmission network
Meteorologic measurement stations ○
Exit points to distribution ◆

Disaggregated data fit to the annual statistics



Comparing aggregated daily gas consumption (left) to annual consumption (right) statistics

- Both distribution data and industry/power plant are within 5% difference

ESTIMATING THE DEMAND ADJUSTMENT EFFECT

Estimation logic: training and test period

01.10.2018. — 31.07.2022. — 31.12.2024.

Training period:
OLS for each exit point

$$GasCons_n = \beta_0 + \beta_1 HDD_n + \beta_2 Mon + \beta_2 Tue + \beta_2 \text{Wed} + \beta_2 Thu + \beta_2 Fri + \varepsilon$$

$$HDD_n = \begin{cases} 0, & if\ t_n > 16 \\ 16 - t_n, & if\ t_n \leq 16 \end{cases}$$

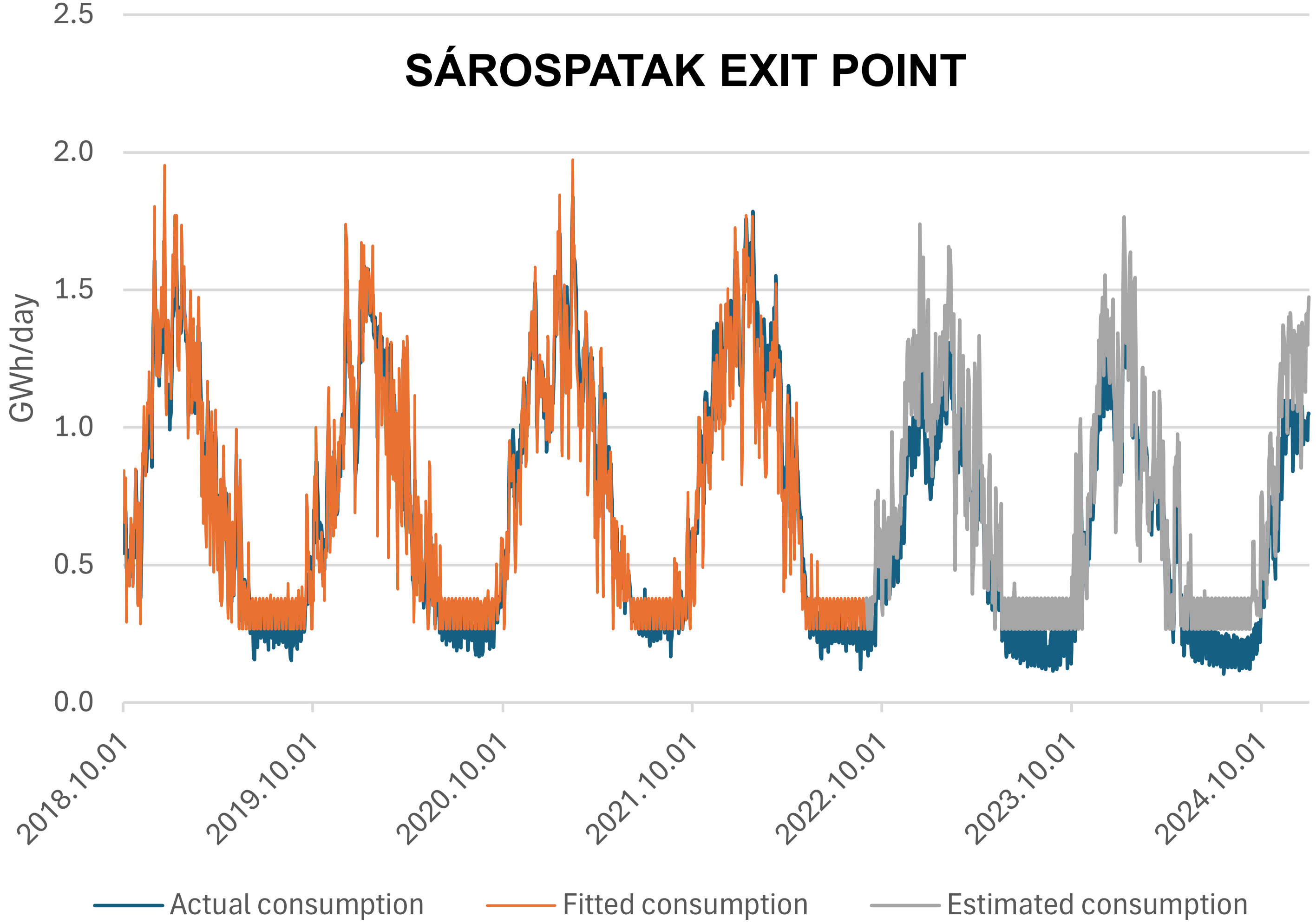
Forecast on test period

Comparison with observed consumption

Difference of forecast and observation: direct or indirect effect of the two-tier price regime

Controlling for the temperature and workday related variables the effects of the regulation can be quantified
Assuming no major changes occured which affect gas consumption

Illustration for one exit point

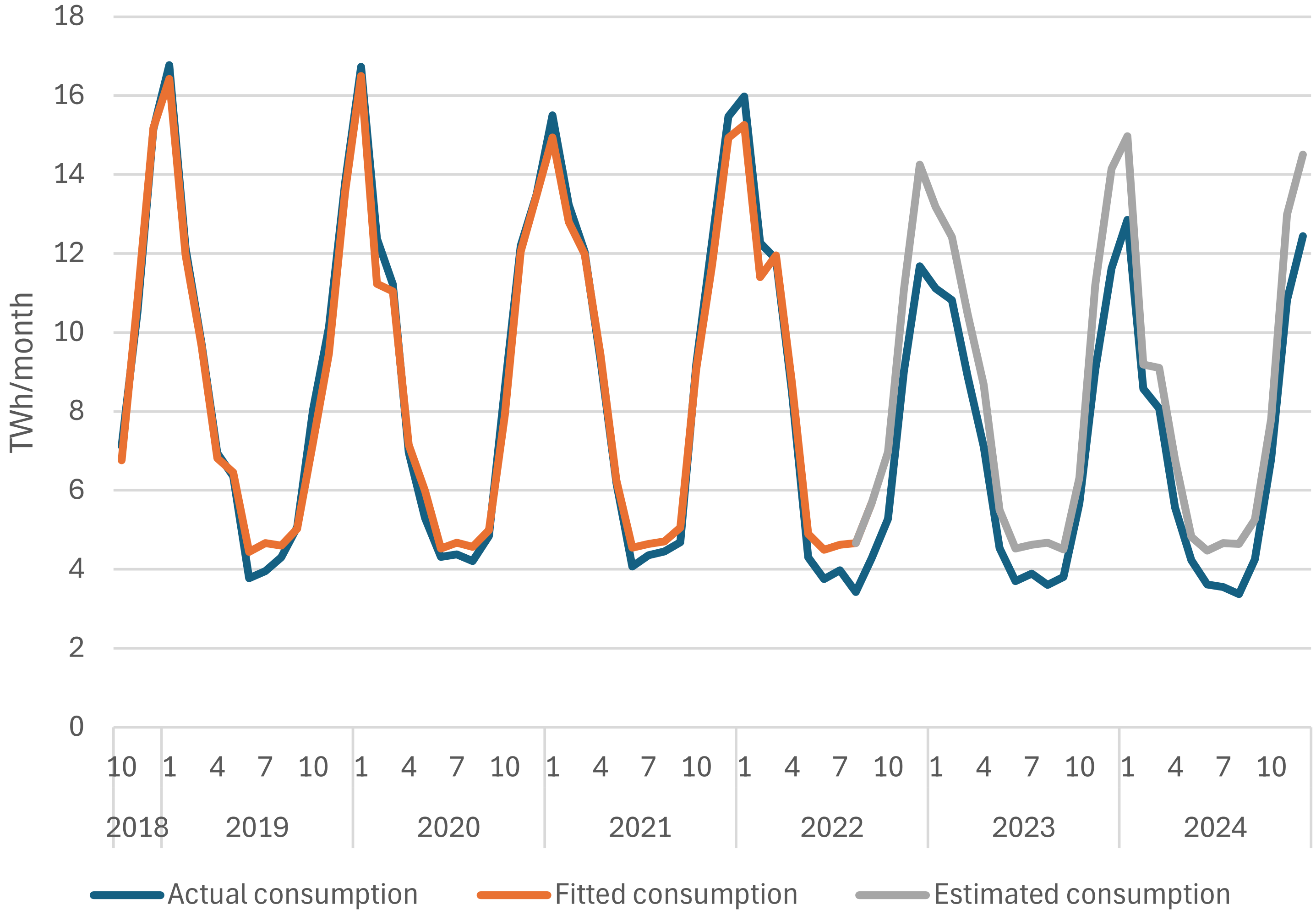


	Actual cons	Est. cons.	Act/Est. diff
	TWh/year	TWh/year	%
2019	0.26	0.26	-2.1%
2020	0.27	0.27	-1.8%
2021	0.30	0.29	2.6%
2022*	0.26	0.27	-5.9%
2023	0.22	0.26	-19.3%
2024	0.21	0.26	-22.3%

** Regulatory change occured in mid-2022*

OLS performs well on the training data for Sárospatak exit point, and shows high (19-22%) differences for the test data
Results are similar for other exit points

Aggregating unique estimates for national consumption



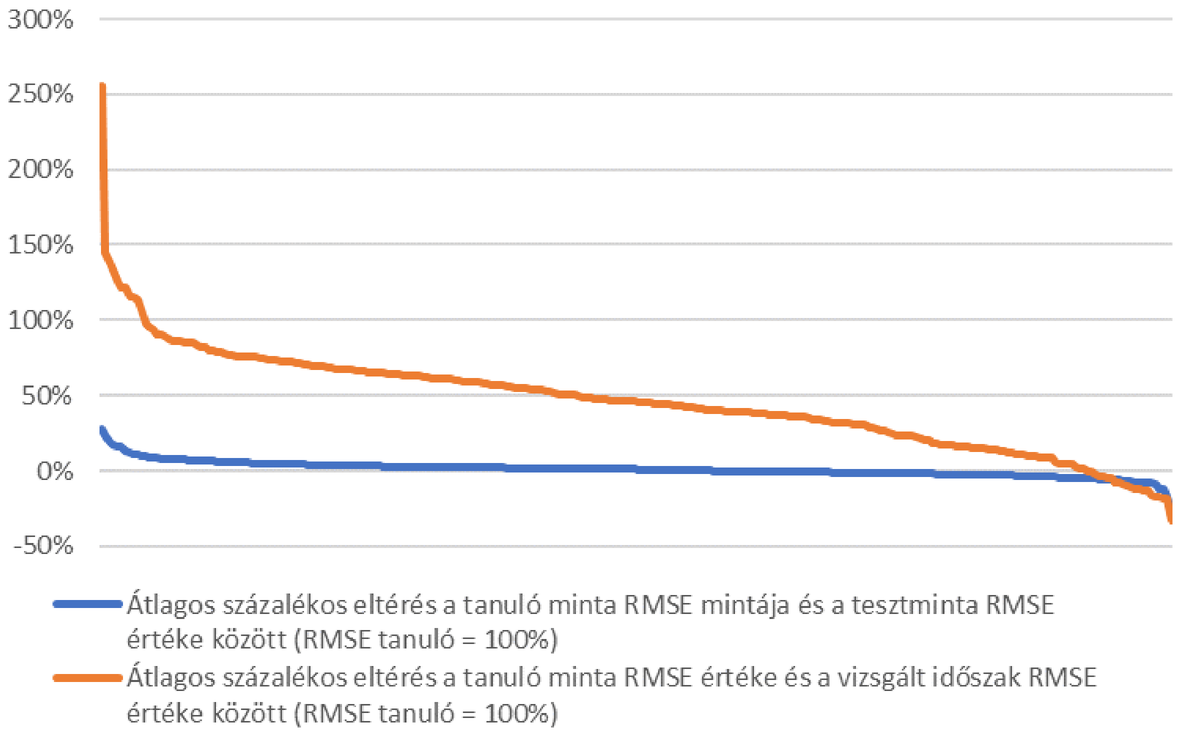
	Actual	Est.	Act/Est. diff
	TWh	TWh	%
2019	101.1	100.3	1%
2020	104.6	104.1	0%
2021	110.8	110.1	1%
2022*	94.3	104	-9%
2023	83.8	100.2	-16%
2024	84.1	99.2	-15%

** Regulatory change occured in mid-2022*

Aggregating exit point level results, we get a 15-16% demand adjustment due to the change in regulation

RMSE of the test and training period

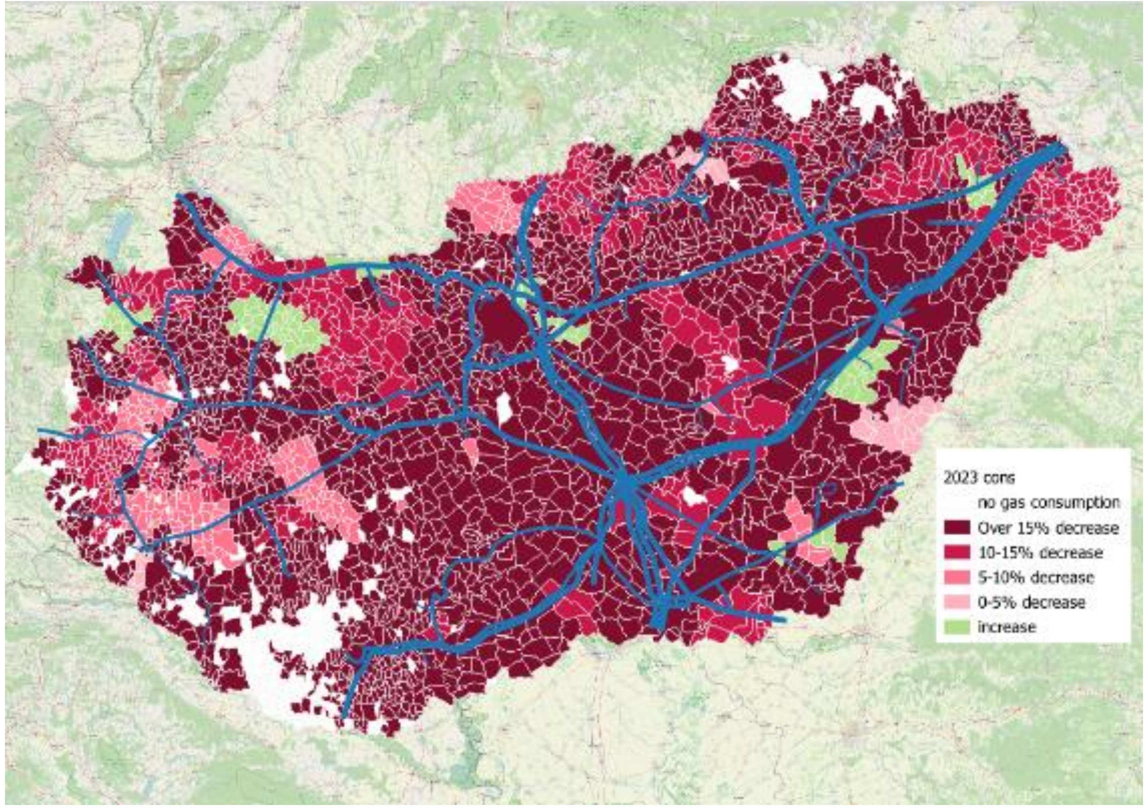
- RMSE: root mean square error for each exit point (average difference of predicted and actual values)
- If the block tariff has no effect on the consumption of households, RMSE should be the identical for the training and test period



RMSE of the model is clearly greater for the test period than the training period
This means that the block tariff has significantly altered consumption

Regional patterns: no difference

	2023			
	Actual	Estimated	Diff	Diff
	TWh	TWh	TWh	%
Capital	15.7	19.4	-3.8	-19%
Large city	16.4	20.0	-3.6	-18%
City	19.9	23.9	-4.0	-17%
Town	1.0	1.3	-0.2	-19%
Village	8.2	9.9	-1.7	-17%
Final consumers	22.7	25.7	-3.0	-12%
Total	83.8	100.2	-16.4	-16%



No major difference in household reaction
Somewhat higher reduction in cities and large cities than in villages and towns
In some areas, new industrial activity and changing patterns may have caused increase in consumption

ESTIMATING THE
OWN PRICE ELASTICITY OF DEMAND

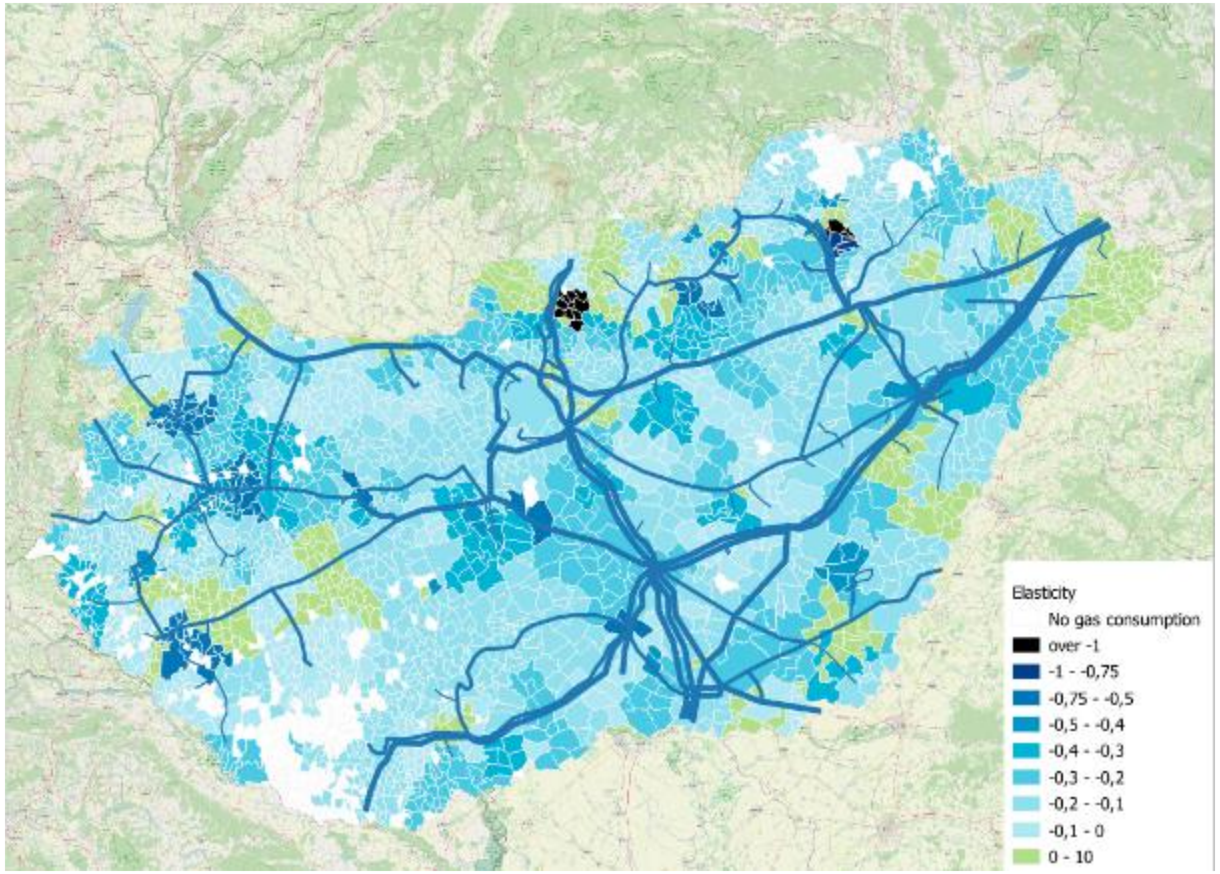
Estimating the own price elasticity of natural gas

$$ln(GasConsumption_n) = \beta_0 + \beta_1 HDD_n + \beta_2 Mon + \beta_3 Tue + \beta_4 Wed + \beta_5 Thu + \beta_6 Fri + \beta_7 ln(GasPrice_m) + \varepsilon$$

- OLS estimation for each exit point, log-log formulation, 268 unique estimates
- Adding price as an independent variable
- Estimation period: 01.10.2018-31.12.2024 (n=2283)
- OLS performence
  - Before regulatory change: slightly under-estimate
  - After regulatory change: no difference/ slightly over-estimate

	TOTAL GAS CONSUMTION, TWH			
	Actual	Estimated	Diff	Act /Est Diff
	TWh	TWh	TWh	%
2019	101.1	98.4	-2.7	-3%
2020	104.6	101.5	-3.1	-3%
2021	110.8	110.1	-0.7	-1%
2022	94.3	94.7	0.4	0%
2023	83.8	84	0.2	0%
2024	84.1	86.1	2	2%

Own price elasticity



Out of 268 estimates, 242 were of negative sign
Consumption-weighted own-price elasticity -0.3 (i.e. 1% price increase causes 0.3% demand drop)
A perceived 50% price increase causes a 15% demand reduction
Territorial differences: blue areas with negative elasticity, green areas with positive elasticity

Caveats

- Sectoral disaggregation of results is not possible, as exit flows may include non-household consumers as well (SMEs, service sector, industry connected to distribution network)
- Gas is primarily used for heating, and can be substituted with alternate fuels such as electricity and biomass (firewood). Including price of alternative fuels was done in other model formulations, but did not prove significant

Conclusions

- Weather and workday-adjusted Hungarian gas consumption decreased by 16% (-16.4 TWh) due to the introduction of block pricing
- Consumption-weighted average own price elasticity of natural gas was estimated -0.3
- An average 50% increase in prices would mean a 15% reduction in demand
- Price controls of 2012-2022 made it impossible to estimate own price elasticity before
- The „punitive” nature of the block tariff caused consumer reaction even in consumer categories which would not be affected by the higher price
- Results did not reveal difference between consumers living in various settlement types
- Even though the own price elasticity for gas proved to be inelastic, households showed a sizeable reaction to the block tariffs

THANK YOU FOR YOUR ATTENTION

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