Retail price convergence across EU electricity and natural gas markets

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AIEE Energy symposium, December 15, 2021

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Background

- Performance indicators of a European Union (EU) fully-integrated internal energy market (Jamasb and Pollitt, 2005): (lower) average price and (higher) degree of price convergence
- In a fully integrated internal energy market, electricity should be produced in one Member State and delivered to industrial and residential consumers in another one.
- As a consequence of an increasing competition prices would progressively force down, become less volatile and converge between Member States
- The reform of the national electricity markets to achieve one single market is a process that takes time (Pollitt and Chyong, 2018).
- Although harmonization of the design of national electricity markets and reduction of barriers to cross border exchanges there are still large differences in electricity prices continue in EU

Background and research aims

- The process of building an internal electricity market is not completed yet and some obstacles remain (Pollitt, 2019).
- Large heterogeneities in retail electricity prices across Member States
- Investigate cross-country convergence of residential and industrial end-user electricity prices in the EU between 2007 and 2021

- **Do empirical findings from club convergence analysis reveal the existence of multiple clubs?**
- **Differences across markets?**

Club convergence analysis

- With heterogeneity, β and σ convergences
  - fail to address the characteristics that might lead to detect some specific clusters or sub-groups converging to given equilibrium states;
  - cannot analyze the movement or persistence of specific sub-groups.
- Instead, club convergence (Phillips and Sul, 2009, 2007)
  - allows different transitional paths as well as individual heterogeneity;
  - does not require stationary of the series;
  - determines endogenous or data-driven convergence clubs.

  →EU market harmonization/integration process

  → its effects on electricity prices given different regulatory frameworks and levels of market competition.

Club convergence analysis

- Introduced by Baumol (1986), further extended by Phillips and Sul (2009, 2007) and Apergis et al. (2012).
- Trends of the row (annual) series with the Hodrick-Prescott (HP) filter removing the shorter-term cyclical components (Whittaker, 1923; Hodrick and Prescott, 1997 - Bastianin et al., 2019; Cassetta et al., 2021).
- Panel model for the variable P_{it} where $i = 1, \dots, N$ (countries) and $t = 1, \dots, T$ (sample size)

$$P_{it} = g_{it} + a_{it} \qquad (1)$$

- g_{it} the systematic factor and a_{it} transitory component

$$P_{it} = \left(\frac{g_{it} + a_{it}}{\mu_t} \mu_t \right) = \delta_{it} \mu_t \qquad (2)$$

- μ_t is the common component (or path) while δ_{it} is a time varying idiosyncratic component (distances between the trends of the price series of country i and μ_t).

Club convergence analysis

- Relative transition component

$$h_{it} = \frac{P_{it}}{(1/N)\sum_{i=1}^{N} P_{it}} = \frac{\delta_{it}}{(1/N)\sum_{i=1}^{N} \delta_{it}} \qquad (3)$$

- the cross-sectional mean of the relative transition paths h_{it} is 1,
- it is easy to see that if all δ_{it} converges to a constant term δ_i, then the transition paths h_{it} of each economy should converge to 1 and the cross-sectional variation H_t should converge to zero:

$$H_t = \frac{\sum_{i=1}^{N}(h_{it}-1)^2}{N} \quad \rightarrow 0 \quad \text{as } t \rightarrow \infty \qquad (4)$$

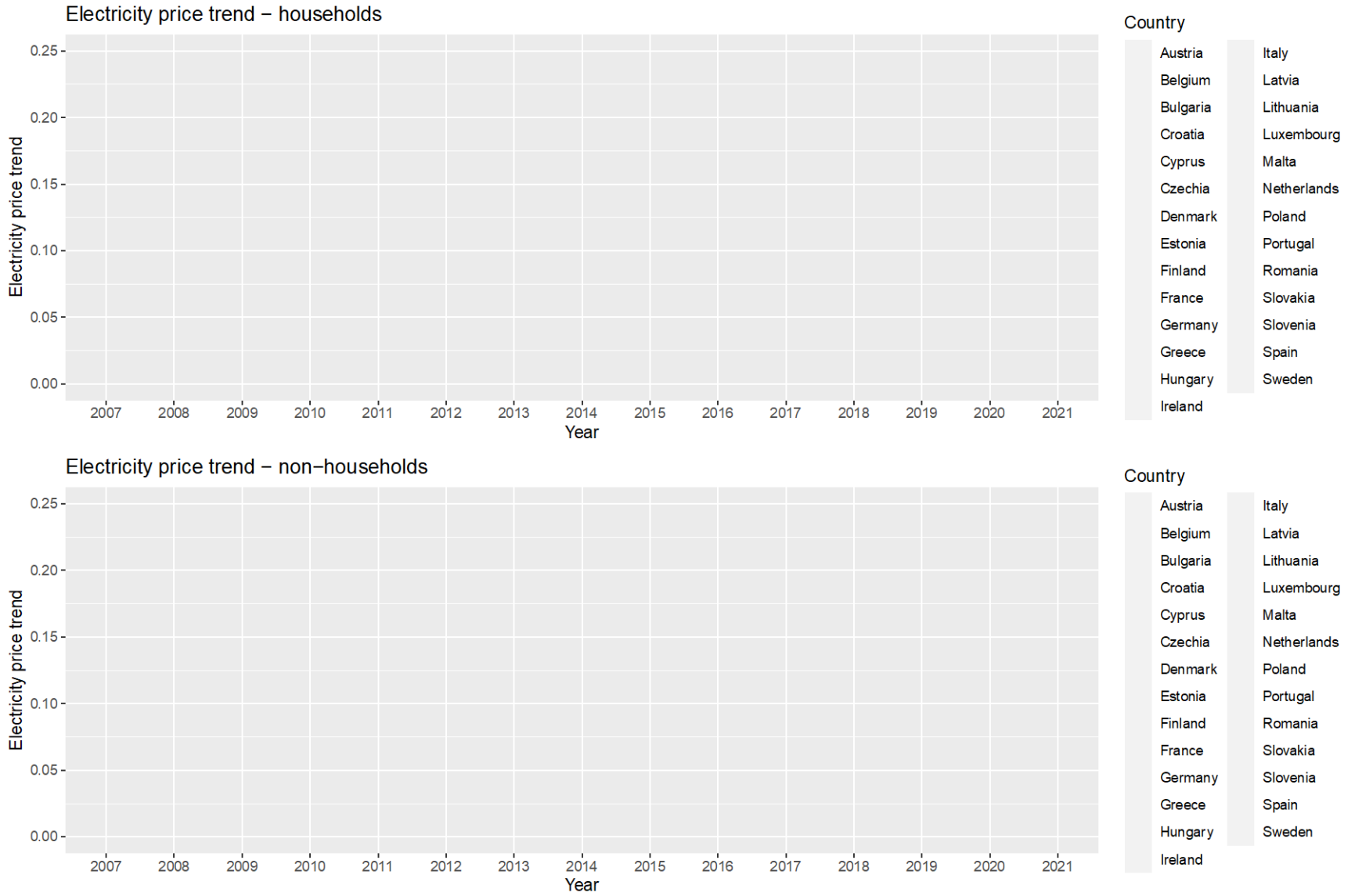
Club convergence analysis

- To allow for local subgroup convergence, the following specification for δ_{it} is assumed
- $\delta_{it} = \delta_i + \frac{\sigma_i \xi_{it}}{L(t) t^{\alpha}}, \quad \xi_{it} \sim N(0,1) \qquad (5)$
- where $L(t)$ is a slowly varying increasing function. Eq. (5) allows δ_{it} to converge to δ_i for non-negative values of the rate of convergence α.
- $\log\left(\frac{H_1}{H_t}\right) - 2\log \mathrm{L}(t) = c + \beta \log t + \varepsilon_t, \quad$ for $t = [\mathrm{rT}], [\mathrm{rT}] + 1, \ldots, \mathrm{T}$, r=1/3 (6)
- where $\mathrm{L}(t)$ is a penalization function and β is an estimate of the convergence parameter α.
- → H_0: $\beta \geq 0$ vs H_1: $\beta < 0$ tested with a standard one-sided t-test, called log-t-test, based on heteroskedasticity and autocorrelation consistent standard errors (Newey and West, 1987)

Data

- Average national retail electricity prices, expressed in €/kWh (Eurostat) from 2007 to 2021 for each EU-27 countries
- residential medium-sized consumers (2500 kWh and 5000 kWh)
- Industrial medium-sized consumers (500 MWh and 2000 MWh)
- 30 observations for each EU country

Results


Electricity price trend − households
Electricity price trend
0.25
0.20
0.15
0.10
0.05
0.00
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Year
Country
Austria
Belgium
Bulgaria
Croatia
Cyprus
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Sweden
Electricity price trend − non−households
Electricity price trend
0.25
0.20
0.15
0.10
0.05
0.00
2007
2008
2009
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2021
Year
Country
Austria
Belgium
Bulgaria
Croatia
Cyprus
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Sweden

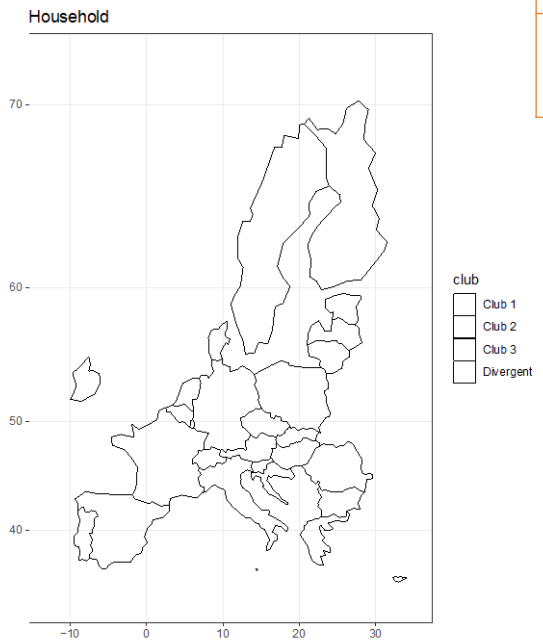
Results

Resident consumers						
	EU countries	# of units	$\widehat{\beta}$	std.err	t-value	c-star
Full sample convergence	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden	27	-0,937	0,016	-57,722	
Industrial consumers						
	EU countries	# of units	$\widehat{\beta}$	std.err	t-value	c-star
Full sample convergence	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden	27	-0,402	0,080	-5,017	

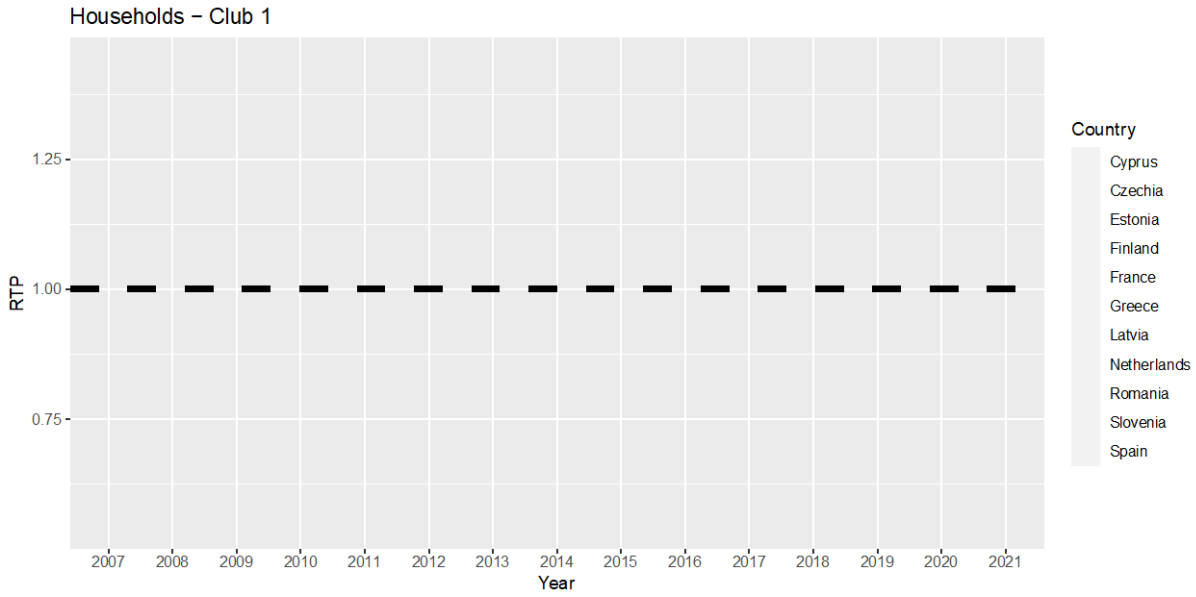
Results:

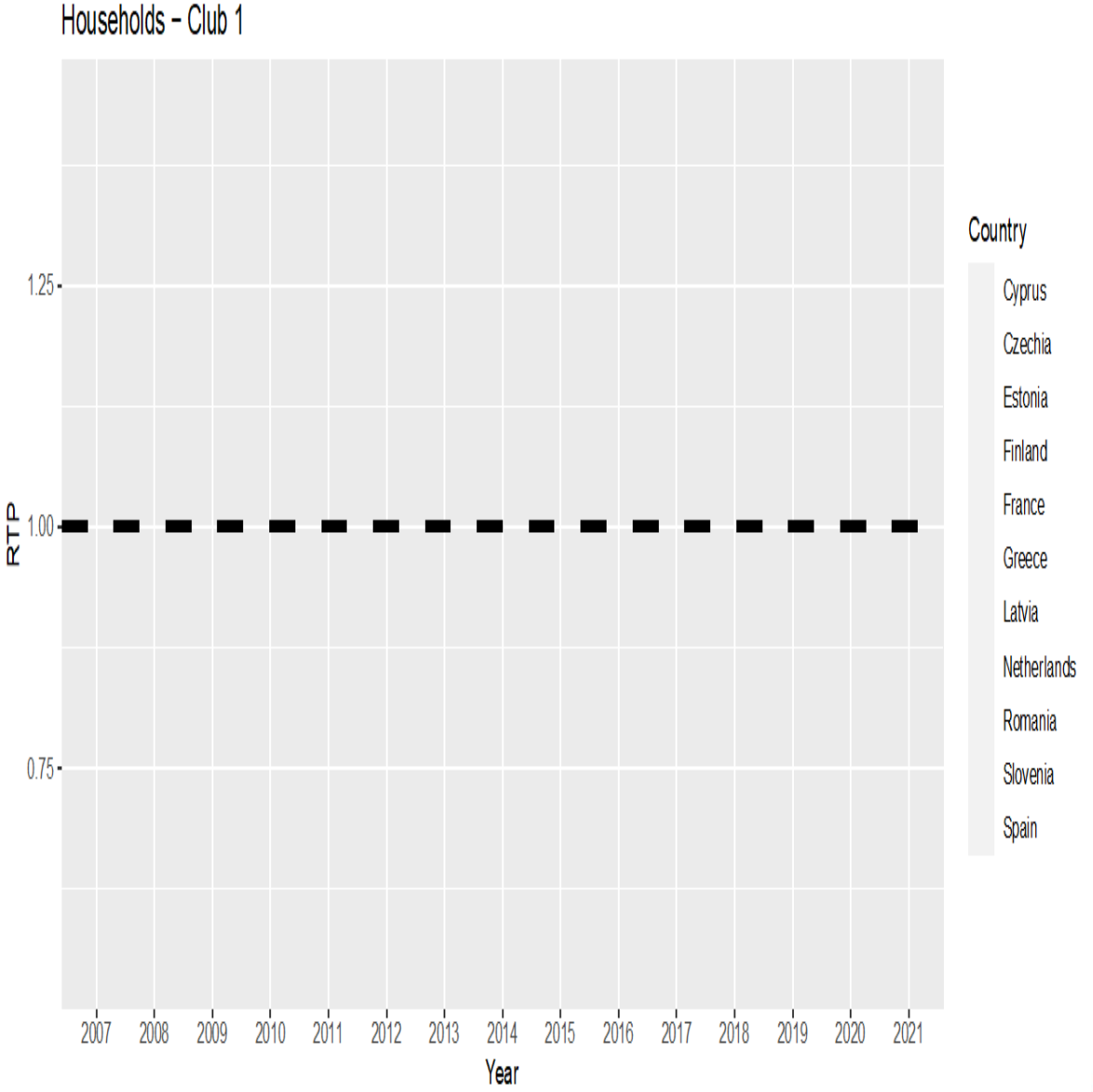
Residents

Club	EU national electricity market	# of units	$\widehat{\beta}$	std.err	t-value	c-star
Club 1	Cyprus, Czechia, Estonia, Finland, France, Greece, Latvia, Netherlands, Romania, Slovenia, Spain	11	0,748	0,223	3,348	0
Club 2	Bulgaria, Croatia, Lithuania, Portugal, Slovakia	5	0,905	0,13	6,984	0
Club 3	Italy, Luxembourg	2	-1,768	1,410	-1,254	0
Non convergent MS	Austria, Belgium, Denmark, Germany, Hungary, Ireland, Malta, Poland, Sweden					



Results





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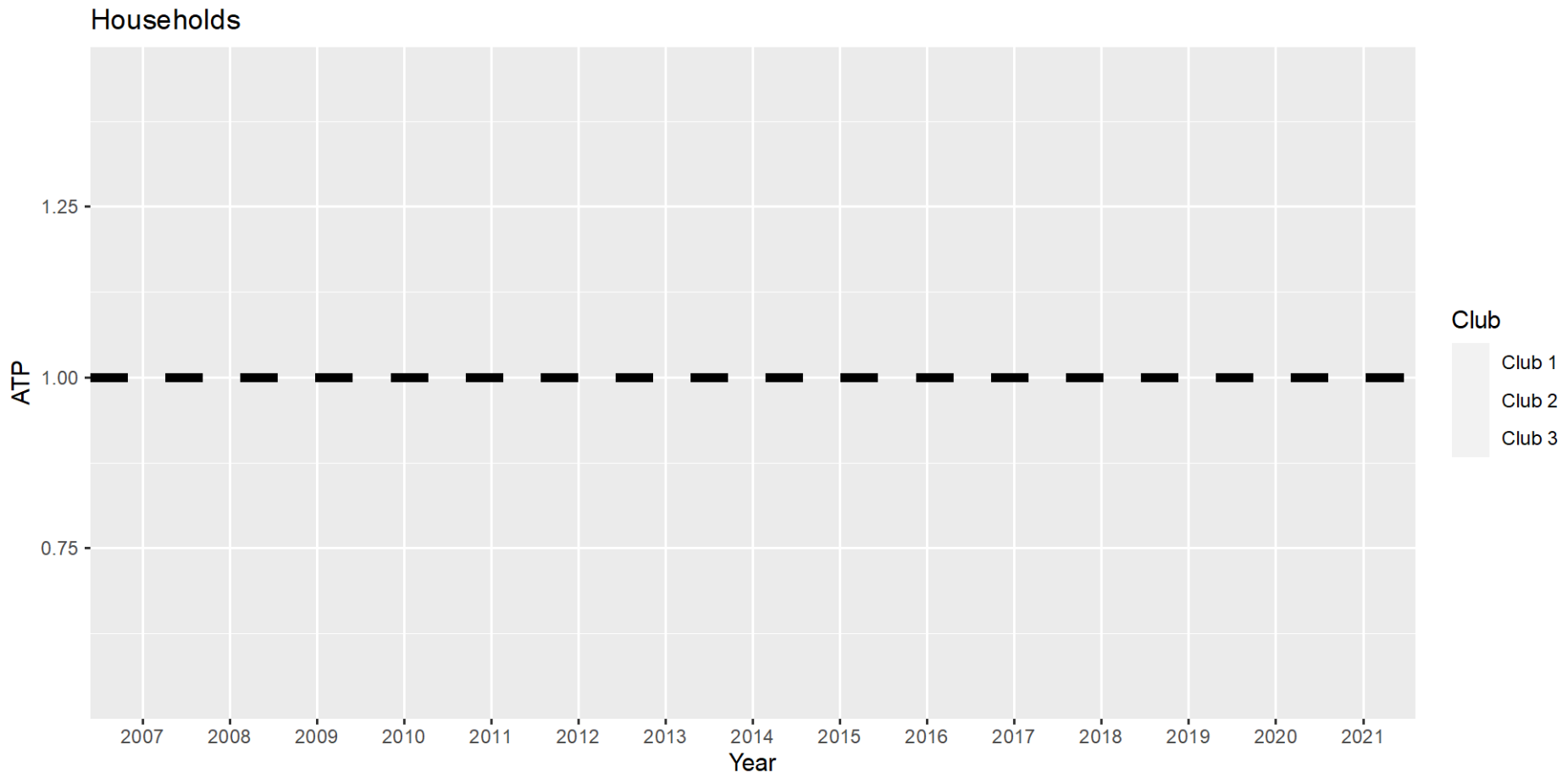
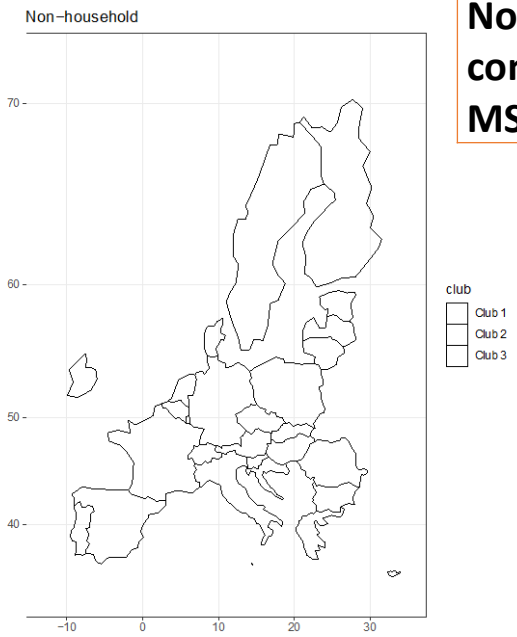
Results


Households
ATP
1.25
1.00
0.75
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Year
Club
Club 1
Club 2
Club 3

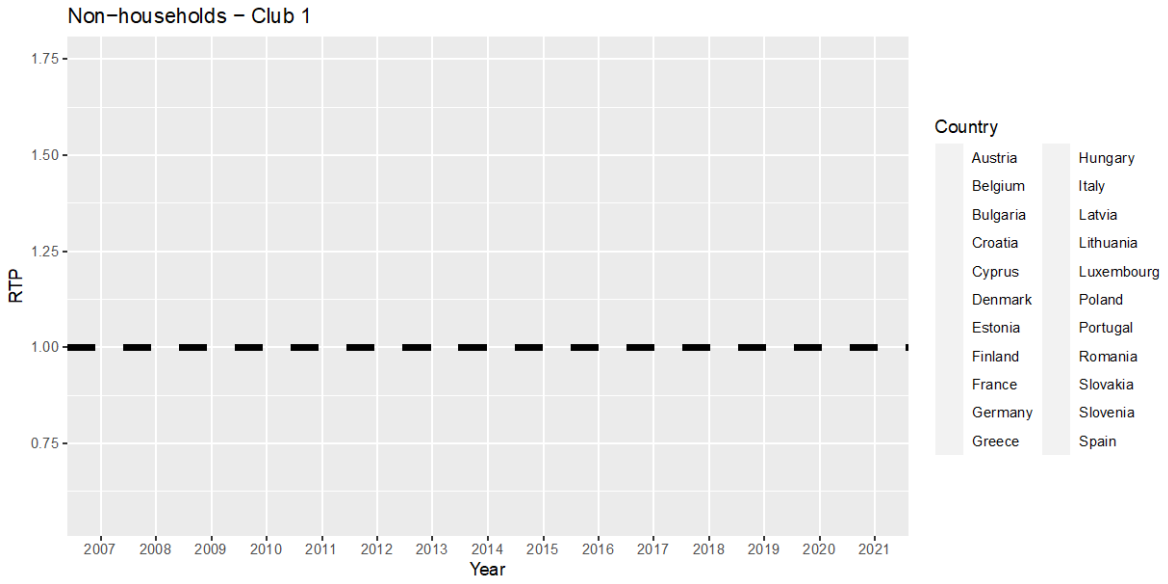
Results:

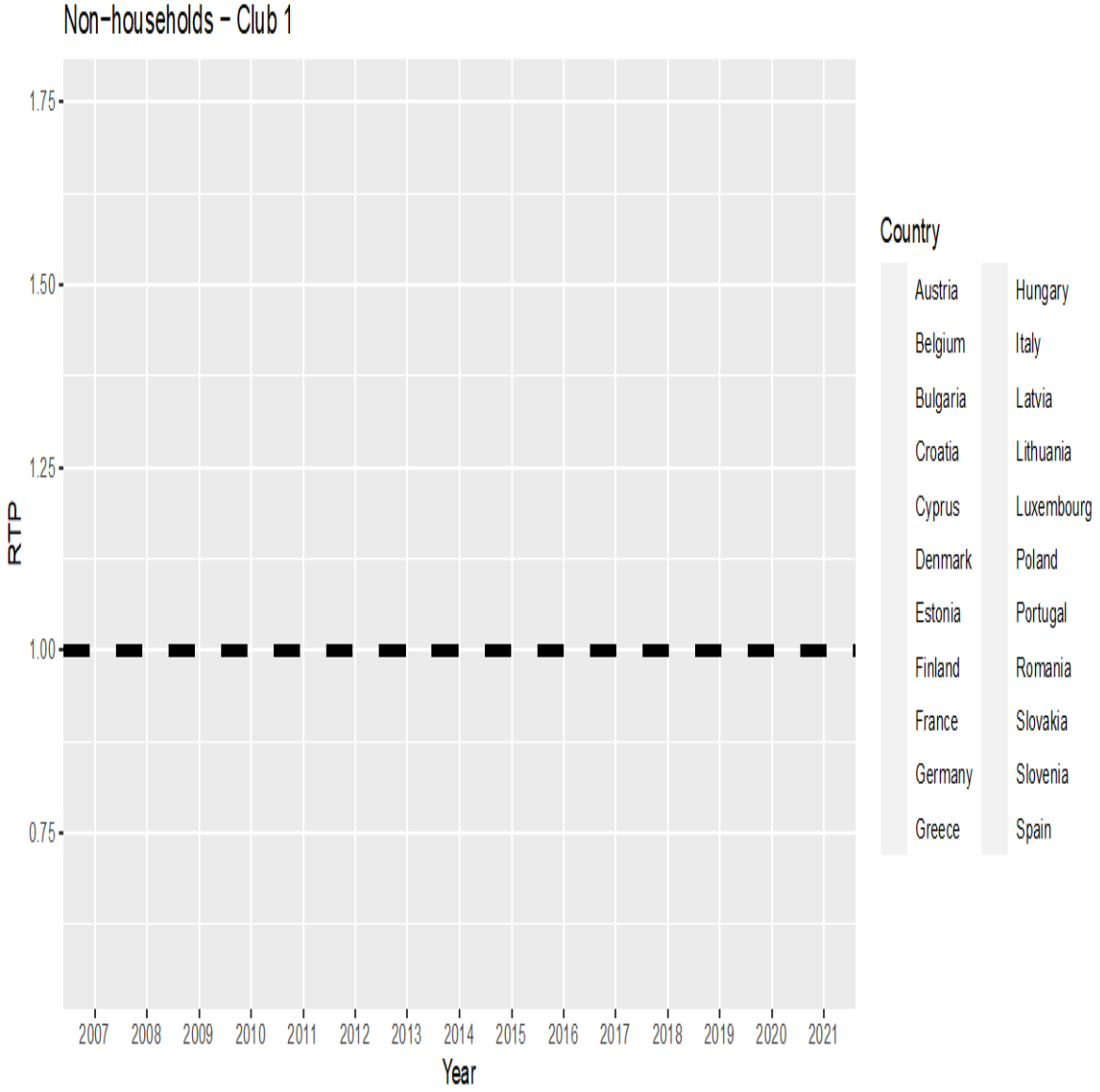
Industrial

Club	EU national electricity market	# of units	$\widehat{\beta}$	std.err	t-value	c-star
Club 1	Austria, Belgium, Bulgaria, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Romania, Slovakia, Slovenia, Spain	22	0,388	0,164	2,372	0
Club 2	Czechia, Netherlands, Sweden	3	2,985	0,503	5,928	0
Club 3	Ireland, Malta	2	4,175	1,699	2,457	0
Non convergent MS		None				



Results





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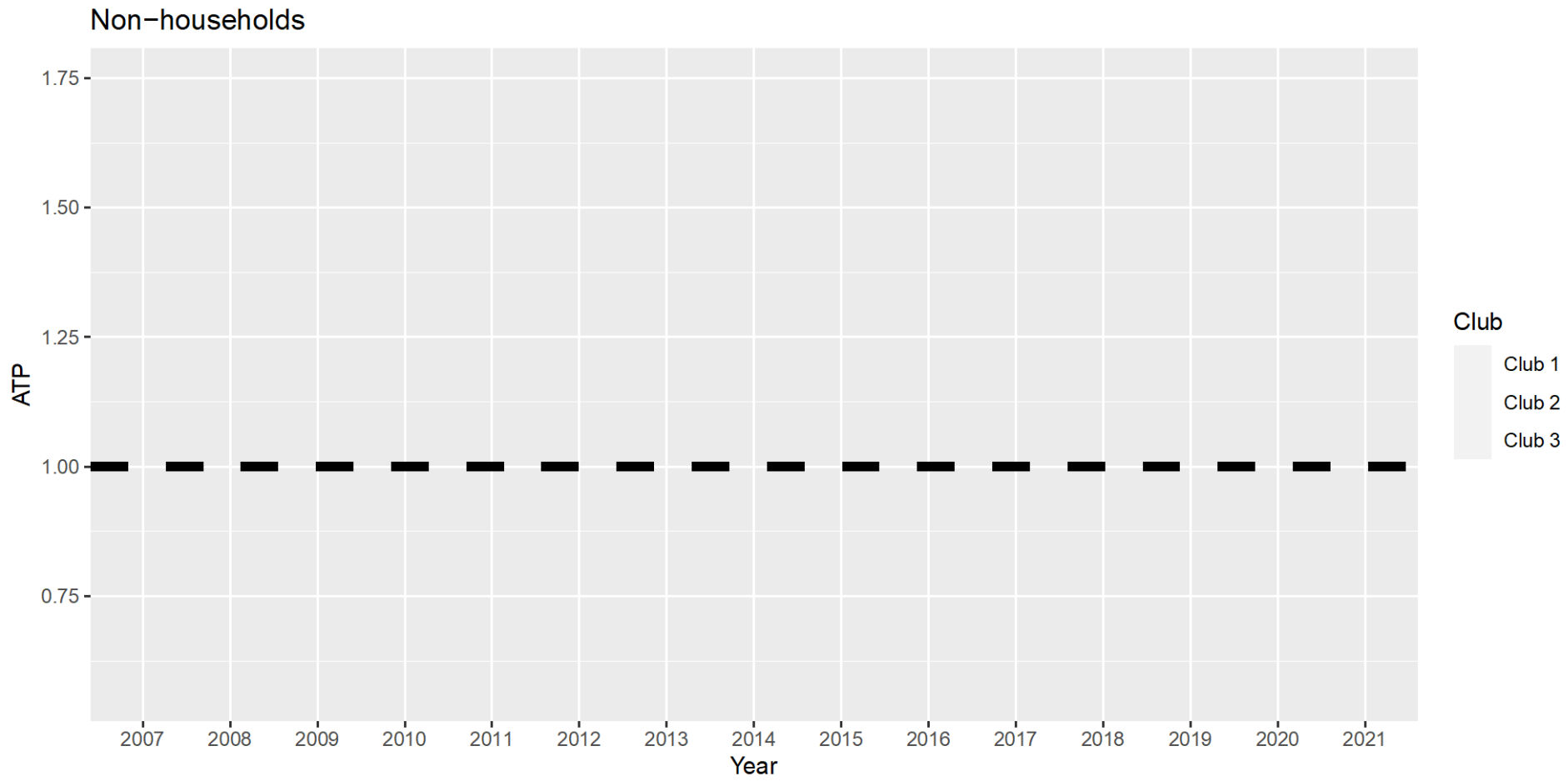
Non−households
1.75
1.50
1.25
1.00
0.75
ATP
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Year
Club
Club 1
Club 2
Club 3

Conclusion

- The retail and domestic segments exhibit rather *different paths* in terms of price convergence.
- *Domestic* end-user prices show higher dispersion and *heterogeneity* across national electricity markets than industrial one.
- The long-term convergence is greater for industrial electricity prices with no countries included in the non-convergent group.
- Differences across convergence clubs seem not to be related with common structural features in terms of *market fundamentals* (electricity generation mix, market integration policies and investments in cross-border transmission capacity.)

Conclusion

- The process of gradually *relaxing the regulated end-consumer price regimes*, especially in the household market segment, has been strongly slowed down as a result of:
  - the change in the priorities of the energy policy
  - greater attention to the ecological transition and security of supply (Joskow, 2021; Pollitt, 2019; Roques and Finon, 2017).
- Our analysis is in line with studies suggesting *persisting difficulties* in reducing end-user electricity price dispersion across EU countries (Pollitt, 2019).

Conclusion

- Differences across convergence clubs seem to be related with *public intervention* in the electricity end-user price setting, *disparities* in the range of household or industrial consumers under regulated end-user prices, and different criteria used among countries in defining *energy components*.
- Policy-wise, the club convergence analysis emphasizes the need of *stronger cooperation* for public intervention and regulation, while considering how end-user price setting can support the decarbonization of the EU electricity systems.

Thank you!