SPATIAL DISPERSION OF ELECTRICITY PRICES: A CHALLENGE TO THE EUROPEAN SINGLE MARKET

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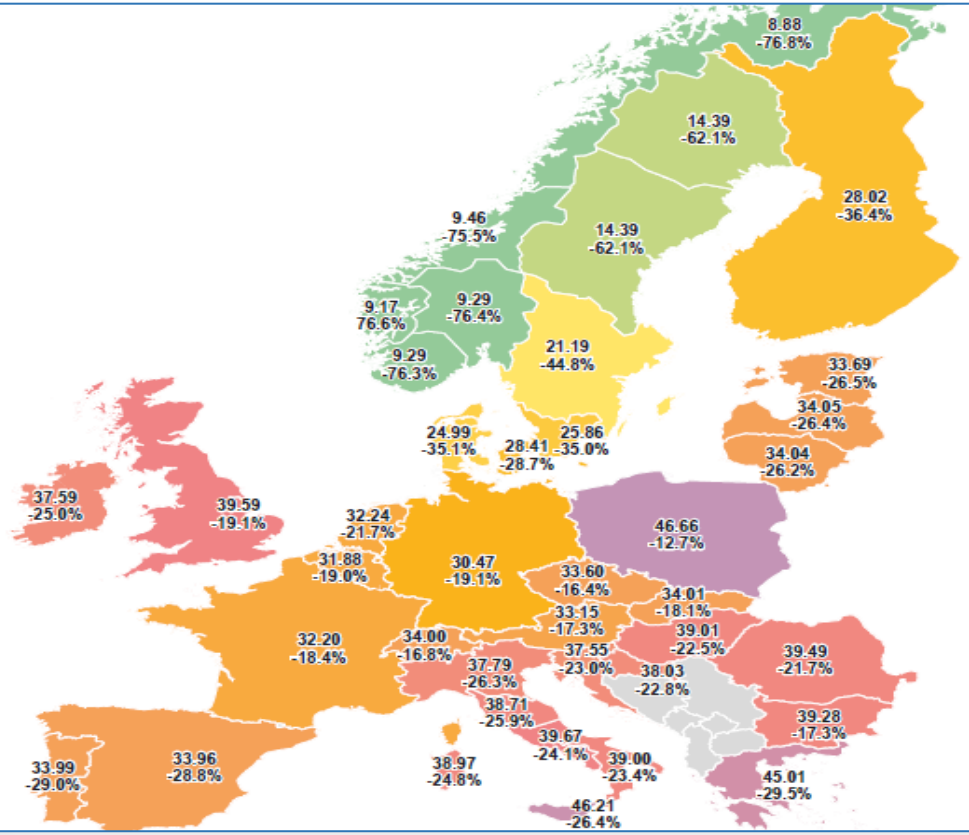
Problem. The challenge of creating a single European electricity market is due to the unique conditions of the internal electricity markets that lead to significant and persistent price dispersion over European space

Methods:

1) quartile analysis of electricity prices;
2) cluster analysis by the generation mix and the directions of electricity flows;
3) correlation analysis of electricity prices and transitive closure of commercial electricity flows;
4) positioning matrix by causes of price dispersion



Purpose

is to assess how conditions of electricity markets (generation mix, directions of electricity flows, geographic orientation) influence the dispersion of electricity prices in the European market space.

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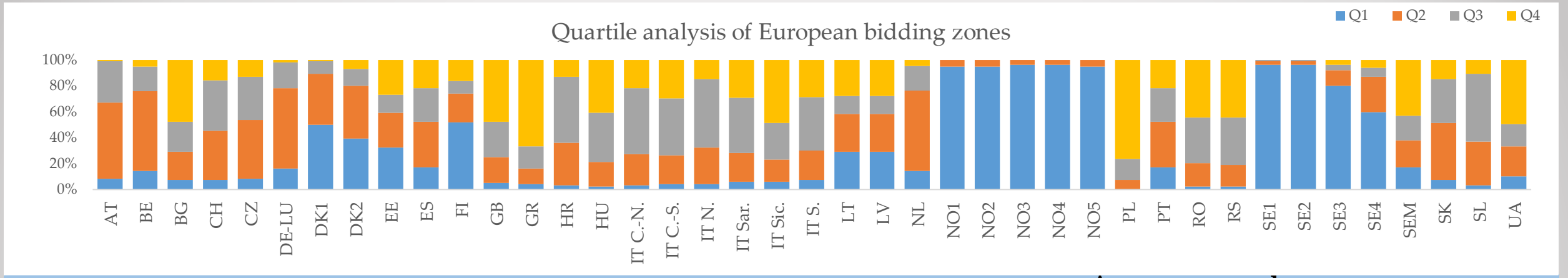
INSTABILITY OF MARKET CONDITIONS CAUSES A PERSISTENT DISPERSION OF ELECTRICITY PRICES IN ALL EUROPEAN BIDDING ZONES



Quartile	Bidding zones	Average annual electricity price, € / MWh	Price range, %
Q1	DK1, EE, FI, LT, LV, NO1, NO2, NO3, NO4, NO5, SE1, SE2, SE3, SE4	19.76	283
Q2	AT, BE, CZ, DE-LU, DK2, ES, NL, PT, SK	32.41	20
Q3	CH, HR, IT C.-N., IT C.-S., IT N., IT Sar., IT South, SL	37.97	17
Q4	BG, GB, GR, HU, IT Sic., PL, RO, RS, SEM, UA	41.32	24

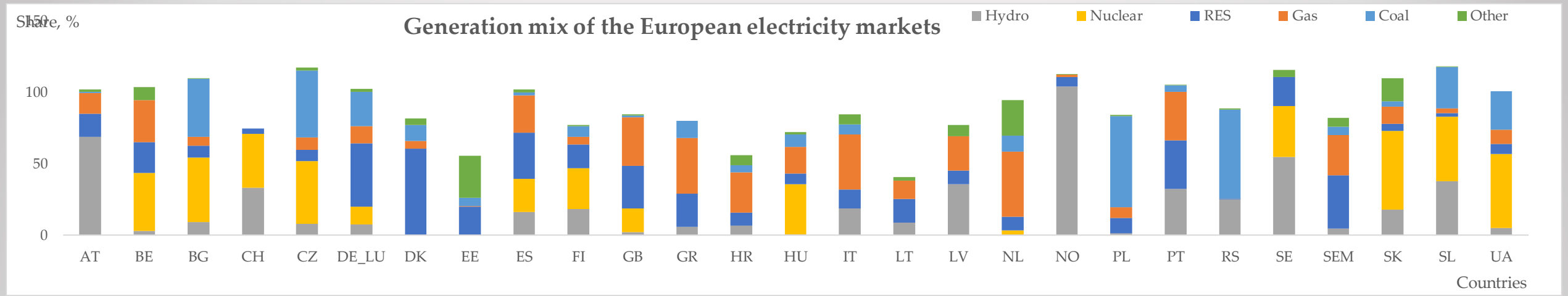
Q1 comprised 14 bidding zones of the Nordic and Baltic countries. Q1 was characterized by rare negative spikes, with sharp positive spikes occurring. Q1 had the greatest price range.

Q2 consisted of 9 bidding zones of Central-Western Europe and Iberian Peninsula. Negative price spikes were most frequent, compared to other quartiles, whereas positive price spikes were smoother and rarer. The quartile had a smaller price range.

Q3 comprised 8 bidding zones of Central-Southern Europe. There were practically no negative or positive price spikes. The price range was the lowest.

Q4 included 10 bidding zones of the Southern and Western Europe, and British Isles. Negative price spikes were only in the British Isles, while positive price spikes were recorded in all bidding zones except PL. The price range increased compared to Q2 and Q3.

ELECTRICITY MARKETS IN THE EUROPEAN SPACE ARE HETEROGENEOUS IN TERMS OF GENERATION MIX



Cluster name		Hydro generated	Nuclear generated	RES generated	Gas generated	Coal generated
Countries		AT, NO	BE, CH, FI, HU, SE, SK, SL	DE-LU, DK, EE, LT	ES, GB, GR, HR, IE, IT, LV, NL, PT	BG, CZ, RS, PL, UA
Mean values, %	Hydro	87	24	4	14	11
	Nuclear	0	40	2	5	32
	RES	12	11	28	24	7
	Gas	8	10	6	34	6
	Coal	0	7	8	6	44
Average annual electricity price, € / MWh		21.18	28.03	30.32	38.23	39.60
Price range, %		259	171	36	43	39

The 1st cluster included 2 countries with a high share of hydro generation. The electricity prices were the lowest but varied significantly since the countries belonged to Q1 and Q2.

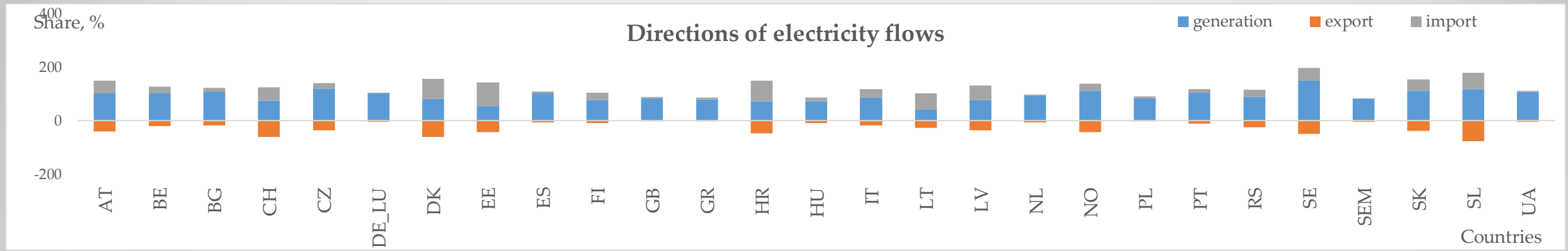
The 2nd cluster included 7 countries that used mainly nuclear generation. The countries were assigned to Q1-Q3.

The 3rd cluster comprised 4 countries with highly developed RES generation. Most often they belonged to Q1 and Q2.

The 4th cluster was made by 8 countries dominated by gas-fired generation. In terms of price range, the countries belonged to each of the quartiles.

The 5th cluster consisted of 5 countries dominated by coal-fired generation, with the prices being the highest, and the price range - the lowest. The countries were most often in Q4.

ELECTRICITY MARKETS IN THE EUROPEAN SPACE ARE HETEROGENEOUS IN TERMS OF SELF-SUFFICIENCY



Cluster name		Export-directed	Import-directed	Inward-directed
Countries		AT, CZ, NO, SE, SK, SL	CH, DK, EE, HR, LT, LV	BE, BG, DE-LU, ES, FI, GB, GR, HU, IE, IT, NL, PL, PT, RO, RS, UA
Mean values, %	Import	40	68	10
	Export	46	45	13
	Net generation	119	67	93
Average annual electricity price, € / MWh		20.01	32.46	37.88
Price range, %		323	52	67

The 1st cluster comprised 6 export-directed markets. The participation in cross-border trade allowed them to sell expensive production surplus to other countries. The average prices were the lowest, the price range was the highest. Most of the countries belonged to Q1 and Q2.

The 2nd cluster consisted of 6 import-directed markets. Here, the average price of electricity was higher, but the price range was the least among all. The openness of the borders of the national electricity markets allowed them to benefit from international trading. The countries were assigned to Q1-Q3.

The 3rd cluster included 16 inward-directed countries. The average price of electricity turned out to be the highest, the price range being significant. They had to consider all the risks of covering the costs of internal generation. Most of the countries belonged to Q2-Q4.

INTEGRATION OF ELECTRICITY MARKETS RESULTS IN THE REDUCTION OF PRICE DISPERSION AMONG BIDDING ZONES

Bidding zones	Average annual electricity price, € / MWh	Price range, %	Quartile range
Highly integrated markets			
AT, CH, CZ, DE-LU, SK	33.04	12	2-3
BE, NL	32.06	1	2
DK1, DK2, SE1, SE2, SE3, SE4	25.15	34	1-2
EE, LT, LV	33.93	1	1
ES, PT	33.97	0	2
HR, HU, RS, SL, RO, IT N, IT C-N, IT C-S, IT S, IT Sar	38.72	10	3-4
NO1, NO2, NO3, NO4, NO5	9.22	7	1
Moderately integrated markets			
AT, HU, SL, SK	35.93	18	2-4
BE, DE-LU, CH, CZ, DK1, DK2, NL	30.73	36	1-3
BG, RO, RS	39.21	1	4
EE, FI, SE3	27.63	59	1
GB, SEM	38.53	5	4
IT S, IT Sicily	42.61	18	3-4
Poorly integrated markets			
BE, GB, NL, DK1, SE3	29.98	87	1-4
DE-LU, DK2	29.44	7	2
LT, PL, SE4, SK	35.14	80	1-4
Non-integrated markets			
GR	45.09	–	4

7 highly integrated markets, including: CWE, SEE, Baltic, Norwegian, Swedish-Danish, Belgian-Dutch, Iberian markets. There is a significant reduction in the price range on highly integrated markets.

6 moderately integrated markets:

1) Central-Eastern Europe (HU, SL, SK) are partially integrated with the CWE market through the AT bidding zone.

2) BE with NL and DK1 with DK2 have moderate commercial links with the CWE market.

3) BG has adopted a decision to integrate into the SEE market through the RO and RS.

4) EE and FI have also decided to integrate into the Swedish-Danish market through SE3.

5) SEM and GB are trying to create a single market in the British Isles.

6) IT Sicily has moderate links with the main part of Italy through the IT South bidding zone.

These markets have a higher price range.

3 poorly integrated markets:

1) GB is trying to integrate into the continental Europe through the Belgian-Dutch market, while the latter is trying to become part of the Swedish-Danish one.

2) The gradual opening of commercial trade is taking place between CWE and Swedish-Danish through DE-LU and DK2.

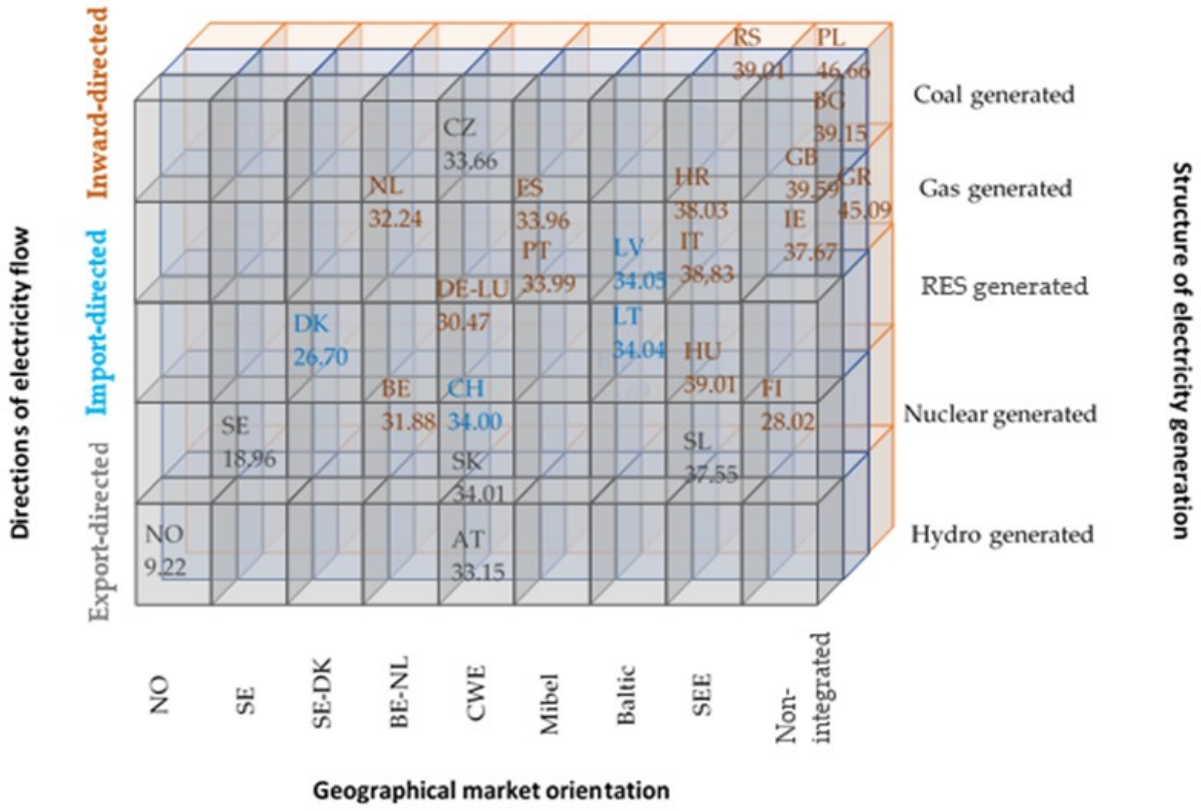
3) The PL is developing trade in 3 directions: with the CWE, Swedish-Danish, and Baltic markets. In this group, there is the greatest price range.

2 isolated markets, namely, the GR and UA, which have no significant

Result: The three-dimensional matrix combines the three identified causes for the spatial price dispersion and shows how, as we move through the matrix quadrants (to the right, upward and inward), the electricity prices increase

The 1st axis demonstrates how the electricity prices change by directions of flows from the cheapest export-directed markets to the most expensive inward-directed ones

The 2nd axis compares how the electricity prices change in terms of geographic orientation: from the cheapest Nordic markets to the most expensive SEE and non-integrated markets



The 3rd axis indicates how the electricity prices change by dominated type of generation from the cheapest hydropower generation to the most expensive coal generation

The export-directed Norwegian market of a hydropower-dominated type (quadrant 1×1×1) has the lowest electricity prices. The poorly integrated Polish market and non-integrated Ukrainian market, both of them being inward-directed and of a coal-dominated types (quadrant 3×8×5), have the highest electricity prices.