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Assessment of the competitive position of foreign thermal coal trade in European countries in 2010–2023

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Abstract

The main objective of this study was to present changes in the competitiveness of foreign thermal coal trade in European countries in the years 2010–2023. The research used the adjusted RCA index, the Trade Coverage Index and the Import Penetration Index. The research results indicate that there has been a dynamic and diversified nature of the changes in the competitive position of foreign coal trade in Europe. Although many European countries are gradually moving away from the use of coal, there are still countries that maintain competitiveness in this market, in particular Russia.

Keywords

- energy policy
- import
- export
- coal market

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Introduction

Coal is the most important raw material for electricity generation in the world (EIA, n.d.). Its largest consumers are China (54%), India (18%), the USA (6%), Japan (3%) and South Africa (2.3%) (Phengsaart et al., 2023). Despite efforts to decarbonise, this raw material remains an important element of the energy mix in many European countries. Its role in ensuring energy security was particularly visible during energy crises, such as the reduction of gas supplies as a result of the Russian-Ukrainian conflict or pandemic shocks. During this period, not only changes in import and export were observed, but also the growing importance of coal costs and quality, which affected the competitive capacity of countries in this sector.

Coal trade research indicates the need to understand not only traditional market mechanisms, but also the impact of energy and environmental policies on the formation of the international coal market. The need to cope with competition and maintain or increase competitiveness requires further action to increase energy efficiency (Firlej & Stanuch, 2023). Countries such as Poland have had to face the challenge of electricity affordability and supply security, as reflected in the updated NECP. In this context, research on the export-to-import ratio of coal and its impact on the trade balance is crucial to understanding the directions of Europe's energy transformation.

The main objective of this study is to present changes in the competitiveness of foreign thermal trade in coal in European countries in the years 2010–2023. This analysis allows us not only to assess market dynamics, but also to indicate the challenges and opportunities in the coal sector, which, despite the trend away from fossil fuels, still plays an important role in the energy policies of many European countries (EURACOAL, 2024). These studies are important in several respects. Many analyses focus on the general goals of decarbonisation and their consequences for the energy sector, but few of them examine how climate policies shape foreign trade in coal, especially in terms of limiting imports. It is very important to simultaneously show the differences between individual countries in terms of the role of coal in their energy mix, as well as its position in foreign trade.

The research is based on the following hypotheses:

H1: The competitive position in foreign coal trade in European countries declined between 2010 and 2023, especially among EU member states.
H2: Russia increased their comparative advantage in thermal coal exports between 2010 and 2023.

Given the significant institutional and policy-related differences among European countries, this study must take into account the distinctions between EU and non-EU members, taking into account distinct decarbonisation strategies, regulatory

environments and the role of coal in their respective energy mixes. European Union countries have committed to ambitious emission reduction targets, largely phasing out coal, while non-EU countries such as Russia or Belarus pursue independent energy policies, often prioritising security of supply and maintaining a high share of coal in their energy mix.

1. Literature review

Coal remains an important raw material in Europe, despite the dynamic development of renewable energy sources (RES) and the ambitious climate goals of the European Union. Phasing out coal from electricity generation is essential to stop global warming (IPCC, 2022). This urgent need is reflected in the Glasgow COP26 'pact' to gradually reduce global coal consumption, which came after increasing political and financial pressure to implement decarbonisation policies (Yanguas-Parra et al., 2021). The energy transformation initiated by the EU Green Deal aims at gradually reducing the role of coal in the energy mix, which results, among other things, in the implementation of the Emissions Trading System (EU ETS) and stricter environmental standards, which have significantly reduced the profitability of coal investments (Holz et al., 2018). Carbon reduction strategies include the establishment of a carbon tax (Wang et al., 2019; Wang & Yu, 2021), a carbon tax (Jiang et al., 2020; Wang-Helmreich & Kreibich, 2019) and carbon pricing (Brauers et al., 2020; Osorio et al., 2020). Bódis et al. (2019) highlighted the role of solar PV in helping to transform European coal regions, and Böhringer and Rosendahl (2022) quantitatively evaluated the economic and environmental impacts of different scenarios using a CGE model.

The global structure of energy consumption is changing, as evidenced by the gradual decline in total coal consumption (Paltsev, 2016). In the European Union, Germany remains the EU's largest coal-based electricity producer in the share of energy mix (BP, 2021). This country has a long tradition of domestic coal mining, justified primarily by considerations of national energy security (Storchmann, 2005). Galgóczi (2019) points out that countries such as Poland and Germany face serious challenges related to the transformation of mining regions. Upper Silesia, being one of the key coal mining centres (Wehnert et al., 2017), requires comprehensive restructuring measures. In turn, Oei et al. (2020a, 2020b) examined the socioeconomic effects of coal phasing out in Germany, emphasising the importance of supporting policies for a successful transformation.

Geopolitics has a significant impact on the coal sector in Europe („European…", n.d.; Kotek et al., 2023). The reduction in natural gas supplies from Russia has tem-

porarily increased the demand for coal. This has forced many Member States to prioritise energy security over climate goals (Mišík, 2022). Countries like Hungary, Slovakia and Czechia were among the most vulnerable, facing potential gas shortages of up to 40% and significant economic impacts. These countries increased coal use and delayed coal phase-outs to maintain energy security (Gritz & Wolff, 2024). Germany and Italy expanded LNG infrastructure and increased coal-fired power generation. Germany, despite its climate commitments, temporarily postponed coal phase-outs and invested in new LNG terminals (Goldthau & Youngs, 2023; Prontera 2023). Poland, already coal-dependent, further leaned on coal to offset gas shortages, though it also accelerated renewable energy investments (Goldthau & Youngs, 2023).

The global energy crisis has highlighted the complexity of the energy transition challenge. On the one hand, coal still plays a significant role in ensuring short-term energy security. The global energy crisis has shown that eliminating coal as a key means of promoting energy transformation is a mistake in terms of energy security, as demonstrated by the European Union countries (Barrasso, 2022; Cohen, 2021). To replace fossil fuel imports from Russia, alternative sources of these raw materials are being sought, mainly in African countries (Harvey, 2022). Despite the general marginalisation of the coal sector in Europe, coal still plays an important role in ensuring energy security, especially in the context of high dependence on gas and oil imports. According to EURACOAL (2024), European coal resources, including lignite, can act as a strategic buffer in crisis situations. On the other hand, many studies emphasise the need for a rapid phase-out of fossil fuels, including coal, in order to achieve climate goals and avoid long-term environmental costs (Diluiso et al., 2021; Minx et al., 2024). This debate shows that the role of coal in the energy transition requires a balanced approach that takes into account both energy security and decarbonisation objectives.

The crises that occurred caused a significant decrease in energy consumption in many countries, which affected the market prices of natural resources (Dutta et al., 2020; Mensi et al., 2020). The analysed period includes two major crises: firstly, the COVID-19 pandemic (2020), which disrupted international trade and energy demand, and secondly, the outbreak of the war in Ukraine (2022), leading to widespread disruptions in fuel markets and a significant decrease in coal imports from Russia (Huang et al., 2023; Parra et al., 2021). Furthermore, the subsequent freeze of economic life did not immediately increase the demand for coal. This situation occurred in China, where the average level of coal consumption in power plants was the lowest in four years (Wang & Su, 2020).

At the same time, the literature points to the important role of foreign coal trade. Although many countries in the European Union have ceased coal production in recent years, coal consumption has declined at a much slower pace, resulting in an increase in import dependence. Wang et al. (2019) constructed a global

coal trade network covering the period 1996–2015, and Wang et al. (2021) constructed a coal import competition network from 1998 to 2017. In addition, Chen et al. (2022) examined coal trade from 1999 to 2018, analysing trade relations, scale and distribution to identify countries involved in coal trade.

2. Research methodology

The study was based on the statistical data on international trade of individual European countries in coal, briquettes and similar solid fuels produced from coal. The research focuses solely on trade in hard thermal coal, which dominates international flows. Lignite is excluded from the main analysis due to its local use and minimal cross-border trade. Similarly, coking coal is not analysed here. The research area was assumed to be European countries. The article uses abbreviated names of countries, according to the ISO 3166 symbol (Rozporządzenie, 2020). The study does not include countries that, according to the International Energy Agency (IEA), did not produce thermal coal in 2022: Andorra, Cyprus, Gibraltar, Luxembourg and the Faroe Islands (International Energy Agency, n.d.). Data were sourced from the International Trade Centre.

The time period 2010–2023 was chosen to encompass the latest phase of energy transition in Europe, including pre-pandemic stability, the COVID-19 shock, and post-2022 market turbulence following the war in Ukraine. These years capture key geopolitical, regulatory and economic trends shaping coal trade in the region. 2023 is the last year for which complete statistical data is available.

The analysis is based on volume data of coal exports and imports, which reflect physical quantities traded rather than their monetary value. This approach avoids distortions caused by price fluctuations, which are sensitive to geopolitical and economic factors.

As part of the foreign trade conducted by individual countries in the era of globalisation, it is important to check whether there is a high level of competitiveness in the transactions conducted. The research methods were selected to allow a comprehensive assessment of the competitive position of coal in international trade. The basic measure that allows one to examine this phenomenon is the RCA (Revealed Comparative Advantage Index) proposed by Balassa (1965). It is calculated according to the following formula:

$$RCA_i = \frac{X_{ij}}{\sum_{i=1}^{n} X_{ij}} : \frac{X_{iw}}{\sum_{i=1}^{n} X_{iw}} \tag{1}$$

where:

RCA_i – Revealed Comparative Advantage Index,
X_{ij} – export of i-th product by a given country j,
X_{iw} – export of i-th product by a group of countries w,
n – number of product types.

This indicator is primarily designed to determine the relative share of a product group in the export of a given country in relation to the share of the same product group in the export of the area compared (Kubala & Firlej, 2019; Szczepaniak, 2014). During interpretation, it should be noted that values below one mean that a given country does not have a comparative advantage in the reference market, while values above one indicate the existence of such advantages. However, this indicator has a disadvantage, as it is not limited from above. Therefore, it becomes reasonable to remove this interpretation difficulty by modifying this indicator in the following way (Dalum et al., 1998; Salamaga, 2013):

$$RCA_k^{(a)} = \frac{RCA^a - 1}{RCA^a + 1} \tag{2}$$

where:

$RCA_k^{(a)}$ – adjusted Revealed Comparative Advantage Index,
RCA – Relative Comparative Advantage Index (Balassa index),
a – any positive number (exponent).

The adjusted RCA index can reach values from –1 to +1. Values above zero indicate the existence of a comparative advantage in the export of a given product, while negative values mean that such an advantage does not exist. At the same time, the index indicates the strength of the existing advantage (Firlej & Kubala, 2018). Values closer to one indicate the existence of a stronger advantage, whereas the closer they are to negative one, the greater the lack of advantage.

The value of RCA indicators was calculated as the ratio of the export value of coal, briquettes and similar solid fuels produced from coal in a given country to the total export value of this product in European countries and the ratio of the export value of this country to the total export value in European countries. In the next step of the analysis, the adjusted relative comparative advantage indicator was used. In the calculations, the value of parameter a was assumed to be equal to 1.

The second indicator used to assess competitiveness is the Trade Coverage indicator, which illustrates the relationship between export and import of a given product. Its main purpose is to determine to what extent the revenues from export of a given product cover the costs related to its import. This indicator shows the level of export specialisation of a country in a given economic sector. It is calculated on the following formula:

$$TC = \frac{Ex}{Im} \tag{3}$$

where:

TC – Trade Coverage Index,
Ex – export value,
Im – import value.

According to the adopted interpretation, an index value above one indicates a relative competitive advantage in the analysed area and confirms export specialisation. On the other hand, values below one indicate limited competitiveness in a given sector and signal the occurrence of a deficit in international trade.

The third indicator is the Import Penetration Index. It is a measure of the share of imports in the total supply of a given product or group of products on the market of a given country. It is used to assess the dependence of the domestic market on imports and to analyse the competitiveness of domestic production in the context of international trade (Nguyen et al., 2019). This indicator is expressed by the formula (Hellberg & Mannerson, 2019):

$$IPI = \frac{M}{D + M - E} \tag{4}$$

where:

IPI – Import Penetration Index,
M – import volume,
D – production volume,
E – export volume.

An indicator value greater than 1 indicates that the country is dependent on imports, which means that the imported product constitutes a larger share of the domestic market than domestic production. A value of one indicates countries that import exactly as much as they produce, while values less than 1 indicate that the country produces more than it imports of a given product.

Selected methods are optimal for this study, as they allow for differentiation between exporting and importing countries, identify changes in the competitive position over time, and exclude distortions stemming from trade intermediaries or countries with negligible trade volumes. Although other approaches, such as price-adjusted quantitative models or econometric techniques, could complement the analysis, the selected indicators provide clear insight into broad market trends with the available data.

3. Results

The overall value of exports and imports of coal, briquettes and solid fuels in Europe in the years 2010–2023 shows variation (Figure 1). The value of imports of the raw materials considered gradually decreased for most of the first decade. This trend is related to the intensification of climate policy and the implementation of the EU ETS. The level of exports remains relatively stable until 2021. In 2022, the value of exports increased to a record level of almost USD 50 billion. This is the result of the energy crisis caused by the war in Ukraine, the reduction of natural gas supplies from Russia, and the search for alternative energy sources by European economies. A year later, the energy market stabilised.

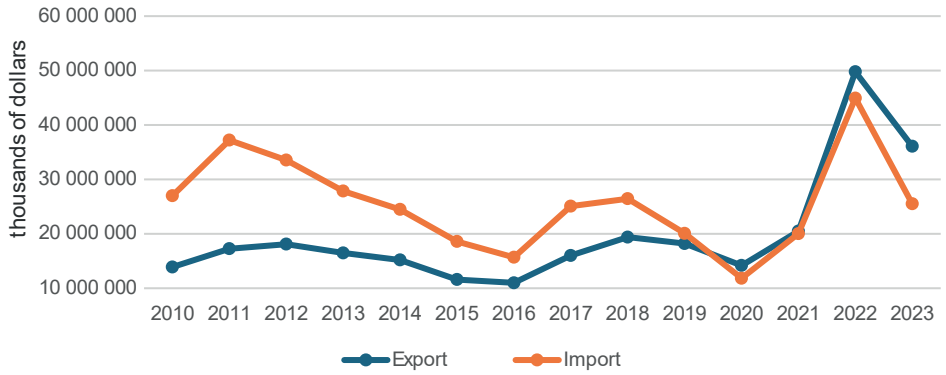

Figure 1. The value of exports and imports of coal, briquettes and similar solid fuels produced from coal in European countries in 2010–2023

Source: own study based on data from the International Trade Centre (n.d.).

In the first stage of the analysis, the adjusted Relative Comparative Advantage Index (Table 1) was used. The a parameter value was assumed to be 1 in the calculations. Data on the adjusted comparative advantage index RCA of coal, briquettes and similar solid fuels produced from coal in European countries in the years 2010–2023 show interesting conclusions regarding the competitiveness of these countries on the coal market. Many countries have RCA values below 0 for most years of the analysed period, which means that they do not have a comparative advantage in the production of solid coal fuels. In some cases, such as Austria, Malta, Norway, Sweden and Switzerland, these values remained at a constant level of –1, which suggests a lack of competitiveness in this industry in a given period. However, in Eastern European countries, such as Belarus or Ukraine, larger fluctuations in the results are visible. For example, Belarus had a positive RCA value in 2019 and 2020, indicating a temporary comparative advantage, but since 2021

this value has turned negative. Ukraine also experienced periods with positive RCA values (2010–2014), but after 2017 its indicator fell to negative values, reaching –1 in 2020 and then improving slightly in 2023 to 0.06. In the case of Poland, there was a comparative advantage in 2010–2018 and in 2021. In the other years under analysis, the values achieved were slightly negative. Positive values were also recorded in the Netherlands in 2011–2012, in the Czech Republic in 2010–2015, and in Albania in 2023. Among the countries that showed a positive RCA index, it is worth highlighting Russia, whose index increased from 0.82 in 2010 to 0.90 in 2023, indicating an increase in the country's competitiveness in the production of coal and similar fuels. These changes are due to energy policy and the increase in coal mining in Russia, which allows it to strengthen its position in the coal market.

The table presenting the Trade Coverage Index of coal, briquettes and similar solid fuels produced from coal in European countries in the years 2010–2023 shows a large variation in results depending on the country and year (Table 2). Russia clearly dominates this table, with the highest values of the index in each year, which range from about 15 to over 200 in the years 2022–2023. This indicates its large share in the production and trade of coal and its derivatives in Europe, as well as significant exports of these raw materials. High values of the index are characterised by Denmark (except for 2012, 2018 and 2022) and the Czech Republic in the years 2010–2016. In the period under review, the value of exports exceeded imports simultaneously in Poland (in 2013 and 2015–2016), Belarus (2019–2020) and Estonia (2022).

In the last stage, the Import Penetration Index of coal, briquettes and similar solid fuels produced from coal was analysed (Table 3). The results achieved allow us to distinguish five groups with similar trends. The first group includes countries with a stable IPI close to 1, such as Austria, Croatia, Estonia (except for 2022), Finland, France, Ireland, Sweden, Portugal, Moldova, Switzerland, Iceland, Italy (except for 2015) and Malta. They are characterised by a balanced dependence on imports. The second cluster includes countries with a relatively high and stable IPI, such as Belgium, Lithuania, Latvia and the Netherlands. These are countries with a strong dependence on imports. The third group includes countries with a low IPI index, such as Poland, Bulgaria, Germany, Greece, the Czech Republic, Bosnia and Herzegovina, Montenegro, Northern Macedonia, Slovenia, Romania, Serbia, Hungary and Russia. They are characterised by a low dependence on imports, which indicates the dominance of domestic production in the economy. The fourth cluster distinguishes countries with atypical IPI values, such as Denmark and Belarus. These countries are characterised by fluctuations or anomalies in the values of the index, e.g. a very high IPI in Belarus in 2019 (5.48) or negative values in Denmark in some years. The last group includes countries with moderate and variable IPI, Albania, Norway, Slovakia, Ukraine, Spain and the UK. These countries show an upward trend, in the last years of the analysis reaching values above the level of 1.

Table 1. Adjusted comparative advantage index RCA of coal, briquettes, pellets and similar solid fuels produced from coal in European countries in 2010–2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
AL	–1.00	–0.99	–0.99	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	0.14
AT	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00
BY	–1.00	–1.00	–1.00	–1.00	–0.99	–0.88	–0.90	–0.67	–0.09	0.49	0.25	–1.00	–0.98	–0.99
BE	–0.17	–0.23	–0.30	–0.37	–0.50	–0.55	–0.58	–0.63	–0.66	–0.69	–0.69	–0.66	–0.65	–0.74
BA	–0.96	–0.96	–0.93	–0.94	–0.90	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–0.95	–1.00	–0.97
BG	–0.71	–0.69	–0.67	–0.66	–0.77	–0.80	–0.88	–0.92	–0.96	–0.98	–0.98	–0.99	–0.90	–0.94
CZ	0.53	0.50	0.33	0.23	0.13	0.04	–0.01	–0.14	–0.29	–0.42	–0.65	–0.39	–0.64	–0.67
DK	–0.94	–0.86	–0.99	–0.94	–0.89	–0.93	–0.97	–1.00	–1.00	–0.94	–0.94	–0.81	–0.98	–0.92
EE	–0.87	–0.99	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–0.94	–1.00
FI	–1.00	–1.00	–1.00	–0.99	–1.00	–1.00	–1.00	–0.97	–1.00	–1.00	–1.00	–0.88	–1.00	–0.90
FR	–0.96	–0.97	–0.96	–0.97	–0.95	–0.97	–0.96	–0.99	–0.99	–0.96	–0.96	–0.84	–0.97	–0.96
DE	–0.96	–0.96	–0.97	–0.96	–0.97	–0.97	–0.96	–0.97	–0.98	–0.96	–0.95	–0.94	–0.94	–0.93
GR	–0.98	–0.96	–0.94	–0.97	–0.96	–0.97	–0.94	–0.96	–0.95	–0.96	–0.98	–0.91	–0.95	–0.99
HR	–1.00	–1.00	–0.99	–0.83	–0.80	–0.60	–0.56	–0.71	–0.42	–0.79	–0.85	–0.74	–0.71	–1.00
HU	–0.99	–0.99	–1.00	–0.97	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00
IS	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–0.99	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00
IE	–0.96	–0.97	–0.94	–0.91	–0.91	–0.87	–0.86	–0.88	–0.85	–0.86	–0.82	–0.84	–0.91	–0.91
IT	–0.99	–0.99	–0.98	–0.99	–0.99	–0.97	–0.97	–0.98	–0.99	–0.98	–0.99	–0.96	–0.98	–0.96
LV	–0.89	–0.92	–0.95	–0.83	–0.63	–0.49	–0.93	–0.95	–0.93	–0.95	–0.97	–0.93	–0.66	–0.81
LT	–0.85	–0.89	–0.98	–0.90	–0.89	–0.85	–0.86	–0.79	–0.77	–0.82	–0.82	–0.84	–0.67	–0.82
MK	–0.85	–1.00	–0.89	–0.95	–1.00	–0.87	–0.96	–0.98	–0.99	–0.99	–0.99	–0.99	–0.98	–1.00
MT	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00

cont. Table 1

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
MD	–0.99	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–0.98	–0.93	–0.94	–1.00
ME	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–0.99	–1.00	–1.00	–1.00	–1.00	–0.99	–0.97	–1.00
NL	–0.17	0.05	0.02	–0.06	–0.18	–0.13	–0.14	–0.28	–0.38	–0.52	–0.46	–0.33	–0.37	–0.42
NO	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00
PL	0.53	0.43	0.34	0.45	0.34	0.33	0.29	0.21	0.02	–0.02	–0.04	0.02	–0.09	–0.11
PT	–0.96	–0.95	–0.97	–0.97	–0.98	–1.00	–0.98	–1.00	–0.99	–1.00	–1.00	–1.00	–1.00	–1.00
RO	–0.86	–0.97	–0.99	–1.00	–1.00	–0.99	–0.99	–0.99	–1.00	–1.00	–1.00	–1.00	–0.97	–0.98
RU	0.82	0.80	0.81	0.81	0.83	0.87	0.89	0.88	0.87	0.87	0.89	0.87	0.86	0.90
RS	–0.87	–0.95	–0.99	–0.97	–0.99	–0.99	–0.98	–1.00	–1.00	–0.99	–0.99	–0.99	–0.98	–0.99
SK	–0.97	–0.96	–0.95	–0.94	–0.95	–0.97	–0.97	–0.84	–0.83	–0.94	–0.90	–0.89	–0.92	–0.95
SI	–0.99	–0.97	–0.99	–0.95	–0.98	–0.98	–0.98	–0.98	–0.98	–0.99	–0.98	–0.99	–0.99	–0.99
ES	–0.62	–0.64	–0.59	–0.77	–0.66	–0.67	–0.81	–0.91	–0.92	–0.74	–0.66	–0.84	–0.69	–0.39
SE	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00
CH	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00
UA	0.65	0.64	0.54	0.67	0.64	–0.15	–0.20	0.00	–0.87	–0.99	–1.00	–0.99	–0.07	0.06
GB	–0.73	–0.78	–0.76	–0.76	–0.79	–0.81	–0.81	–0.86	–0.83	–0.79	–0.66	–0.75	–0.86	–0.83

Source: own study based on data from the International Trade Centre (n.d.).

Table 2. Trade Coverage Index of coal, briquettes and similar solid fuels produced from coal in European countries in 2010–2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
AL	0.00	0.00	0.00	0.00	×	0.00	×	×	×	×	×	×	×	3.47
AT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BY	0.00	0.01	0.00	0.00	0.01	0.07	0.06	0.29	0.70	1.08	1.12	×	0.08	×
BE	0.49	0.39	0.41	0.42	0.39	0.37	0.36	0.30	0.27	0.26	0.29	0.41	0.42	0.29
BA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BG	0.02	0.03	0.05	0.08	0.04	0.05	0.05	0.03	0.02	0.01	0.01	0.00	0.04	0.06
CZ	3.46	2.44	2.56	2.13	1.46	1.33	1.22	0.69	0.53	0.38	0.24	0.38	0.22	0.21
DK	6.47	6.25	0.59	3.68	20.85	20.28	25.09	2.45	0.55	405.85	1.06	4.06	0.58	1.30
EE	0.10	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.10	0.00
FI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.04
FR	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.00	0.02	0.03	0.10	0.02	0.03
DE	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.02	0.02	0.04
GR	0.01	0.04	0.14	0.04	0.05	0.03	0.07	0.05	0.06	0.06	0.03	0.17	0.26	0.05
HR	0.00	0.00	0.00	0.03	0.04	0.09	0.10	0.11	0.36	0.10	0.08	0.09	0.11	0.00
HU	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IE	0.03	0.02	0.04	0.05	0.06	0.08	0.12	0.11	0.17	0.49	0.58	0.18	0.15	0.21
IT	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.01	0.03
LV	0.07	0.05	0.05	0.20	0.51	0.73	0.17	0.14	0.19	0.14	0.17	0.54	0.81	0.89
LT	0.13	0.08	0.02	0.09	0.12	0.18	0.20	0.27	0.34	0.29	0.41	0.35	0.66	0.69
MK	0.03	0.00	0.02	0.01	0.00	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.00
MT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.00
MD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00

cont. Table 2

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
ME	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.07	×	0.00
NL	0.41	0.62	0.57	0.46	0.39	0.33	0.32	0.29	0.27	0.36	0.58	0.48	0.68	0.54
NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PL	0.69	0.54	0.78	1.06	0.88	1.07	1.03	0.53	0.32	0.36	0.49	0.56	0.28	0.33
PT	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.21	0.00
RO	0.08	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.05
RU	54.17	28.62	15.27	15.40	19.60	22.04	34.61	28.57	42.36	43.49	38.82	42.59	200.4	214.2
RS	0.07	0.03	0.00	0.04	0.01	0.00	0.02	0.00	0.00	0.00	0.01	0.01	0.02	0.01
SK	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.03	0.04	0.01	0.03	0.03	0.02	0.01
SI	0.06	0.19	0.09	0.41	0.14	0.17	0.22	0.24	0.22	0.17	0.16	0.19	0.38	0.32
ES	0.09	0.07	0.08	0.07	0.10	0.08	0.06	0.02	0.02	0.16	0.41	0.10	0.15	0.50
SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
UA	0.32	0.28	0.23	0.37	0.29	0.03	0.03	0.04	0.00	0.00	0.00	0.00	0.18	0.93
GB	0.05	0.03	0.03	0.04	0.04	0.05	0.12	0.09	0.10	0.19	0.43	0.26	0.11	0.32

Source: own study based on data from the International Trade Centre (n.d.).

Table 3. IPI index of coal, briquettes and similar solid fuels produced from coal in European countries in 2010–2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
AL	0.87	0.95	0.94	0.91	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46
AT	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BY	1.00	1.01	1.00	1.00	1.01	1.07	1.05	1.28	2.07	5.48	3.29	×	1.03	0.00
BE	2.51	1.85	2.21	1.89	1.67	1.60	1.64	1.65	1.40	1.44	1.44	1.64	1.70	1.42
BA	0.17	0.16	0.13	0.16	0.19	0.18	0.17	0.16	0.18	0.19	0.17	0.19	0.09	0.09
BG	0.09	0.08	0.06	0.06	0.05	0.03	0.02	0.03	0.03	0.02	0.03	0.03	0.04	0.02
CZ	0.04	0.05	0.04	0.05	0.07	0.06	0.07	0.08	0.08	0.00	0.00	0.13	0.12	0.00
DK	–0.13	–0.10	–0.61	–0.04	–0.01	0.00	0.00	–0.96	1.00	1.00	0.00	×	0.00	1.00
EE	1.04	1.02	1.01	1.00	1.00	1.00	1.00	0.00	1.00	1.00	×	×	–0.09	×
FI	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	1.06	1.00	1.03
FR	1.01	1.01	1.01	1.01	1.02	1.01	1.02	1.00	1.00	1.02	1.03	1.07	1.02	1.02
DE	0.18	0.19	0.18	0.21	0.24	0.23	0.24	0.22	0.21	0.24	0.22	0.24	0.25	0.23
GR	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.02	0.01	0.00
HR	1.00	1.00	1.00	1.01	1.01	1.03	1.03	1.12	1.31	1.04	1.03	1.06	1.10	1.00
HU	0.16	0.14	0.14	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
IE	1.01	1.01	1.02	1.02	1.02	1.03	1.04	1.07	1.08	1.46	1.54	1.22	1.03	1.13
IT	1.00	1.00	1.00	1.00	1.00	0.00	1.01	1.00	1.00	1.00	1.00	1.00	×	1.00
LV	1.03	1.04	1.04	1.14	1.47	1.83	1.12	1.11	1.18	1.08	1.08	1.37	2.39	1.71
LT	1.11	1.08	1.02	1.09	1.11	1.18	1.17	1.27	1.39	1.30	1.42	1.32	1.65	1.91
MK	0.02	0.02	0.03	0.02	0.03	0.02	0.04	0.03	0.04	0.04	0.03	0.03	0.05	0.09
MT	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00	1.00	1.00
MD	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.02	1.00

cont. Table 3

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
ME	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NL	1.70	1.00	1.00	1.00	1.00	1.43	1.44	1.46	1.39	1.70	1.92	1.70	1.00	1.00
NO	0.11	0.13	0.15	0.10	0.11	0.14	0.16	0.66	0.70	0.76	0.85	0.82	0.92	0.90
PL	0.10	0.10	0.07	0.07	0.07	0.06	0.06	0.10	0.14	0.13	0.12	0.11	0.16	0.00
PT	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.00	1.42	1.00
RO	0.03	0.03	0.04	0.04	0.03	0.03	0.03	0.03	0.04	0.00	0.05	0.04	0.04	0.02
RU	0.01	0.01	0.10	0.10	0.10	0.09	0.08	0.09	0.09	0.08	0.10	0.09	0.07	0.06
RS	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01
SK	0.59	0.62	0.00	0.00	0.00	0.65	0.66	0.69	0.75	0.00	0.72	0.76	0.79	0.79
SI	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
ES	0.00	0.00	0.78	0.76	0.81	0.90	0.90	0.87	0.88	1.15	0.00	×	×	×
SE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CH	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01
UA	0.19	0.19	0.20	0.20	0.27	0.30	0.33	0.45	0.44	0.45	0.41	0.44	0.22	0.04
GB	0.58	0.64	0.72	0.79	0.78	0.73	0.67	0.75	0.82	0.68	1.06	1.02	0.99	1.07

Source: own study based on data from the International Trade Centre (n.d.).

4. Discussion

The results obtained are consistent with the research of Huang et al. (2023), who indicate that the outbreak of the conflict in Ukraine contributed to significant changes in the coal market. When the Russian Federation reduced coal exports, most countries were forced directly or indirectly to look for other sources of energy resources. This conflict deepened the shortage of natural gas supplies in European countries, which forced them to restart coal-fired power plants, in particular in Germany, Austria, France and the Netherlands („Bulgarian media…", 2024). These shifts underline the vulnerability of European energy security in times of a geopolitical crisis and highlight the ongoing reliance on fossil fuels despite climate objectives.

The research results are also consistent with the analysis made by Lee et al. (2011), who indicate that in the case of crises, disruptions in supplies also apply to countries indirectly related to the countries directly involved in the conflict. It should also be emphasised that throughout the research period, Russia has been competitive on the European coal market (Chambers, 2020). In addition, over the years, a slow decline in the importance of coal in foreign trade has been visible, which is caused by a gradual departure from the supply of this energy source (Jakob et al., 2020; Keles & Yilmaz, 2020). This transition reflects broader global trends towards decarbonisation but remains uneven and subject to external shocks. This is also confirmed by the research by Finkelman et al. (2021), at the same time as indicating that some countries (including Russia) are increasing their energy production and consumption. This transition reflects broader global trends towards decarbonisation, but remains uneven and subject to external shocks. This is also confirmed by research by Finkelman et al. (2021), which also indicates that some countries (including Russia) are increasing their energy production and consumption.

Moreover, the evolving regulatory environment within the European Union continues to exert pressure on coal markets, accelerating the need for diversification of energy sources (Igliński et al., 2024; Rabbi et al., 2022). Technological advancements in renewable energy and energy storage are likely to play a pivotal role in reducing coal dependency in the near future while balancing energy security concerns.

The findings highlight the crucial role of policy and institutional context in shaping trade flows. EU member states face stricter decarbonisation regimes and related investment constraints, leading to a rapid drop in coal import demand; non-EU countries such as Russia do not face such restrictions and remain active exporters. The division between thermal coal, coking coal and lignite is also relevant – only the first is widely traded internationally.

The main limitations of this research include the inability to fully disaggregate flows by coal type in some national statistics, difficulty in correcting for re-export effects in hub countries, and partial aggregation of intra-EU trade due to the customs union. Future research could employ panel data methods, country case studies or direct surveys of traders and utilities to further isolate market drivers and comparative advantages.

Conclusions

The conducted analysis of the competitive position of foreign coal trade in Europe in the years 2010–2023 indicates the dynamic and diverse nature of changes in the coal sector. The research results confirm the validity of hypotheses H1 and H2, indicating a decline in coal competitiveness among most EU countries and the maintenance of Russia's advantage until 2022.

The results show that although many European countries are gradually moving away from coal use in favour of more sustainable energy sources, there are still countries that maintain their competitiveness in this market. Russia, due to its significant natural resources and energy policy, dominates the European coal market throughout the research period. Central and Eastern European countries, such as Poland, the Czech Republic and Ukraine, show periodic comparative advantages, but their results are subject to significant fluctuations depending on local and global economic conditions.

The outbreak of the conflict in Ukraine in 2022 and the reduction of natural gas supplies from Russia caused rapid changes in the energy market, forcing many countries to temporarily return to coal as a key energy source. At the same time, differences are visible depending on the level of coal imports – countries such as Belgium and the Netherlands are characterised by high dependence on imports, while most countries of Eastern Europe and the Balkans rely on them to a lesser extent.

The results also indicate a general trend of decreasing the importance of coal in international trade, which is consistent with global trends of energy transformation and decarbonisation. However, armed conflicts, energy crises and specific regional conditions may temporarily change this direction. In the future, further research should focus on the impact of climate policies, renewable technologies and transformation of European economies on international trade of energy resources.

The results of this study should be disseminated both within scientific circles (energy economics, international relations, climate policy) and among policymakers at the EU and national levels, as well as energy sector stakeholders. Key find-

ings can inform national energy strategies, coal import contingency planning and electricity market risk assessments. The findings have measurable social utility. By clarifying coal import risks and competitive positions, the study supports more resilient energy policies and helps prepare for supply disruptions. Insights into the timing of trade shifts can guide targeted social support and structural adjustment in regions dependent on coal mining and coal-fired power production.

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