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Price trends on the international steam coal market in 2000–2020

Introduction

The first twenty years of the 21st century saw a strong global demand for primary energy carriers. Between 2000 and 2019, the demand increased by 5.6 billion tonnes of oil equivalent (bn toe; energy equivalent to one metric tonne of crude oil with a calorific value of 10,000 kcal/kg.) to 14.4 bn toe. According to the International Energy Agency (IEA) projections in the Stated Policies Scenario (STEPS) (WEO2020), the demand is expected to rise by another 2.7 bn toe by 2040. In the mix of energy carriers covering the world demand for primary carriers in 2000–2019, the share of coal (hard coal and lignite combined) exceeded more than a quarter. Although the share of coal has decreased in developed countries (e.g. in European Union countries, it has decreased by 45% to 176 Mtoe), in total in Asia and Pacific countries, it has increased 2.5 times to 3.1 bn toe. By 2040, the global share of coal is expected to fall to 19% and be replaced by renewables (19%) and natural gas (25%).

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The main user of coal worldwide is the power industry, whose share in the global consumption of this commodity increased from 55% (in 2000) to 64% (in 2019) (WEO2020). According to the STEPS (WEO2020), the power industry will still be consuming over 60% of global coal consumption (2.1 bn toe) by 2040.

Between 2000 and 2020, the total installed capacity of coal-fired power plants operating worldwide fluctuated widely (Figure 1). The largest increase in capacity (of almost 38 GW) took place between 2005 and 2006 reaching over 91 GW. In addition, India and China are the leading countries to put new coal-fired power capacity into operation. Between 2000 and 2020, the share of new capacity from these two countries alone accounted for between 8% and 94% of the global increase. Coal-fired power plants in the European Union countries and the United Kingdom accounted for a relatively large share of the coal-fired power plant shutdowns. Coal capacity retirements in these countries accounted for between 6% and 63% of all global shutdowns. This information already shows that the Asian direction will play a significant role in the world coal market now and in the future.

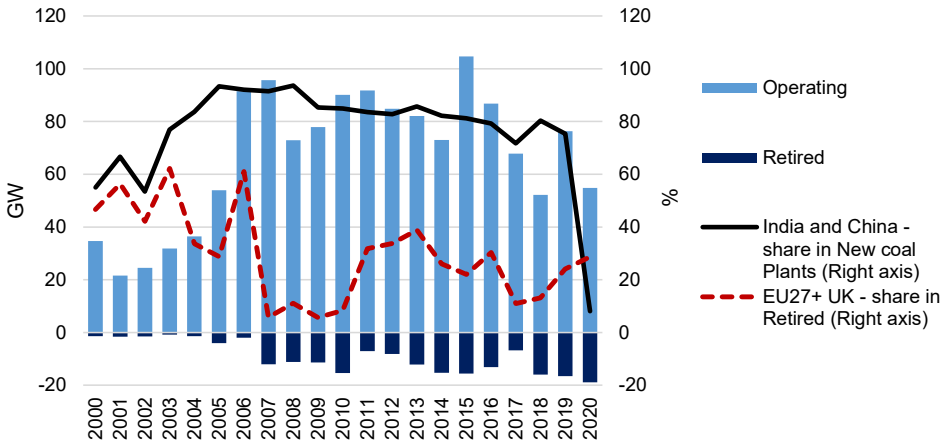

Fig. 1. Total installed capacity of operating and retired power plants in the world, 2000–2020
Source: compiled on the basis of data (Global 2021)

Rys. 1. Łączne moce zainstalowane w elektrowniach pracujących oraz wyłączanych na świecie, lata 2000–2020

Due to the fact that different types of coal (steam coal, coking coal, lignite) are traded worldwide, and the market for each of these commodities has different specifics, the authors of this article focused on steam coal. The authors adopted a methodology (Coal Information 2019) according to which steam coal includes all anthracite, bituminous coals and sub-bituminous coal not included under coking coal.

The aim of the article is to characterize the price trends that took place in the international trade of energy coal in the years 2000–2020 and to distinguish price indices which, in the opinion of the authors, currently play an important role in this trade.

1. Types of transactions on the physical market

Transactions between sellers and buyers in the physical market are carried out in various forms. These can be forward contracts (not longer than five years), spot market transactions, or tenders and electronic purchases via the Internet. A very important coal price setter for international markets has for many years been the prices between Australian coal producers and Japanese power plants. These prices are set through negotiations, but the volumes of supply subject to these negotiations are not known.

Power plants have gradually introduced tendering procedures in place of direct ne-gotiations. Although long-term contracts still prevail in the Asian market, their dominance has been significantly reduced (Lorenz and Grudziński 2009; Lorenz 2014). The European market started to move away from long-term contracts much earlier. In 2000, their share was only 25%, while in Australia, 65% of exports were coal from forward contracts. In the past, long-term contracts were agreed directly between producers and end users for periods of up to 10 years. In Europe, the duration of these contracts has been reduced to 1–2 years.

The second decade of the 21st century saw an increasing tendency for market participants to replace forward contracts with spot transactions. Spot transactions are made on a one-off basis (specifying quantity, price and delivery terms) and are instant transactions with settlement within two working days. Delivery times vary from 25 to 90 days. Globally, spot transactions are estimated to account for approximately 20% of the actual coal trade. Although their share in the total pool of coal purchases is relatively small, their important advantage is an immediate response to the current market situation. This response consists of a price increase at low supply and a price decrease at increased supply.

For many years, the global coal trade has operated with so-called price indexes. These indexes are market prices that have been related to a particular standardised quality. For steam coal, in 2000–2020, the main quality measures used were a calorific value of 6,000 kcal/kg (i.e. approximately 25.1 MJ/kg) and a sulphur content of less than 1%. These indexes provide a reference price that is later used in other types of contracts. These indexes are determined by analysts from specialised companies such as Argus Media Ltd (Argus 2021), S&P Global Platts (CTI Platts 2021; ICR Platts 2021), IHS Markit (IHS Markit 2021), globalCOAL (GlobalCOAL 2021).

With the growth of Asian markets, international trade has adapted to the needs of these markets, and spot index quotations for coal of a lower calorific value are also increas-ingly appearing in publications and on industry platforms (Lorenz 2017). Spot transactions used to be conducted directly between a producer (or seller) and a user. Later, this role was taken over by specialised trading platforms, as well as commodity markets and brokers working within them.

One option for purchasing coal on the spot market is tenders in which coal is purchased by auction. There are also transactions that hedge future coal prices in contracts agreed in over-the-counter markets. Forward and swap contracts are usually concluded for the following months (one or two), quarters (for four consecutive months), years (the following two or three years). The prices in such contracts indicate a certain type of expectation that market

participants have for the near future in relation to coal prices. Prices in forward or swap contracts cannot be considered as a forecast for coal prices.

The geographic distribution of coal deposits in the world in relation to their recipients makes seaborne trade play a significant role in international coal trade. According to data (Coal Information 2019), in 2000–2018, between 86% and 92% of global trade was seaborne, and the seaborne steam coal trade accounted for the largest part of it (67–78%). In the global steam coal trading, it is customary to distinguish between the Atlantic region (also known as the Atlantic market) and the Asia-Pacific region (also known as the Asia-Pacific market). The main exporters of coal to the Atlantic market include South Africa (up to and including 2007, the country had played an important role especially in supplies to customers in NW Europe), Russia, Colombia, and the US, with the US considered as a swing supplier (when coal prices are high, the country increases supply, and when prices fall, it reduces production and withdraws from the market). The buyers are from European and non-European Mediterranean countries. The main exporters of coal to the Asia-Pacific market are Indonesia and Australia, with Russia's share also increasing in recent years. South Africa, on the other hand, has increased its share since 2008 (especially in supplies to Indian power plants) and the United States has also appeared periodically.

2. Identified periods of steam coal price fluctuations in spot markets

In order to characterise the price trends that occurred in the international steam coal trade in 2000–2020, and to identify the price indexes that the authors believe currently play an important role in this trade, the authors conducted a deep literature study of steam coal spot price quotations (Argus 2021; BP 2021; CTI Platts 2021; ICR Platts 2021; Coal Information 2019; GlobalCoal 2021; Tarazanov 2016–2021a, b; World Bank 2021).

The authors decided they would conduct all analyses on their own calculated annual averages (Figure 2). Such a decision was intended to eliminate short-term fluctuations in prices observed during a given calendar year. The prices of exporters (producers) are given as FOB (Free-On-Board; franco ship in port of loading) prices, together with the name of the port in which the coal is loaded onto the vessel. On the other hand, prices of importers (buyers) are given as CIF (Cost-Insurance-Freight to the port of destination) or CFR (Cost-and-Freight designated port of destination) prices at the port of coal delivery. All indexes compared in the article refer to coal with a calorific value of 6,000 kcal/kg (approximately 25.1 MJ/kg; sulphur content of less than 1%).

When analyzing the fluctuations of annual spot prices for steam coal, it can be seen (see Figure 2) that these changes generally follow an alternating pattern. For the analyzed period 2000–2020, the authors highlighted the periods of:

- rising prices – 2000–2001, 2003–2004, 2007–2008, 2010–2011, 2016–2018;
- falling prices – 2002, 2009, 2012–2015, 2019–2020;
- stabilisation of prices – 2005–2006.

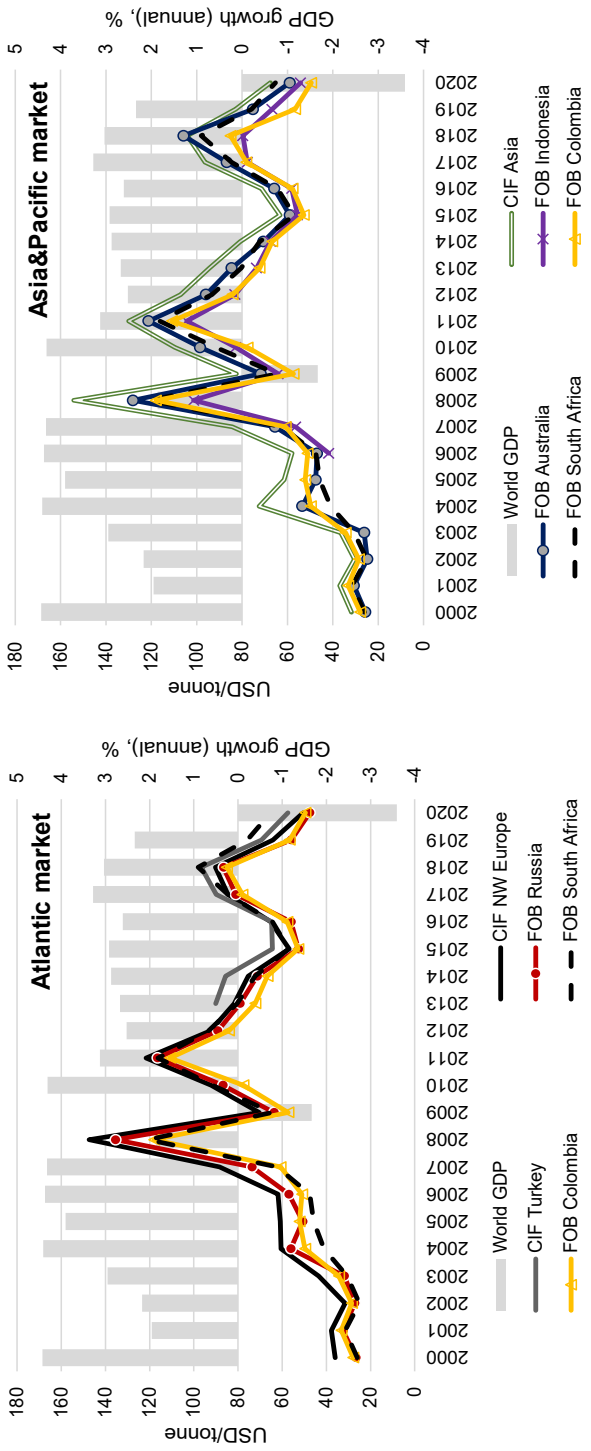

Fig. 2. Atlantic and Asia-Pacific markets – FOB and CIF steam coal price indexes (6000 kcal/kg) vs change of global GDP

Source: own study based on: (Argus 2021; BP 2021; CTI Platts 2021; ICR Platts 2021; Coal Information 2019; GlobalCoal 2021; Tarazanov 2016–2021a, b; World Bank 2021)

Rys. 2. Rynek Atlantyku oraz Azji i Pacyfiku – indeksy cen węgla energetycznego (6000 kcal/kg) na warunkach FOB i CIF na tle zmian światowego PKB

The length of the highlighted periods of price fluctuations varies from one to four years, but it most often covers a period of two years.

Steam coal prices in Figure 2 are compared with world annual GDP growth. The figure gives a good indication of when coal was in oversupply globally. This is indicated by the equalisation of FOB and CIF coal prices observed in 2009–2017.

2.1. 2000–2001 – period of rising prices

The disturbances in the international steam coal market at the end of the 20th century were caused by coking coal. The recession that occurred then in the steel industry in Europe and in the US contributed to the sale of coking coal by some of its producers to the steam coal market, in effect weakening in effect the established relationships (Ozga-Blaschke 2008, 2021; Lorenz and Ozga-Blaschke 2016). The first two years analyzed in this article show the recovery of both the international coal market and the world economy as a whole. In 2000, world GDP reached more than 4% and in 2001, it was less than 2%. The disruption to this growth was due to the terrorist attack on the United States on 11 September 2001. FOB prices of the major steam coal exporters, i.e. South Africa and Russia, to the Atlantic market increased by USD 5–27/t year-on-year, and to the Asia-Pacific market (Australia and Colombia) by about USD 5/t (steam coal prices (6,000 kcal/kg) from Indonesia are available from 2006 onwards).

2.2. 2002 – period of falling prices

The growing output and export of steam coal (by China, Australia, Indonesia, as well as Russia and Colombia) contributed to the global oversupply of this commodity and consequently resulted in a fall in prices. Another factor to push prices down was the excessive appreciation of the US dollar against domestic currencies. The environmental directives introduced in the European Union and the directives deregulating the electricity and gas market also added pressure to imported steam coal prices. In addition, a period of intensive development of global e-commerce began, which also affected the volatility of coal prices in the spot market. In both markets (i.e. Atlantic and Asia-Pacific) exporters' prices fell (year-on-year) by approximately USD 5–6/t.

2.3. 2003–2004 – period of rising prices

The main reason for rising steam coal prices in 2003–2004 was the high economic growth in Asian countries (mainly in China, Japan, South Korea and India) as well as in the US. In the case of the latter, increased domestic demand reduced the country's coal exports and, by

increasing coal imports from Colombia, reduced the availability of Colombian coal on the European market. One of the reasons for the high demand for commodities and energy in China was that the country prepared for the Beijing 2008 Olympic Games. To meet internal demand, China reduced its coal exports. Furthermore, the increase in demand for steel (in addition to higher prices for metallurgical and coking coal) contributed to the commitment of a large fleet of bulk carriers in this part of the world. The mismatch between the handling capacity of Chinese ports and imported cargoes, which translated into several weeks of ship downtime coupled with the lack of adequate supply of bulk carriers, resulted in a cumulative increase in FOB coal prices. It was also accompanied by a rise in freight rates and the CIF prices of imported coal. In NW European ports, the average annual price of steam coal in 2004 exceeded USD 60/t, and in Asian ports, this figure was USD 70/t.

2.4. 2005–2006 – period of price stabilisation

In response to high demand, the supply of steam coal into world markets increased relatively quickly thanks to increased exports from Indonesia and Russia. In addition, an im-proved number of bulk carrier fleets and increased port handling capacity contributed to the stabilisation of coal prices between 2005 and 2006. On a year-on-year basis, steam coal prices fluctuated only slightly by a few dollars.

2.5. 2007–2008 – period of rising prices

The period 2007–2008 saw the largest increases in steam coal prices accompanied by a rise in sea freight costs. The turbulence in the sea freight market largely contributed to the increase in coal prices in 2007. Supporting the increase in steam coal prices were restrictions on coal exports from China, as well as unusually heavy rainfall in Indonesia and insufficient capacity at Australian seaports (high port congestion in Australia, limiting the availability of transport fleets to carry coal to other regions of the world and translating into higher freight rates). The rise in Australian coal prices prompted some Asian users to purchase South African coal. India, in particular, turned to South African coal and, due to a reduction in Chinese exports, was forced to find a new supplier (especially for power plants located on the west coast of India). The decline in Chinese coal exports was driven not only by higher demand exceeding production but also by exchange rates. The appreciation of the Chinese currency against the US dollar contributed to lower import revenues, and higher prices in the domestic market provided Chinese producers with higher profits from sales on that market.

The largest price movements in the history of steam coal markets (as well as other commodities) took place in 2008 and there were a number of factors contributing to this situation. The beginning of the year was marked by a number of weather-related difficulties

limiting the availability of coal (abnormal rainfall and storms in Australia and Indonesia, which hampered mining, transport and the movement of coal ships). In China, snowstorms hampered the supply of coal. Supply difficulties also affected South Africa (increased internal consumption, electrical traction failures hampering coal transport) and Russia (transport problems due to wagon shortages, freezing ports of the Sea of Azov, delays in transshipment at Baltic ports). The second half of 2008 brought about further changes. After the Olympic Games in Beijing, the Chinese demand for commodity imports and shipments decreased, which was also reflected in a drop in interest in transport and translated into lower freight prices. The global financial crisis with its impact on stock exchanges and financial markets affected all areas of the economy worldwide.

In 2007, the FOB prices of major steam coal suppliers to the Atlantic region increased by USD 10–17/t year-on-year, amounting to USD 61–74/t, and in 2008 increased by as much as USD 57–62/t year-on-year, amounting to USD 118–135/t. On the other hand, in the Asia-Pacific region, 2007 brought similar increases to those recorded in the Atlantic market, whereas already in 2008, changes had already amounted to USD 45–63/t year-on-year (exceeding USD 121/t).

2.6. 2009 – period of falling prices

2009 was a period when the world economies were in crisis and global GDP was negative at –1.67%. The reduced demand for energy did not generate an increase in the demand for steam coal. CIF steam coal prices for imports to the ports of north-western Europe (Amsterdam–Rotterdam–Antwerp) fell by USD 77/t (yoy) to USD 70/t. FOB steam coal prices of major suppliers to the Asian market experienced year-on-year declines of USD 37–61/t, ranging from USD 57 to USD 72.

2.7. 2010–2011 – period of rising prices

2010–2011 was another period of price increases, largely driven by weather, political, mining and geological factors. Heavy rains hampered the mining and transport of coal by major exporters, i.e. Australia (February 2011, cyclone Yasi), Indonesia and Colombia, thus reducing the availability of coal on the international market. In 2010, the Eurozone crisis began in Europe, and at the end of 2010, Europe suffered a severe winter attack which paralysed land and maritime transport. Political unrest began in North African countries and spread to the Middle East region (the so-called Arab Spring). As there is a strong correlation between the commodity markets (coal, oil, gas), the unrest in the oil and gas markets stimulated increases in coal prices. Price relationships and the study of cor-relationscorrelations between the prices of these three commodities have long been the subject of much scientific analysis (i.a. Li et al. 2017; Zamani 2017).

Another factor pushing up steam coal prices was the disaster at the Raspadskaya mine, Russia (May 2010), followed by safety checks commissioned at other mines. As a result of those inspections, coal production was suspended at some of the mines for a period of time.

Another important factor contributing to the rise in coal prices was the Fukushima nuclear accident in Japan. The tsunami wave caused by the earthquake damaged, among other things, the power plant. The damage was also felt in other parts of the world, and some European countries (Germany, Belgium, Switzerland) closed down or gradually shut down their nuclear power plants. Japan decided to reduce its dependence on nuclear energy. As a result, one of the beneficiaries of that situation was, for instance, the coal power industry. In the European market, steam coal prices in NW European ports increased year-on-year by USD 22/t in 2010 (to USD 92/t) and by USD 29/t in 2011 (to USD 122/t). On the other hand, prices of major exporters to the Asian market increased year-on-year by USD 19–27/t (to USD 76–98) and by USD 22–33/t (to USD 104–121), respectively.

At this juncture, it is worth pointing out the increased share of US coal exports in international trade. In 2011, almost 10% of domestic production was exported (EIA 2021), partly as a result of a shortage of coal on international markets.

2.8. 2012–2015 – period of falling prices

Between 2012 and 2015, the global economy entered a period of economic slowdown, with growth rates falling below 3% per year (see Figure 2). Factors such as weather, politics, strikes and changes in the US dollar against domestic currencies contributed to the decline in coal prices. The economic slowdown in 2012 (global GDP fell to 2.52%) resulted in lower energy demand while end-user coal stocks remained high (helped by a warm winter earlier in the season in Europe). South Africa's exports grew thanks to improved rail capacity delivering coal to the port of Richards Bay. However, the wave of strikes did not spare South Africa's mining industry either (an effect of the bloody crackdown on strikers in the platinum mines). And although Colombia struggled with armed attacks by guerillas on coal shipments, the country's activity in the market increased. Russia started to implement *the Long-term Programme for Coal Sector Development until 2030* (Russia 2021a) adopted in 2012. As a result, its share in the international coal market had grown, increasing the oversupply of this commodity.

A key factor adding to the oversupply of coal worldwide was the significant reduction of China's participation in spot transactions, as well as weaker economic growth performance not only in China but also in India. In addition, falling domestic coal prices in China and the exchange rate at the time caused Chinese buyers to shift away from coal imports. The economic slowdown translated into high inventories at Chinese power plants which began to abandon their contracts. In June 2012, thirty bulk carriers with unclaimed coal from Australia, Colombia, Indonesia and the US began to look for a new market, which also translated into lower prices. In addition, the shale gas boom in the US led to increased activity of cheap

US coal in Europe. Compared to 2011, coal exports fell by more than 48% to around 51 million tonnes (mn t) (Coal Information 2019).

No improvement in the situation of the international market was seen in 2013. In Colombia, coal companies were faced with strikes by miners; in Australia, strikes were organised at the port of Newcastle. The ongoing downward price trend forced many mining companies in Australia to decide to reduce production (mines whose costs could not withstand the competition at the time would be closed). The US continued to maintain a relatively high level of coal exports (47 mn t according to (Coal Information 2019)). With unsatisfactory prices in spot markets, Russian producers reduced their activity in Europe. During the winter period, Russian exporters faced transport problems at home (the Russian Railways RZhD imposed restrictions on coal shipments due to congestion on routes leading to ports). The Chinese authorities began to try to introduce various administrative measures that regulated and controlled coal imports. One of those measures was to reduce certain taxes that burdened domestic producers and reduced their revenues.

Subsequent years did not show any improvement in the situation. China's lower economic activity in 2014 as well as continued high hydropower generation did not increase the demand for coal from overseas markets. Driven by the need to reduce air pollution and diversify the fuels used, the Chinese government announced a number of measures to be implemented in order to curb the growth of coal consumption. In general, the oversupply of coal, both from users and at port terminals (e.g. at ARA ports, coal stocks fluctuated around 6 mn t in 2015), as well as the undersupply of demand and the weakness of the currencies of coal-exporting countries against the US dollar did not support coal price increases. Low coal prices worldwide forced some producers in South Africa to close or suspend mining. The US reduced its activity in the international market. Following the strengthening of the US dollar, production costs increased and the profitability of Indonesian mines deteriorated. In addition, the Chinese government announced a new Chinese Energy Strategy for 2014–2020, according to which, the structure of the country's energy balance was to be changed. One of the sub-goals of this strategy was to limit the growth of energy consumption over the following six years to around 3.5% per year. In addition, China has announced its intention to reduce CO_2 emissions, although this will not happen until after 2030. While coal will remain a key component of China's energy mix, there will be a greater emphasis on the use of high efficiency, low-emission technologies, and carbon capture and storage. In contrast, a significant reason for India's increase in 2015 imports was the availability of cheap coal on international markets as a result of falling demand in China.

A major 2015 event was the December meeting of the climate conference in Paris (COP 21) where participating countries declared their targets and plans to reduce CO_2 emissions. The implementation of these plans will be a key factor affecting the fuel and energy mix, as well as the level of energy consumption. Most of these national plans include the intention to increase the use of renewables and nuclear energy. This will have the effect of reducing the use of fossil fuels.

In the last year of this cycle, coal prices at ARA ports fell to less than USD 57/t. The price level of the main suppliers of coal to Europe, i.e. Russia and Colombia, fell to less than

USD 53. Similar price levels were found in the Asia-Pacific market. The FOB Australia coal price was USD 59/t, while the FOB Indonesia coal price fell to USD 55/t and the FOB South Africa price was just USD 57/t.

2.9. 2016–2018 – period of rising prices

The reduction in coal mining output that occurred in the last period of falling prices (2012–2015) had the consequence of rising coal prices recorded in 2016. FOB prices of major exporters to the Atlantic market increased by USD 3–5/t on an annual basis, while the Asia-Pacific market recorded increases of USD 3–7/t (see Figure 2).

Political decisions in China (capacity reductions by another 100 mn t) and disruptions in coal transport were important triggers of price increases. High heat caused increased demand during the summer season, which together translated into increased demand for imported coal. However, we should also mention the political decisions of the Chinese authorities which in order to increase the price of coal in the domestic market, imposed a duty on imports of this commodity.

Other factors pushing up prices were temporary disruptions to coal supplies from Australia (Cyclone Debbie) and Indonesia (the effect of the La Nina phenomenon) due to heavy rainfall. The effects of energy-related national policies, including energy efficiency improvements, were increasingly felt. In addition, policy measures to protect the envi-ronment and to enhance energy security are increasingly making a difference in the global energy balance.

In the European market, the position of two steam coal exporters, i.e. Colombia and Russia, started to strengthen while the role of South Africa and the US weakened.

Another important factor supporting price increases was the structural difficulties of Indonesian producers, namely poor rail infrastructure and financial problems of related energy distributors.

Following the Fukushima nuclear power plant accident in 2011, Japan started to re-place nuclear power with conventional power (coal-, oil- and gas-fired). As a result, power generation from Japan's conventional thermal power plants accounted for 90% of the country's generating capacity. In addition, Japan is building new coal-fired power plants (20.5 GW) to replace existing plants based on older technology. Asia's strong growth in demand for imported coal was the main contributor to the price increase in 2017. Another boost came from coal supply difficulties in Australia. Contributing to these were strikes by workers of the main rail freight operator Pacific National (NSW) and miners at some key coal mines in Australia's Hunter Valley. Since 2017, the global economy had grown at a rate of more than 3% per year (see Figure 2). Declining demand in European countries (due to a greater share of RES, including hydro and wind power), rising freight rates as well as, weather disruptions (Cyclone Iris) and logistical troubles in Australia were among the factors keeping coal prices up in 2018.

Coal prices (and prices of other commodities) in international markets were significantly influenced by US policy (sanctions on Iranian oil supplies, tensions with Saudi Arabia and the trade war with China). A ban on coal imports introduced by China in October 2018 also added pressure to coal prices in both markets.

Overall, between 2016 and 2018, in both markets (i.e. Atlantic and Asia-Pacific), ex-porter prices increased annually from a few to more than USD 20/t. In the last year of this cycle, FOB prices of major coal suppliers were USD 85–87/t and in the case of the Asia-Pacific market, they reached USD 80–90.

2.10. 2019–2020 – period of falling price

The last two years of the analysis were characterised by a downward trend. In 2019, the decline in the price of this commodity on the European market was triggered by the escalation of the conflict between the United States and China, lower coal consumption (reaching record low levels), growing stocks at European ports, an increase in the production of renewable energies, with an oversupply of gas and another mild winter. Compared with 2018, exporters' prices had decreased by USD 28–31/t.

Weak interest from European buyers led most exporters to focus on Asian customers. Although India showed an increase in imported coal shipments, weakening demand from China and major transportation problems due to heavy rains in Indonesia contributed to sustaining the downward trend. In addition, poor weather conditions in Australia as well as import restrictions imposed by China on Australian coal did not support coal prices. Overall, exporters in both markets recorded year-on-year declines of more than USD 20–30/t (see Figure 2).

The next milestone in the international coal market (and the markets of other commodities) market was 2020. The outbreak of the global COVID-19 pandemic freezing many world economies (widespread lockdowns resulted in a significant reduction in energy demand) contributed to a decline in world GDP to –3.9%. In addition, heavy rains in Indonesia and decisions made by coal companies to reduce production due to low prices contributed to the high supply of Indonesian coal on the international market. In addition to the lockdowns, the supply of coal from Colombia was limited by the poor economic conditions of the two leading coal producers (Prodeco and CNR) and strikes by workers at Cerrejon.

In June 2020, Russia adopted another Long-term Programme for the Development of the Russian Coal Industry to 2035 (Russia 2021b). Two options had been considered in the program: a conservative and an optimistic option. The conservative variant assumed an increase in production volume from 440 mn t to 485 mn t, and the optimistic variant assumed an increase to 668 mn t. In order to meet the level of exports assumed in the program, Russian Railways introduced a new system of fees. Half of the quota amount depended on how much a given trader exported to these less popular destinations (not eastern, i.e. but towards the south and north-west of Russia).

In order to secure coal supplies for the country's energy industry, China's National Development and Reform Commission urged coal producers to increase their output. In September 2020, the country imposed further import restrictions on the Australian com-modity.

As a result of all these factors, the prices of exporters to the Atlantic market declined by USD 7–8/t year-on-year, with declines of USD 7–16 in the Asia-Pacific market (see Figure 4).

In the presented characteristics, in addition to the highlighted periods of steam coal price fluctuations in 2000–2020, apart from the demand and supply factor, a number of other factors were found, which refer to: seaborne transport (freight costs, availability of transport fleet, etc.) land transport (mainly railways), weather, economic and political decisions of important world economies (especially China but also the US, EU, etc.), costs of coal production, currency exchange rates in coal-exporting and importing countries against the US dollar (quotations of coal prices in the international market are expressed in USD/t), strikes (by miners, carriers), global events, pandemics (e.g. COVID-19), global crises, natural disasters (e.g. earthquakes and the tsunami effect, as well as the damage to the nuclear power plant in Japan), implementation of national programs e.g. related to mining and resulting in increased exports (e.g. Russia programs implemented in 2012 and 2020), stricter climate policy.

3. Share of freight costs in coal price

One of the factors influencing the price of coal at an importer's port is freight costs. Apart from the transport distance, sea freight costs also depend, i.a. on the size of the vessel (in the case of coal, this cargo is transported in bulk carriers), the cost of bunker fuel, the loading and unloading of instalments in ports and the attractiveness of the unloading port in terms of ensuring return cargo.

Figure 3a shows the share of freight costs in the delivery of coal to NW Europe ports from two suppliers: South Africa and Colombia. As coal is imported into ARA ports by both panamax and capesize ships, the authors estimated their own freight consists of 70% panamax bulk ship deliveries and 30% capesize bulk ship deliveries. Since 2011, a similar share of freight costs from South Africa and Colombia has been apparent, varying between 9 and 21%. Figure 3b shows the share of freight costs in the delivery of coal from Australia to ports in Japan, South Korea and Taiwan. The share of freight by panamax vessels varied between 2007 and the first half of 2021 (1H2021) from 11 to 44.5%.

The Baltic Dry Index (BDI) provides information on changes in the global economic situation. The index is quoted daily on the London Baltic Exchange. This index takes into account not only information on demand for physical transport, but also on commodity exchanges and derivative contracts. The BDI refers to the world trade of dry bulk commodities (such as coal, Fe ore, bauxite, grain, phosphate) and their transport by sea (BDI 2021). The index is expressed in points.

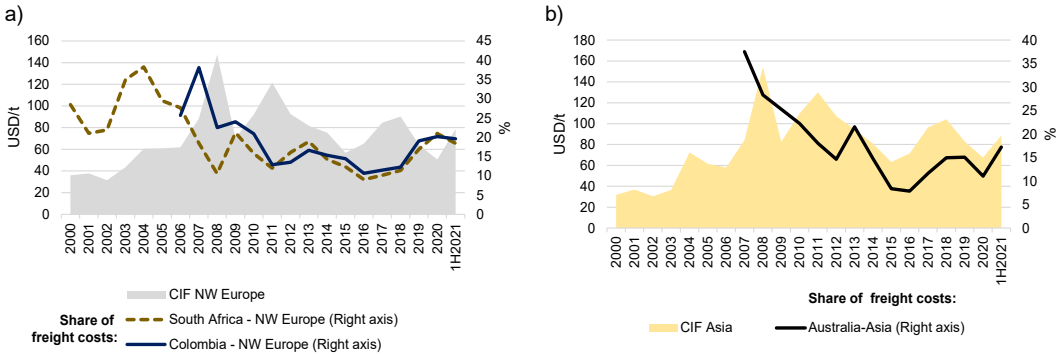

Fig. 3. Share of freight costs in coal deliveries to NW Europe (a) and Asia (b) ports
Source: own study based on data (Argus 2021; CTI Platts 2021; ICR Platts 2021)

Rys. 3. Udział kosztów frachtu w dostawie węgla do portów NW Europy (a) oraz portów Azji (b)

In Figure 4, the developments of FOB Australia and CIF NW Europe steam coal prices are deliberately repeated, while the first half of 2021 is also included to trace trends in global markets. Coal prices were related to the left axis on the graph, and the BDI to the right axis. Since the BDI is quoted daily, as in the case of coal prices, annual averages were also calculated for the BDI.

When analyzing the data in the chart in Figure 4, a high consistency can be observed in the compared indexes. When comparing annual changes for average annual freight rates on the routes: South Africa – Amsterdam–Rotterdam–Antwerp ports (ARA ports), Colombia – ARA ports and Australia – ports in Asia (in Japan, South Korea and Taiwan), and the average annual value of the BDI, it can be seen that they also show a high convergence (see Table 1) which strengthens the quotations of the coal price indexes and makes a given trend more durable.

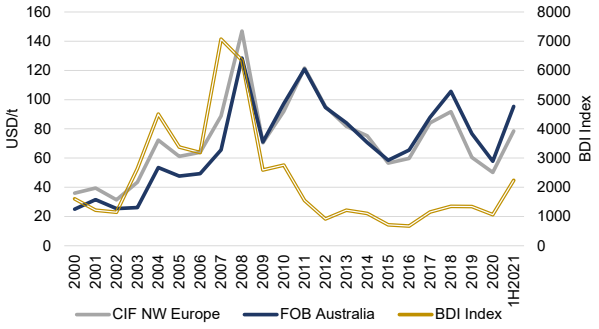

Fig. 4. Developments of FOB Australia and CIF NW Europe steam coal prices against annual averages of the BDI
Source: own study based on data: (Argus 2021; CTI Platts 2021; ICR Platts 2021; GlobalCoal 2021; Tarazanov 2016–2021a, b; BP 2021; World Bank 2021; BDI 2021)

Rys. 4. Przebieg zmienności cen węgla energetycznego FOB Australia i CIF NW Europe na średnich rocznych wartości indeksu BDI

Table 1. Comparison of changes in freight rates in highlighted periods of coal price fluctuations against BDI changes, annual averages for 2000-1H 2021

Tabela 1. Porównanie zmian stawek frachtowych w wyróżnionych okresach fluktuacji cen węgla na tle zmian indeksu BDI, średnie roczne dla lat 2000-1H2021

Highlighted periods of coal price fluctuations	Change of freight cost in %			Change of BDI in %
	from South Africa to NW Europe ports	from Colombia to NW Europe ports	from Australia to Asian ports	
2000–2001 (↑)	–23	N/A	N/A	–24 ÷ 51
2002 (↓)	–13	N/A	N/A	–6
2003–2004 (↑)	52 ÷ 120	N/A	N/A	71 ÷ 130
2005–2006 (↑↓)	–5 ÷ –22	N/A	N/A	–6 ÷ –25
2007–2008 (↑)	–4 ÷ –5	–1 ÷ 111	–25	–10 ÷ 122
2009 (↓)	–5	–49	–11	–59
2010–2011 (↑)	–2 ÷ 0	–19 ÷ 14	–12 ÷ –19	–44 ÷ 6
2012–2015 (↓)	–35 ÷ 4	–29 ÷ 9	–43 ÷ 47	–41 ÷ 32
2016–2018 (↑)	–16 ÷ 46	–15 ÷ 40	–6 ÷ 48	–5 ÷ 71
2019–2020 (↓)	–2 ÷ 5	–175 ÷ 11	–27 ÷ 1	–1 ÷ –21
1H2021 (↑)	37	51%	56%	111

(↑) – period of rising coal prices, (↓) – period of falling coal prices, (↑↓) – period of stabilisation of coal prices; 1H – 1H stands for First Half of the year, N/A – not applicable.

Source: own study.

4. Investigating the correlation between coal prices in different markets

The next step of the analysis was to examine the correlation between steam coal prices in different markets. To this end, the linear regression method was used and the main parameter of evaluation was the coefficient of determination R^2.

Due to the fact that for many years (and most notably in the second decade of the 21st century) the European market has no longer been a trendsetter in international coal markets but instead has been affected by general trends, the first step was to correlate this index with FOB Australia coal prices (Figure 5a). A very high coefficient of determination R^2 of 0.86 was obtained. Thus, with a high degree of confidence, these correlations can be applied to determine the coal price forecast for the European market.

FOB Australia prices were also correlated with other coal suppliers to the Asia-Pacific market, namely FOB Indonesia (Figure 5b), FOB South Africa (Figure 5c) and FOB Colombia (Figure 5d). The very high correlation coefficients obtained confirm the close relationship between the prices of these coals. The obtained values of the coefficient of determination were:

- FOB Australia – FOB Indonesia: R^2 0.96;
- FOB Australia – FOB South Africa: R^2 0.98;
- FOB Australia – FOB Colombia: R^2 0.94.

The results show how important the Australian coal prices are as a benchmark for the international market. In addition, information on historical and forecast prices for this index is continuously published and publicly available on the Australian Department of Industry, Science, Energy and Resources website (DISA 2021). In addition, Australia is a very stable country economically; it is the only country in the world to annually publish prices in annual contracts for the supply of coal from Australia to Japan. For years, there has been a practice of negotiators (representing both sides) setting a single price which has then been applied to a given group of contracts for the following 12 months.

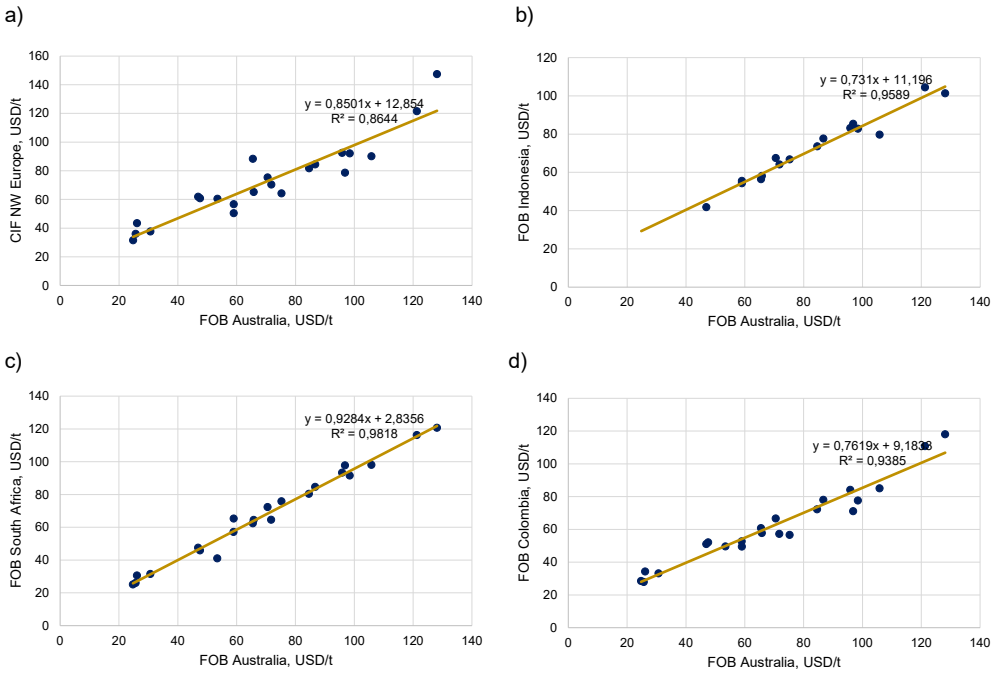

Fig. 5. Asia-Pacific market – correlation of coal index FOB Australia with coal indexes: CIF NW Europe (a), FOB Indonesia (b), FOB South Africa (c) and FOB Colombia (d)
Source: own study

Rys. 5. Rynek Azji i Pacyfiku – korelacja indeksu węgla FOB Australia z indeksami węgla: CIF NW Europa (a), FOB Indonezja (b), FOB RPA (c) i FOB Kolumbia (d)

The links shown between prices are obvious. Their differences are the result of the impact of the geographical rent on prices and the associated sea freight costs.

Although the European market (Atlantic market) no longer sets the trend for international markets, the links were was also examined between the two main suppliers of coal over the last ten yearsto ARA ports (ports located in NW Europe, i.e.: Amsterdam specifically Amsterdam–Rotterdam–Antwerp), namely Russia and Colombia (Figure 6). In this case, a very high correlation coefficient was also obtained ($R^2 = 0.98$), which indicates that Russian exporters pay considerable attention to the FOB Colombia coal price quotations.

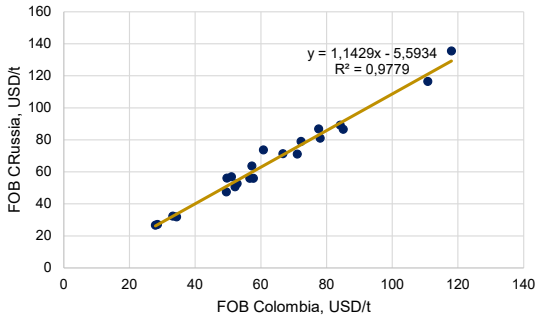

Fig. 6. Atlantic market – correlation of coal index FOB Colombia with coal index FOB Russia
Source: own study

Rys. 6. Rynek Atlantyku – korelacja indeksu węgla FOB Kolumbia z indeksem węgla FOB Rosja

The studies of correlations between individual coal prices, except for FOB Indonesia coal, referred to average annual prices in 2000–2020. In the case of Indonesian coal, prices were available from 2006 onwards.

Conclusions

The analysis of steam coal prices in international markets in the first two decades of the 21st century made it possible to highlight the following periods of price fluctuations for this commodity:

- five periods of rising prices (2000–2001, 2003–2004, 2007–2008, 2010–2011, 2016––2018);
- four periods of falling prices (2002, 2009, 2012–2015, 2019–2020);
- one period of stabilization of prices (2005–2006).

The duration of the highlighted periods of coal price fluctuations ranged from one to four years, but the most frequent period was two years.

Of course, the authors are aware that a slightly different result will be obtained when monthly prices are analyzed. However, average annual prices were deliberately calculated as

most coal supply contracts are valid for a period of one year. Besides, the conversion of prices into annual average prices offsets the effect of "momentary" trends in coal prices, which had been lost over the entire calendar year. Consequently, all other variables considered in the studies (e.g. freight costs, BDI) were also converted into annual averages.

A detailed analysis of the highlighted periods of steam coal price fluctuations in 2000––2020 made it possible to identify groups of factors that significantly affect the level of prices of the analyzed coal in the long term. Among these factors, the following had a particular impact:

- the level of demand for this commodity – in this case the implementation of the raw materials policy pursued by the world's largest importers of steam coal, i.e. China and India, is of key importance;
- the level of coal production costs, the amount of resources and their geographical distribution;
- the sea freight costs of coal, which is dependent upon the transport of other bulk commodities (Fe ore, as well as bauxite, grains and phosphate);
- environmental conditions which put stronger emphasis on the reduction of coal share in power generation – this is particularly evident in North American and European countries and translates into lower demand in these parts of the world;
- cost-price competitiveness of other energy carriers such as natural gas, LNG and crude oil;
- disruption of traditional trade flows as a result of economic and political decisions – an example of this group of factors is China which regulates its imports by means of quotas – in addition, for over a year it has imposed an informal ban on coal imports from Australia;
- the efforts of major importers to reduce coal imports as much as possible and to become as self-sufficient as possible in their own extraction of this commodity;
- falling demand for coal due to the implementation of environmental policies in countries such as South Korea and Japan, and also increased demand for this commodity in ASEAN-5 countries;
- coal quality standards and the cost of CO_2 emission allowances;
- processes that open up electricity markets, forcing a reduction in generation costs (fuel costs being one of the largest costs).

Further ad hoc factors can be mentioned which influence coal prices in international markets:

- weather (affecting both mining conditions in opencast mines and energy demand from end users – in the latter case, it has an indirect impact on the coal market through the power generation sector;
- fortuitous events defined as force majeure (natural disasters, catastrophes, and also prolonged strikes in large coal-exporting mines);
- pandemics (COVID-19 is an example) paralysing the world economy for months and reducing energy demand;

- transport limitations (both in land and maritime transport) – this group of factors may include rail disasters disrupting coal deliveries to ports in countries such as South Africa, Russia or Australia.

A study of the correlation (using linear regression) between Australian steam coal prices (FOB Australia) and those of major suppliers to the Asia-Pacific market, namely Indonesia (FOB Indonesia), South Africa (FOB South Africa) and Colombia (FOB Colom-bia), showed that Australian coal is an important benchmark for the international steam coal market. For 2000–2020, very high values of the coefficient of determination R^2 were ob-tained, which in these three pairs of coals were in the range of 0.94–0.98. However, the performed correlation for Australian coal (FOB Australia) and coal imported to NW Europe ports (i.e. ARA ports) showed strong links between this pair of coals (coefficient of determination R^2 was 0.86). Obtaining such a high correlation coefficient allows Australian coal to be used in forecasting coal prices at NW Europe ports.

A detailed analysis of fluctuations in 2000–2020 steam coal prices has shown how many factors shape the value of these indexes. Thanks to systematic analyses of not only the current coal price quotations but also the current situation in the world, it is possible to "predict/ex-pect", to a large extent, the impact of various phenomena (political devel-opments, economic developments, transport, cost, day-to-day situations, pandemics, the economic condition of individual countries, environmental decisions, etc.) on the coal price trend in the near future.

Prices in the first half of 2021 are signalling an upward trend. This may indicate a re-covery of the world economy after the first waves of the COVID-19 pandemic. However, it should be borne in mind that the world is still in the midst of this pandemic, which causes great uncertainty in the global economic situation. This is a new phenomenon and of such a long duration that its effects will continue to be felt for many years to come, and it is there-fore difficult to forecast future coal price levels.

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REFERENCES

Argus 2021 – Argus Media Ltd. [Online] https://www.argusdirect [Accessed: 2021-06-29].

BDI 2021 – [Online] https://www.balticexchange.com/en/index.html [Accessed: 2021-08-30].

BP 2021 – BP Statistical Review of World Energy 2021, 70th ed.; BP p.l.c., UK, London, June 2021. [Online] https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html [Accessed: 2021-08-15].

Coal Information 2019 – Coal Information with 2018 data; International Energy Agency, Paris, France, 2019, p. 508.

CTI Platts 2021 – CTI – Coal Trader International. S&P Global Platts (Editions from the years 2003–2021).

DISA 2021 – Department of Industry, Science, Energy and Resources. [Online] https://www.industry.gov.au/policies-and-initiatives/industry-innovation-and-science-australia [Accessed: 2021-08-30].

EIA 2021 – U.S. Energy Information Administration. [Online] https://www.eia.gov/coal/data.php [Accessed: 2021-08-30].

Global 2021 – Global Energy Monitor. [Online] https://globalenergymonitor.org/projects/global-coal-plant-tracker/summary-data/ [Accessed: 2021-06-29].

GlobalCoal 2021 – globalCOAL. [Online] https://www.globalcoal.com/ [Accessed: 2021-09-10].

ICR Platts 2021 – ICR – International Coal Report. Wyd. Platts – The McGraw Hill Companies, England (Editions from the years 2003–2013).

IHS Markit 2021 – Thermal Coal and Petcoke Marker Price Methodology and Specifications. Effective July 2021. [Online] https://cdn.ihsmarkit.com [Accessed: 2021-09-10].

Li et al. 2017 – Li, H., Chen, L., Wang, D. and Zang, H. 2017. Analysis of the Price Correlation between the International Natural Gas and Coal. *En-ergy Procedia* 142, pp. 3141–3146. DOI: 10.1016/j.egypro.2017.12.376.

Lorenz, U. 2014. *Impact of international steam coal price changes on domestic coal market* (*Ocena oddziaływania zmian cen węgla energetycznego na rynkach międzynarodowych na krajowy rynek węgla*). *Studia, Rozprawy, Monografie* 188, 138 pp., MEERI PAS (*in Polish*).

Lorenz, U. 2017. Lower quality steam coals in international trade (*Węgle energetyczne o obniżonej jakości w handlu międzynarodowym*). *Polityka Energetyczna – Energy Policy Journal* 19(3), pp. 19–34 (*in Polish*).

Lorenz, U. and Grudziński, Z. 2009. International hard coal markets (*Międzynarodowe rynki węgla kamiennego energetycznego*). *Studia, Rozprawy, Monografie* 156, 103 pp., MEERI PAS (*in Polish*).

Lorenz, U. and Ozga-Blaschke, U. 2016. The influence of changing market conditions on forecast prices of coal in international trade (*Wpływ zmieniających się warunków rynkowych na prognozowane ceny węgla kamiennego w handlu międzynarodowym*). *Przegląd Górniczy* 5, pp. 3–12 (*in Polish*).

Ozga-Blaschke, U. 2021. Dynamics of coking coal pricing in international trade in 1980–2020. *Gospodarka Surowcami Mineralnymi – Mineral Resources Management* 37(3), pp. 125–138. DOI: 10.24425/gsm.2021.138656.

Ozga-Blaschke, U. 2008. The relationships between prices of coking coal and metallurgical coke in the international markets (*Relacje cen węgla koksowego i koksu metalurgicznego na rynkach międzynarodowych*). *Polityka Energetyczna – Energy Policy Journal* 11(1), pp. 335–350 (*in Polish*).

Russia 2021a – Russian Federation: Long-term Program for Coal Sector Development until 2030. [Online] https://policy.asiapacificenergy.org/node/203 [Accessed: 2021-08-30].

Russia 2021b – Russian Federation: Long-term Program for Coal Sector Development until 2035. [Online] https://docs.cntd.ru/document/565123539 [Accessed: 2021-08-30] (*in Russian*).

Tarazanov, I. 2016. Russia's Coal Industry Performance for January–December, 2015. *Ugol* 3, pp. 58–72. DOI: 10.18796/0041-5790-2016-3-58-72 (*in Russian*).

Tarazanov, I. 2017. Russia's Coal Industry Performance for January–December, 2016. *Ugol* 3, pp. 36–50. DOI: 10.18796/0041-5790-2017-3-36-50 (*in Russian*).

Tarazanov, I. 2018. Russia's Coal Industry Performance for January–December, 2017. *Ugol* 3, pp. 58–73. DOI: 10.18796/0041-5790-2018-3-58-73 (*in Russian*).

Tarazanov, I. 2019. Russia's Coal Industry Performance for January–December, 2018. *Ugol* 3, pp. 54–69. DOI: 10.18796/0041-5790-2020-3-54-69 (*in Russian*).

Tarazanov, I. 2020. Russia's Coal Industry Performance for January–December, 2019. *Ugol* 3, pp. 64–79. DOI: 10.18796/0041-5790-2019-3-64-79 (*in Russian*).

Tarazanov, I. 2021a. Russia's Coal Industry Performance for January–December, 2020. *Ugol* 6, pp. 25–36. DOI: 10.18796/0041-5790-2021-6-25-36 (*in Russian*).

Tarazanov, I. 2021b. Russia's Coal Industry Performance for January–Mart, 2021. *Ugol* 6, pp. 27–43. DOI: 10.18796/0041-5790-2021-3-27-43 (*in Russian*).

WEO2020 – World Energy Outlook 2020. International Energy Agency, Paris, France, 462 pp.

World Bank 2021 – The World Bank – Commodity Markets "Pink Sheet" Data. [Online] https://www.worldbank.org/en/research/commodity-markets [Accessed: 2021-08-15].

Zamani, N. 2016. The Relationship between Crude Oil and Coal Markets: A New Approach. *International Journal of Energy Econom-ics and Policy* 6(4), pp. 801–805.

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PRICE TRENDS ON THE INTERNATIONAL STEAM COAL MARKET IN 2000–2020

Keywords

steam coal, trade, prices, spot market

Abstract

Approximately 95% of international trade in steam coal is concentrated in two areas: Asia-Pacific and Atlantic. Prices on the international market depend on the largest exporters and users of coal. The aim of the article is to characterize the price trends that took place in the international trade of energy coal in the years 2000–2020 and to distinguish price indices which, in the opinion of the authors, currently play an important role in this trade. The analysis of steam coal prices in international markets in 2000–2020 made it possible to highlight five periods of rising prices, four periods of falling prices, and one period of the stabilisation of prices. A detailed analysis of the highlighted periods of steam coal price fluctuations in 2000–2020 made it possible to identify groups of factors that significantly affect the level of prices of the analyzed coal in the long term. International steam coal markets are interlinked despite periodic volatility. A very important factor influencing world steam coal prices is the situation in China as it is the largest producer, user and importer of steam coal. A small change in coal production in China significantly affects the volume of trade on the international market. Therefore, the level of freight prices is an important factor influencing the price level for the customer. FOB Australia prices are also correlated with coal suppliers to the European market and Asia-Pacific market in this paper. The very high correlation coefficients obtained confirm the close relationship between the prices of these coals. For many years, the European market has no longer been a trendsetter in international coal markets but has instead been affected by general trends.

TRENDY CENOWE NA MIĘDZYNARODOWYM RYNKU WĘGLA ENERGETYCZNEGO W LATACH 2000–2020

Słowa kluczowe

węgiel energetyczny, handel, ceny, rynek spot

Streszczenie

Handel międzynarodowy węglem energetycznym koncentruje się w około 95% na dwóch obszarach: Azji-Pacyfiku i Atlantyku. Ceny na rynku międzynarodowym zależą od największych eksporterów i użytkowników węgla. Celem artykułu jest scharakteryzowanie trendów cenowych, jakie miały miejsce w międzynarodowym handlu węglem energetycznym w latach 2000–2020 oraz wyróżnienie wskaźników cen, które w opinii autorów odgrywają obecnie istotną rolę w tym obrocie. Analiza cen węgla energetycznego na rynkach międzynarodowych w latach 2000–2020 pozwoliła wyróżnić: pięć okresów wzrostu cen, cztery okresy spadku cen oraz jeden okres stabilizacji cen. Szczegółowa

analiza wyróżnionych okresów wahań cen węgla energetycznego w latach 2000–2020 pozwoliła na wyodrębnienie grup czynników, które istotnie wpływają na poziom cen analizowanego węgla w długim okresie. Międzynarodowe rynki węgla energetycznego są ze sobą powiązane pomimo okresowej zmienności. Bardzo ważnym czynnikiem wpływającym na światowe ceny węgla energetycznego jest sytuacja w Chinach, które są największym producentem, użytkownikiem i importerem węgla energetycznego. Niewielka zmiana w produkcji węgla w Chinach znacząco wpływa na wielkość handlu na rynku międzynarodowym. Dlatego poziom cen frachtu jest ważnym czynnikiem wpływającym na poziom cen u klienta. W niniejszym artykule skorelowano również ceny FOB Australia z dostawcami węgla na rynek europejski oraz rynek Azji i Pacyfiku. Uzyskane bardzo wysokie współczynniki korelacji potwierdzają ścisły związek między cenami tych węgli. Rynek europejski od wielu lat nie wyznacza już trendów na międzynarodowych rynkach węgla, lecz podlega ogólnym trendom.