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Energy terms of trade for Poland between 2005–2015

ABSTRACT: Article investigates the issue of terms of trade in energy products. The goal of this paper is to check how the terms of trade in energy fluctuate. The analysis is carried out on the example of Poland as a country which offers an interesting energy imports and exports structure. The time horizon covers the period from 2005–2015 and is extended to give the broader picture of the phenomenon wherever possible. In the research, the author uses the barter terms of trade concept. The paper has been organized in four sections. The study opens with introductory remarks presenting Polish energy situation, which is followed by a description of the terms of trade concept on the grounds of international economics. The results of the research are discussed in section three which ends with a summary and conclusions. The last part includes an additional description of study constraints and suggestions the next research steps. The statistical data used in the paper comes from national databases of the Polish Central Statistical Office and international sources such as the Organisation for Economic Cooperation and Development. Additional information on energy prices was derived from recognized branch sources such as BP Statistical Review of World Energy.

KEYWORDS: terms of trade, energy trade, energy prices

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Introduction

Energy constitutes a vital part of each economy. This is reflected in the macro, mezo and micro levels. In the macroeconomic dimension, energy plays an important role in the process of shaping GDP, both as a factor of production, but also as a component of imports or exports. In the mezoeconomic dimension, its role is visible at the level of the energy sector in general and sector's role in shaping GDP or the employment levels. This applies to every stage of the energy chain, both extraction/generation, transmission/distribution and finally its sale. In the microeconomic dimension, every enterprise in the energy sector is a market participant that maximizes profit while reducing the negative externalities associated with its operations. At the same level, the consumer optimizes their utility function from energy consumption based on his income and preferences in a liberalized energy market. For these reasons, energy is an important element of research in the field of economic sciences, including in international economics focusing mainly on the issues of international trade.

The uneven distribution of energy resources (mainly hydrocarbons) on a global scale favors the concentration of their production in selected regions. The distant location of energy consumption centers from regions rich in fuel deposits, induces trade flows. An issue that arouses particular interest in the imports or exports of energy is its prices. In most cases, attention is focused on absolute values. However, despite transparent international oil prices, prices of natural gas imported on the basis of long-term contracts (excluding spot prices) are confidential. Therefore, any research including gas prices is difficult. Nevertheless, international economics using relative categories offers tools in this area, which mitigate those problems.

The research presented in this paper uses energy terms of trade as a relative measure of international energy trade flows and its prices. An investigation is being carried out on the example of Poland. The country was chosen intentionally due to two reasons. Firstly, Poland is a significant importer of hydrocarbons. The meager domestic production of hydrocarbons does not allow for a self-sufficiency. Imported oil constitutes a vast majority of fuel used in the country and foreign natural gas prevails in the country's consumption. Secondly, Poland's rich coal deposits make the country it's exporter and a significant market player. Combined dualism in Polish energy imports and exports serve as an interesting case to investigate terms of trade. Research covers the period from 2005–2015 and wherever the time horizon extends. The empirical study is based on data stemming from the Central Statistical Office of Poland, the Organisation for Economic Cooperation and Development, the International Energy Agency and BP Statistical Review of World Energy.

The text is organized in four parts. The introduction brings in the topic and presents data assumptions with the subject, time horizon of the analysis and data sources. The second part constitutes a description of the Polish energy mix. This section offers concise information on the primary energy balance, energy exports and imports with a focus on trade balance in the case of energy commodities. The third part describes the research method. The author presents various

types of terms of trade showing their applications and limitations. The paper ends with a summary section, delineating study constraints and suggestions for next research steps.

1. Polish energy mix

Poland's energy mix is dominated by fossil fuels: coal and hydrocarbons. Coal supremacy results from the existence of rich, domestic deposits and mining tradition in the country. Despite the fact that Poland is one of the significant producers and exporters of coal in the world, its production is constantly decreasing. In 1978, coal production in Poland reached 128 Mtoe, while in 2015 – 54 Mtoe (IEA 2017). Therefore, the share of coal in the primary energy balance decreased from 79% in 1985 to 51% in 2015 (Ibidem). Cuts in coal production are the effect of global and regional policy aimed at the reduction of greenhouse gas emissions.

Self-sufficiency in coal production makes this resource basic commodity in the electricity production. In 2015, over 80% of electricity came from coal-fired power plants, out of which hard coal constituted 48% and lignite 33%. At the same time (2015) renewable energy sources (RES) enjoyed a meager 13-percent share in the Polish electricity production. The share of coal in electricity production is gradually decreasing. In 1975 and 1985 it reached 92%, in 1995 – 97%, and in 2005 – again fell to 92% (Ibidem).

Steadily decreasing coal production made Poland it's net importer for the first time in 2008. The majority of foreign coal in 2015 came from Russia (60%) and Australia (19%). In the same year the situation changed in favor of Poland and it again became a net exporter of coal (Ibidem).

Crude oil is the second most important fuel in Poland's primary energy mix. Due to the negligible domestic production (0.9 million tons – 2015), almost all of the commodity comes from

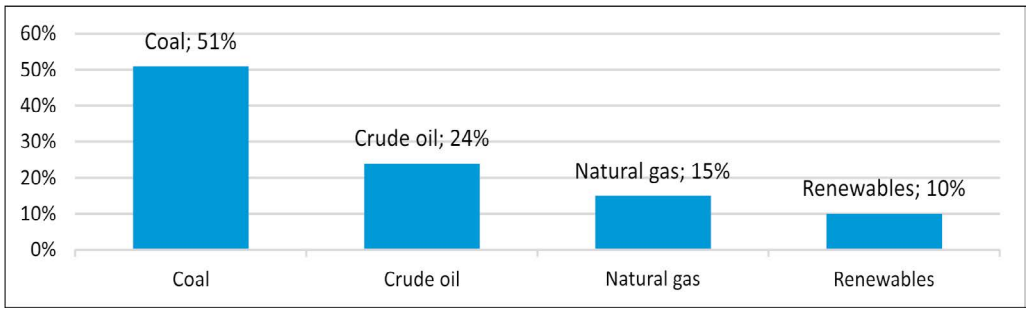

Fig. 1. Polish primary energy balance in 2015 with share of respective fuels [%]
Source: own elaboration based on IEA 2017

Rys. 1. Bilans energii pierwotnej Polski w 2015 roku według udziału poszczególnych paliw [%]

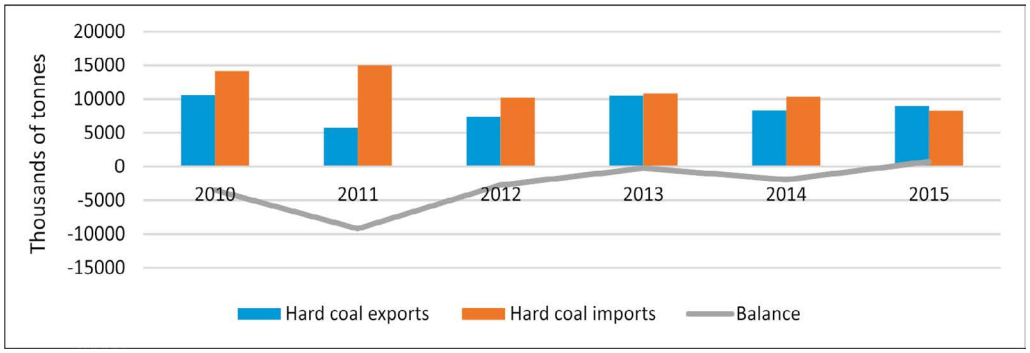

Fig. 2. Polish hard coal exports, imports and trade balance between 2010 and 2015
Only hard coal is subjected to international trade (Poland 2015: 97% of imports, 98% of exports)
Source: own elaboration based on: NETTG.PL 2018

Rys. 2. Eksport, import i bilans handlu węglem kamiennym w Polsce w latach 2010–2015.
Jedynie węgiel kamieny podlega wymianie międzynarodowej (Polska 2015: 97% importu węgla, 98% eksportu węgla)

imports (1,125.9 million tons – 2015) (GUS 2016a). The majority of imported crude oil comes from Russia (88% – 2015) (IEA 2017). Natural gas is another hydrocarbon important from the industrial point of view. The demand for this commodity is met primarily by imports (2/3 of demand, 11,458.3 mln cbm – 2015) and the remaining 1/3 (1995,5 mln cbm – 2015) by negligible domestic production (GUS 2016a). Like in oil imports, the majority of foreign natural gas is delivered by Russia (72% share in imports in 2015) (IEA 2017).

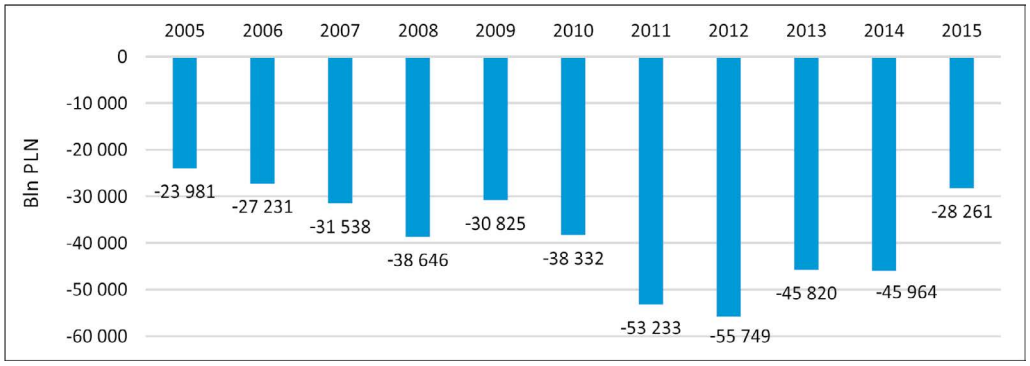

Fig. 3. Polish balance of trade in energy commodities between 2005 and 2015 (bln PLN)
From 2006 excluding natural gas
Source: own elaboration based on PIG 2018

Rys. 3. Bilans handlu energią pierwotną w Polsce w latach 2005–2015 [mld PLN]
Od 2006 roku z wyłączeniem gazu ziemnego

Looking at the balance of trade in energy commodities between 2005 and 2015, it is clear that Poland continuously records deficits. Accordingly to the Polish Geological Institute the above mentioned balance ranged between ca. PLN –24 trillion and PLN –55 trillion. This statistic does not include the cost of natural gas in the years 2006–2015. Adding natural gas import prices would deepen the deficit. In this form, the deficit is a proxy of differences between net coal exports and net oil imports.

2. Research method and results

The terms of trade constitute one of the prime tools for foreign market analysis. The terms of trade show the price relation of different goods traded internationally. This is a ratio of the index price of a nation's export to its import commodities (Salvatore 2011). This is a fundamental part of price analysis on the grounds of international economics. The significance of the terms of trade results from their influence over the balance of payments equilibrium and the division of gains from trade. They gained in importance after the World War II.

There are different types of terms of trade (Budnikowski 2006). The most popular ones include so called commodity or barter terms of trade or net barter terms of trade. They do not include services (Shrivastava 2011). As the International Monetary Fund highlights, commodity terms of trade show the "price of a country's commodity exports in terms of its commodity imports" (IMF 2016). Barter terms of trade are the most often used tool to analyze price ratios in international markets. Terms of trade take values around 100. Another type of terms of trade is called income terms of trade. This is a variation of commodity terms of trade including index of export volume. Income terms of trade measure a "country's export-based capacity to import" (Salvatore 2011). Like commodity terms of trade, index takes values around 100. However, the determinants behind such changes are more complex. Income terms of trade higher than 100 result either from growth in commodity terms of trade or exports volume. Income terms of trade are a useful tool for analysis of the trade situation in developing countries experiencing imports pressure. Single factoral terms of trade are another variation of commodity terms of trade. They include a productivity index in exporting industries. Single factoral terms of trade measure the amount of imports a nation gets per unit of domestic factors of production embodied in exports (Salvatore 2011). As in case of income terms of trade, single factoral terms of trade are a useful tool for analysis of developing nations since any their growth can be treated as a positive sign of economic advance. Double factoral terms of trade differ from single factoral terms of trade only in the inclusion of a productivity index in importing industries. Double factoral terms of trade include how many units of domestic factors embodied in nation's exports are exchanged per unit of foreign factors embodied in its imports. This type of terms of trade is rarely used and it is often presented only for the sake of completeness (Salvatore 2011).

It is worth mentioning that terms of trade literature also distinguishes other type of terms of trade called consumption and production terms of trade (Berka and Crucini 2009). Measures are constructed as a constant-share weighted averages of the logarithms of export and import prices. In consumption terms of trade Berka and Crucini (Berka and Crucini 2009) use retail prices for customers, while in production terms of trade – trade prices at the country's border. Berka and Crucini argue that consumption terms of trade display the relative price which "motivates demand shifts between home exports and imports, while production terms of trade is the relative price that effects resource allocation across the export and import-competing sectors" (Berka and Crucini 2009).

Terms of trade have been widely used to depict the situation of developing nations. They were very often compared to the terms of trade of developed countries. The Singer Preibish theory was established on this basis. Accordingly to this idea terms of trade, in the case of developing nations, constantly deteriorates against developed ones. However, this result has been challenged. Salvatore (2011) sums up few of such conclusions. Firstly, estimation of the terms of trade is sensitive to the data series used in the research. Secondly, aggregating developing nations into one group and calculating for such a unit terms of trade does not bring results coherent with those countries' individual terms of trade. This is a consequence of differences in developing nations' exports structure. Even though it may seem that they are exporting commodities, some of them, like oil experience huge price increases. Thirdly, presenting more advanced terms of trade for developing nations, as for instance factorial terms of trade, is difficult due to the lack of data showing productivity.

Commodity terms of trade have been carefully examined due to the role of energy resources. One of such papers includes the study of the IMF (2009), in which the authors assess commodity booms and busts and their impact over macroeconomic performance with the use of long and broad data sets*. The data covers a time span of 40 years and terms of trade in 150 countries. Authors deliver, among other conclusions connected with the impact of the terms of trade on economic growth, following conclusions referring to commodity terms of trade. Firstly, commodity price booms are larger than busts. Secondly, "1/3 of all booms (busts) are followed by busts (booms) and the larger the boom, the larger the subsequent bust" (IMF 2009). A closer look at the country specific behavior reveals some differences which pertain either to the country's export structure or standard terms of trade. The former is observed on the example of differences among fuel-, non-fuel- and other commodities exporters. To understand those differences it is essential to capture the characteristic of the exported goods set in each group of countries. While fuel covers the export of energy commodities, non-fuel includes metals (e.g. copper) and the general commodities group refers to agricultural products (e.g. sugar). As it could have been expected, commodity terms of trade and standard terms of trade indices follow each other and the price of oil in the group of fuel exporters. In contrast, non-fuel commodity exporters throughout the period of 1970–2007 enjoyed standard terms of trade higher than commodity terms of trade.

* Since this paper does not include the influence that the terms of trade exhibit over macroeconomic performance, this perspective of the IMF paper is here omitted.

The lowest standard terms of trade in this group reached values of 110 and was noted at the beginning of the 1990s. These values constituted record high estimates for commodity terms of trade observed in non-fuel exporters at the beginning of the 1970s and the late 1980s. The group of non-commodity exporters exhibits large qualitative differences between both indices on the one hand and their relative stability depicted by low variation in absolute terms on the other.

Terms of trade are also often used as a general tool for presenting country's price standing in international markets. They are often quoted in the form of barter terms of trade. They can be found in every nation's statistical office. Terms of trade can also be presented on an industry level. Paper by Backus and Crucini (1998) delivers such perspective and proves that between 1972 and 1987 oil prices accrued for much of the terms of trade variation. Therefore, such a perspective is delivered for the Polish market.

Since 1990 barter terms of trade (hereinafter: terms of trade) for Poland have reached levels between 93 or 103. This means that Poland enjoys a relatively balanced structure of exports and imports. Exceptionally low terms of trade were observed in 1991 amounting to 86. That was a consequence of the economic transformation, eliminating energy-intensive industries and reduced exports. Similar situations took place in other post-communist economies at that time. In the case of Hungary, barter terms of trade reached the value of 76, Lithuania 78 (1995 – first available data series by OECD) and Estonia 76 (1993 – first available data series by OECD) in 1991 (OECD 2018). The terms of trade value for Poland reflects the structure of traded products and services along with their prices. In Polish trade categories including: machinery, vehicles, furniture, plastics and meat prevail. Both exports and imports are dominated by consumer and capital goods (World Bank 2018).

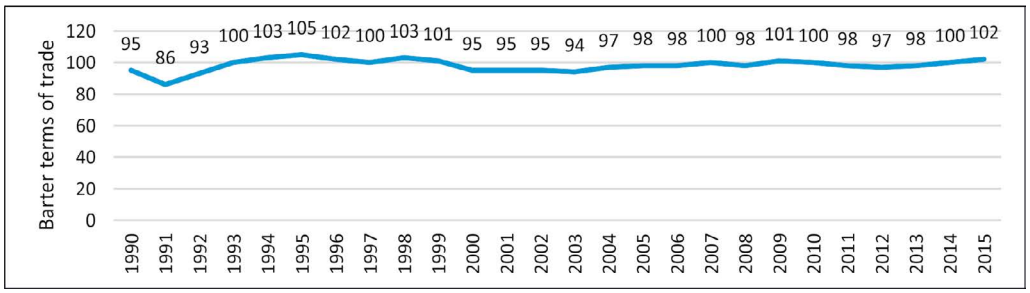

Fig. 4. Barter terms of trade for Poland in 1990–2015
Source: own elaboration based on OECD 2018

Rys. 4. Towarowe *terms of trade* (relacje wymienne) dla Polski w latach 1990–2015

Terms of trade for energy products are presented using Polish Central Statistical Office data.

Energy prices statistics have been aggregated to the level of the third SITC section (SITC – standard international trade classification) by the United Nations. Energy is understood as a category including: mineral fuels, lubricants and derived materials. It consists of coal, briquettes, crude oil and petroleum products, natural gas and electricity. The aggregation of data at such

a high level results from the possibility of its comparison with existing data on prices in international trade. The Central Statistical Office provides terms of trade, among others for the SITC category, but without distinguishing individual types of energy. There is no distinction between primary and secondary energy or individual fuels (gas, oil). The adoption of such reasoning in the case of Poland seems to properly reflect the prices of exported and imported raw materials. The structure of energy imports is dominated by hydrocarbons and related products, while in export (in selected years), it is dominated by coal. The share of electricity in the structure of Poland's supply and demand for energy is marginal (IEA 2017). Hydrocarbons have a significant position in Polish imports and only in 2015 more than half of the value of imports was accrued to oil, and 1/5 – to natural gas (IEA 2017). Terms of trade for energy products are hereinafter referred to as energy terms of trade. Energy terms of trade constitute an index in constant prices with a base = 100 in each previous year.

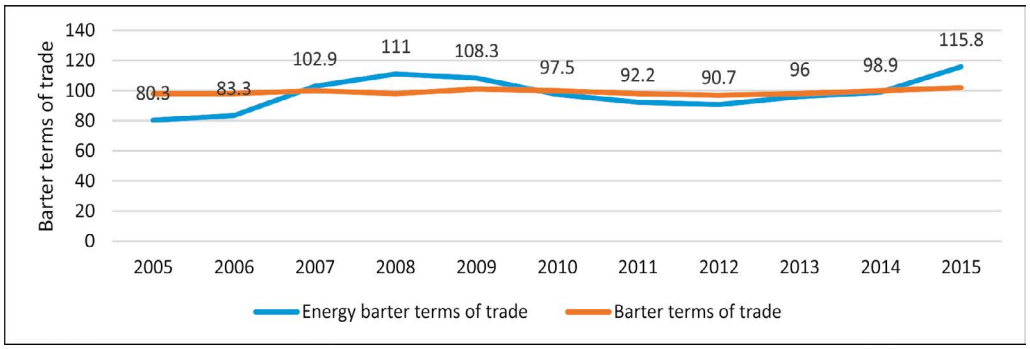

Fig. 5. Barter terms of trade and energy barter terms of trade for Poland in 2005–2015
Source: own elaboration based on OECD 2018 and GUS 2017, 2016b, 2013

Rys. 5. Towarowe *terms of trade* (relacje wymienne) i towarowe terms of trade (relacje wymienne) w handlu energią dla Polski w latach 2005–2015

To depict the relationship between exported coal and imported hydrocarbons, terms of trade is presented against oil and coal prices. Crude oil prices are a proxy of imported hydrocarbons prices. That refers both to crude oil and petroleum products along with natural gas, which is indexed in long-term contracts on the basis of oil prices. Crude oil and coal prices data were derived from the BP Statistical Review of World Energy 2017. They are presented in the value of USD of the day and additionally – of the year 2016 per each oil barrel. Coal prices are depicted by European coal marker price in USD per ton, called Northwest coal Europe marker price.

Terms of trade for the category of mineral fuels, lubricants and derived materials of Poland in the period 2005–2015 varied from 80.3 to 115.8. The least favorable price ratios were maintained between 2005–2006 and 2010–2012. The latter resulted from significant imported oil prices increase. In 2010, Poland paid USD 77.9 for a barrel of imported oil, a year later – USD 109.6, and in 2011 – USD 111 following the global trend (OECD 2018). This period coincides

with a decrease in coal prices on the global markets, which started in 2011. Coal is Poland's main energy export product. Simultaneously increasing or slightly insignificantly changing prices of imported goods combined with decreasing exports prices deteriorated Poland's energy terms of trade. The reverse trend started in 2014 with the drop in oil prices. At that time prices of coal in global markets remained relatively unchanged. All together that improved Polish energy terms of trade. Interestingly, Polish energy terms of trade reached one of the highest values (apart from 2015) between 2005 and 2015 in the year 2011 with record high coal prices.

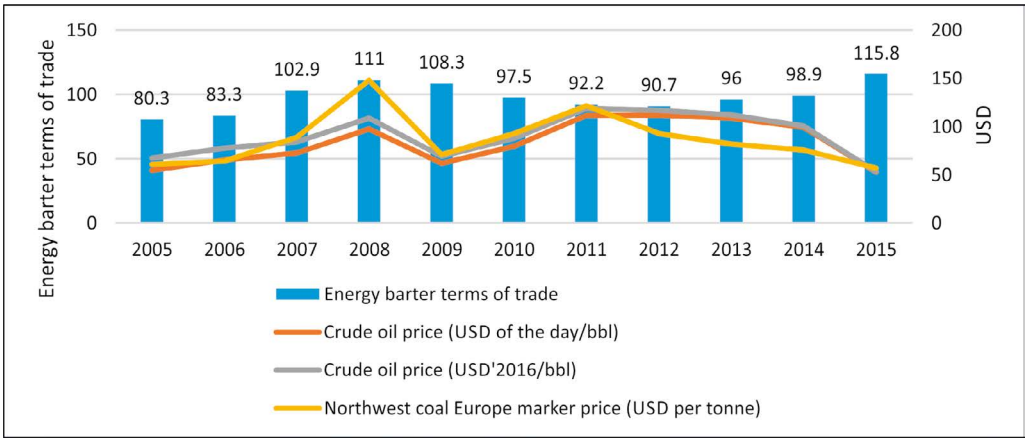

Fig. 6. Energy barter terms of trade for Poland, crude oil prices (USD of the day/bbl and USD' 2016) and Northwest coal Europe marker price (USD per ton) in 2005–2015
Source: own elaboration based on and GUS 2017, 2016b, 2013 and BP 2017

Rys. 6. Towarowe *terms of trade* w handlu energią dla Polski, ceny ropy naftowej (USD ceny bieżące/baryłka i USD'2016) i cena węgla w Europie (Northwest coal Europe marker price, USD/tona) w latach 2005–2015

Summary and conclusions

Terms of trade are a tool from international economics used to compare prices of traded goods. Literature distinguishes various types of terms of trade. There are: barter, income, single and double-factoral terms of trade. Basis of the measure always constitutes export and import price index. It includes, respectively, additional measures of export volume, productivity in a country's exporting industries and its comparison with productivity in a country's importing industries. The most suitable form for analysis of developed economies are barter terms of trade.

Looking at Polish barter terms of trade between 1990–2015 proves that the country's exchange relations were mostly favorable. The index moved around 100 with exception to years following economic transformation. Using terms of trade in the SITC category including: coal, briquettes, crude oil, petroleum products, natural gas and electricity seems to be a good proxy of

energy exports and imports for Poland. Negligible trade in electricity makes this category almost pure measure of price relation depicting hydrocarbon imports and coal exports. Therefore, the author suggests to delineate barter terms of trade in this SITC category for Poland as so called "energy terms of trade". Describing barter terms of trade in coal, briquettes, crude oil, petroleum products, natural gas and electricity might be replaced with phrase "energy terms of trade" as it depicts the same product group. Using such nomenclature facilitates research.

Energy terms of trade for Poland were more volatile than terms of trade in general in the same 2005–2015 period. The index reached values between 80 to 115. The least favorable price ratios were maintained between 2005–2006 and 2010–2012. Increases in terms of trade were mainly driven by either surging coal prices (2008) or combination of slightly changed coal and significant drops in oil prices (2015). It proves that even though Poland from time to time assumes the role of a net coal importer, coal prices still meaningfully affect energy terms of trade.

Like any study, the analysis presented in this article has its research limitations. They are conditioned by sampling and data availability. Since the study presents only Poland, conclusions for other countries may differ. In this sense they would be highly contextual with a strong dependence on the individual energy situation. Nevertheless, replacing the SITC category showing barter terms of trade including coal, briquettes, crude oil, petroleum products, natural gas and electricity with a term "energy terms of trade" seem to be a conclusion of general application. Data availability and the way Poland's Central Statistical Office gathers and presents data do not allow for a deeper analysis of the period of the 1990s.

Results presented in this study may be complemented by further analysis including other Central and Eastern European countries with a similar energy situation.

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Terms of trade (relacje wymienne) Polski w handlu energią w latach 2005–2015

Streszczenie

W artykule zbadano zagadnienie *terms of trade* (relacje wymienne) handlu produktami energetycznymi. Celem pracy jest sprawdzenie, w jaki sposób kształtowały się relacje wymienne Polski w handlu energią. Analizę przeprowadzono na przykładzie Polski, ponieważ kraj odznacza się interesującą strukturą importu i eksportu energii. Horyzont czasowy obejmuje okres 2005–2015 i tam, gdzie było to możliwe, został rozszerzony tak, aby dać szerszy obraz badanego zjawiska. W opracowaniu autor stosuje koncepcję barter *terms of trade*. Tekst został podzielony na cztery części. Badanie rozpoczyna się od wstępnych uwag przedstawiających sytuację energetyczną Polski, po czym następuje opis pojęcia *terms of trade* na gruncie międzynarodowej ekonomii. Wyniki badań omówiono w części trzeciej, która kończy się streszczeniem i wnioskami. Ostatnia część zawiera dodatkowo opis ograniczeń badania i sugestie dotyczące kolejnych

kroków badawczych. Dane statystyczne wykorzystywane w pracy pochodzą z krajowych baz danych Głównego Urzędu Statystycznego i źródeł międzynarodowych, takich jak Organizacja Współpracy Gospodarczej i Rozwoju. Dodatkowe informacje na temat cen energii uzyskano z uznanych źródeł branżowych, takich jak BP Statystyczny Przegląd Światowej Energii.

SŁOWA KLUCZOWE: warunki handlu, handel energią, ceny energii