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SUPPLY AND DEMAND SITUATION AND PRICES ON THE GLOBAL AND POLISH SUGAR MARKET

ŁUKASZ CHMIELEWSKI

Abstract

The aim of the paper is to present the global and Polish sugar balance and the price situation. Several issues have been given particular attention. Firstly, the relationship between the production of sugar and bioethanol in Brazil and world sugar prices. Secondly, the relationship between Brazilian sugar and bioethanol exports and world sugar prices. Thirdly, the relationship between sugar prices in Poland and the world ones when the market support mechanisms at the EU level are in force and after they expire. The study used data from Statistics Poland, USDA-FAS, FAOSTAT, OECD-FAO, to name a few, and was based on correlation and linear regression analysis, as well as the Herfindahl-Hirschman index. The data analysis showed a statistically significant correlation between the production and exports of sugar from Brazil, as well as between Brazilian exports and world sugar prices. The analysis also showed a greater correlation between food prices than sugar and oil price quotas. A much greater correlation was also observed between the selling and retail prices of sugar in Poland and the world sugar prices after the abolition of sugar production quotas and minimum prices for sugar beet in the EU, as compared to the period of application of the support mechanisms.

Keywords: sugar, sugar price relations, sugar exports.

JEL codes: C10, D40, D20.

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Introduction

The European Union protects its internal market with a system of high customs duties. At the same time, it is departing from sectoral support, putting an end to various types of mechanisms supporting production or exports. Sugar market was one of the most strictly regulated in the EU, but the 2006-2010 reform and the abolition of production quotas and minimum prices for sugar beet in 2017 made this industry more dependent on the international situation, both in the case of surplus utilization and meeting internal demand. In such a situation, it seems important to trace the key trends on the global sugar market which is highly concentrated, with Brazil having the dominant position in the geographical system. Therefore, the situation in this country should have an impact on the global market, and indirectly on the situation in Poland. In the case of Poland, it is also worth noting the issue of the impact of the cessation of sectoral support in the EU on the dependence of domestic and world prices. Excessive sugar consumption is associated with an increased risk of many diseases, which is why many countries decide to introduce special taxes. At the same time, we can observe the changing structure of consumption, which is dominated by the consumption of processed products. Poland is one of the countries with a very high sugar consumption in the world. The aim of the paper is to present the supply and demand situation in Poland and in the world, as well as to analyze the price relationship.

The analysis covered the period of 2000-2020 and used data from Statistics Poland, USDA-FAS, FAOSTAT, OECD-FAO, and others. The study was based on the analysis of correlation and linear regression to determine the price relationship. In the case of the concentration study, the Herfindahl-Hirschman index (HHI) was used.

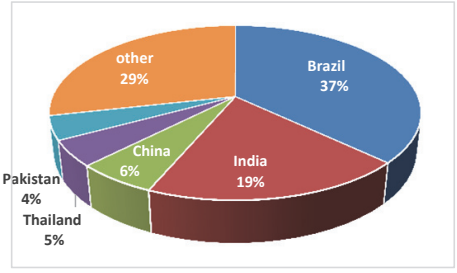
Production of sugar cane, sugar beet and sugar in the world

On an industrial scale, sugar is made from sugar cane and sugar beet. Cane sugar was obtained in antiquity in Asia, but the development of its production is associated with the discovery of the New World and slave trade (Orlewski, 1974; Sheridan, 1974; Shafer, 2001). In turn, the procedures for refining sugar from sugar beet, developed at the end of the 18th century by Franz Karl Achard, enabled the opening of the first sugar factory in Europe in Konary in Silesia in 1802, which resulted in the popularization of the use of this raw material which locally replaced cane (Grzybowski, 1912; Mintz, 1986).

In the world cultivation of sugar beet and sugar cane, there are different tendencies in the long term (Szajner and Hryszko, 2013). Between 2000 and 2019, the world area of sugar cane cultivation increased by 1.7% annually, and the yields by 0.6%. Consequently, its harvest increased to 1.95 billion tonnes and was 55.6% higher than in 2000. At the same time, beet harvest increased by 11.3% to 278.5 million tonnes, which was due to the shrinking acreage (the average annual rate was -1.4%) and increasing yield, on average by 2.0% per year (Table 1).

Sugar cane is grown primarily in Asia and South America, and its plantations are mainly located in Brazil, India, China, Thailand, and Pakistan. In Brazil, sugar cane is used for both sugar and bioethanol production, with less raw material going to sugar factories than to refineries. Sugar beets, on the other hand, are grown mainly in Europe, as well as in the USA and Turkey. Cane crops are more concentrated than beet crops (Figure 1).

a) geographical structure of sugar cane crops, 2000-2019 median



b) geographical structure of sugar beet crops, 2000-2019 median

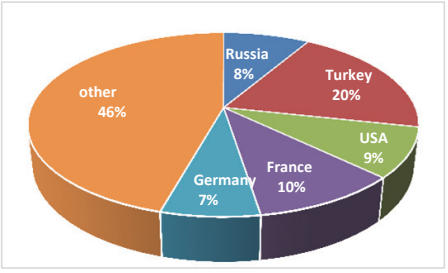


Fig. 1. Structure of sugar cane and sugar beet crops in the world.
Source: author's own study based on data from FAOSTAT.

Table 1

World production of sugar cane and sugar beet

Description	Unit	2019	2019 (2000=100)	Average annual dynamics (%)
Cultivation area				
sugar cane	million ha	26.8	138.1	1.7
sugar beets	million ha	4.6	76.7	-1.4
Yields				
sugar cane	t/ha	72.8	112.6	0.6
sugar beets	t/ha	60.4	145.1	2.0
Harvest				
sugar cane	million t	1,949.3	155.6	2.4
sugar beets	million t	278.5	111.3	0.6

Source: as for Figure 1.

Due to the structure of the raw material base, global production is dominated by cane sugar. From 2000-2019, its share in total production ranged from 72.0 to 80.9%, showing a slight upward trend at the same time. In the analyzed period, the production of cane sugar increased by 33.8% (by 1.5% on average annually) to 125.9 million tonnes, and the amount of beet sugar produced increased by 8.1% to 39.6 million tonnes (0.4 % annually on average). However, the total sugar production increased by 23.6% to 181.9 million tonnes (an average of 1.2% annually). The largest producers in the world are Brazil (about 30 million tonnes), India (about 28 million tonnes), the EU

(about 16 million tonnes), Thailand (about 10 million tonnes), and the USA (about 8 million tonnes), where quantity of sugar produced is subject to large annual fluctuations in Asian and South American countries. The largest EU producers are France (approx. 5 million tonnes), Germany (approx. 4 million tonnes), and Poland (approx. 2 million tonnes). The share of the three countries in the EU production is around 68%.

The forecast for 2020-2029 assumes a 15% increase in global sugar production to 203 million tonnes. As much as 96% of the increase will be generated by developing countries. The annual growth rate will amount to 1.4% (against 0.8% in the decade preceding the forecast period). In nominal terms, sugar prices are set to rise by 2% annually due to the expected slightly tighter global sugar balance than in the previous decade. Sugar cane will remain the main production raw material. Sugar factories will receive 75% of the harvest, in the case of beet it will be 96%. The rest will be used for bioethanol (OECD-FAO, 2020). The latest research has shown that the business cycle on the global sugar market has shortened by half, i.e., to 2-3 years (Szajner, 2019).

World consumption and foreign trade of sugar

The World Health Organization (WHO) recommends that the daily intake of calories from sugar should not exceed 10%. This applies to both naturally present sugars (honey, fruit juice) and sugars in processed products (sweetened with sugar, isoglucose, etc.). Reducing the energy dose from sugars to 5% is expected to bring additional positive health effects (Tigerstrom von, 2012; WHO, 2015; WCRFI, 2017). Studies have shown that excessive sugar consumption is associated with obesity, type 2 diabetes, and tooth decay (Ismail, Tanzer, and Dingle, 1997; McGill, 2014; Clifford and Maloney, 2016). A lot of countries around the world have introduced a special sugar tax on sweetened drinks to reduce sugar consumption, others are planning such solutions (APHA, 2012; Falbe et al., 2016; Sánchez-Romero et al., 2016; Thornton, 2017; WHO, 2017; 2019). The effective tax amount is 20% (World Bank, 2020). The factors will adversely affect sugar consumption in the future. On the other hand, growing population and income growth are the primary factors influencing increase in sugar production (OECD-FAO, 2020).

Sugar as a sweetener is used both in households and in the food industry, as well as in other sectors of the economy. The dynamics of world sugar consumption is slightly lower than that of production (the average annual rate from 2000-2020 was 1.5%, 0.2 pp less than production), it is also subject to smaller fluctuations, which proves the demand low price and income elasticity. In the analyzed period, sugar consumption increased by 33.8% to 174.5 million tonnes. Due to the relatively globally balanced market (the level of production and consumption does not differ significantly on an annual basis), high sugar stocks are maintained, which from 2000-2020 increased by 70.5% to 65.3 million tonnes (the average growth rate was 2.7%). Closing stocks account for about 18-34% of consumption (median 26.2%), while it is worth noting that in the analyzed period, they were historically low from 2008-2011 (only 18-19%), which can be associated with the global economic crisis and high sugar prices.

Per capita, the average annual balance sheet sugar consumption in the world from 2017-2019 was 22.5 kg and is expected to increase over the next decade to 23.5 kg/capita, with continued large regional differences, as it amounts to 36.7 kg/capita in Europe, North America 31.0 kg/capita, Asia 18.6 kg/capita, and in Africa 16.8 kg/capita (OECD-FAO, 2020). The greatest amount of sugar is consumed in Asia (49%) and Europe (16%). The countries with the highest consumption are: India (about 26 million tonnes), China (16 million tonnes), Brazil and the USA (about 10 million tonnes each), and the EU (17 million tonnes) (Tables 2 and 3).

In the long term, global consumption of sugar will grow by 1.4% annually until 2029, reaching a volume of 199 million tonnes. The growth will only be achieved by developing countries (by 1.9% annually), and their share in global consumption will increase by 4 percentage points up to 77%. On the other hand, in developed countries, consumption is expected to stabilize with a tendency to decline (the average annual rate will be -0.03%) (OECD-FAO, 2020).

Table 2

Changes in the world sugar balance

Description	Unit	2020	2020 (2000=100)	Average annual dynamics (%)
Initial stocks	million t	46.2	123.5	1.1
Production	million t	181.9	139.1	1.7
Import	million t	54.5	135.0	1.5
Consumption	million t	174.5	133.8	1.5
Export	million t	65.3	170.5	2.7
Closing stocks	million t	42.8	107.4	0.4

Source: author's as for Figure 1.

Table 3

Supply and demand situation on the world sugar market

Description	2017/2018	2018/19	2019/2020	2020/2021
Initial stocks	42.6	52.1	53.2	46.2
Production	194.3	179.3	165.5	181.9
Import	54.2	52.0	51.7	54.5
Consumption	173.8	173.2	170.9	174.5
Export	65.1	57.1	53.3	65.3
Closing stocks	52.1	53.2	46.2	42.8
Closing stocks of consumption (%)	30.0	30.7	27.1	24.5

Source: author's own study based on data from ERS-USDA and USDA-FAS PS&D.

Global sugar trade is subject to many regulations, with some countries still applying various types of subsidies at the level of production or export and customs tariffs (Larson, Borrell, 2001; Hudson, 2019). Approximately 32% of production is the subject of world trade, with this share ranging from 29 to 35% between 2000 and 2020. Both import and export are dominated by raw sugar. The share of raw sugar in global export oscillated between 58 and 78%, and in the case of imports it was 53-65%. The greater "popularity" of raw sugar results from the specificity of the industry, which is based on the import of nominally cheaper raw sugar (containing molasses that dyes it brown, which additionally gives it a specific taste) and cleaning it in refineries in the importing country. Exporting countries also often do not have adequate technological facilities to produce white sugar and infrastructure for its transport, which causes inefficiency of transport and may lead to a deterioration of the product quality.

Between 2000 and 2020, world sugar exports increased by 70.5% to 65.3 million tonnes, and the average annual rate of the change was 2.7%. On the other hand, the export of raw sugar increased by 102.8% to 42.8 million tonnes (by an average of 3.6% annually), and the export of white sugar increased by 30.8% to 22.5 million tonnes (by an average of 1.4% annually). The volume of world export is strongly related to production, as shown by the high correlation (R=0.95) and linear regression index (R^2=0.89).

In the same period, world sugar import increased by 35.0% to 51.7 million tonnes, and the average annual rate of change amounted to 1.5%. On the other hand, the import of raw sugar increased by 32.1% to 37.6 million tonnes (by an average of 1.4% annually), and import of white sugar increased by 41.9% to 16.9 million tonnes (by an average of 1.8% annually). The volume of world import is quite strongly related to production (correlation: R=0.86, linear regression: R^2=0.75).

In geographical terms, world sugar export is concentrated in South America and Asia, with Brazil and Thailand having the largest share in exports. Other large exporters are: India, Australia, Guatemala, Mexico, South Africa, and the EU. The reform of the EU sugar market in 2006 resulted in a change in world trade, and the EU turned from an exporter to a net importer. The abolition of production quotas and minimum sugar beet procurement prices in 2017 improved the EU foreign trade balance in sugar (EU-AO, 2020).

The main importers of sugar are Asian countries (Indonesia, China, South Korea, Bangladesh, Malaysia) and African countries (Algeria, Morocco, Nigeria), as well as the EU, the USA, Saudi Arabia, and the United Arab Emirates, i.e., countries with a large population and no own production (Table 4).

Table 4

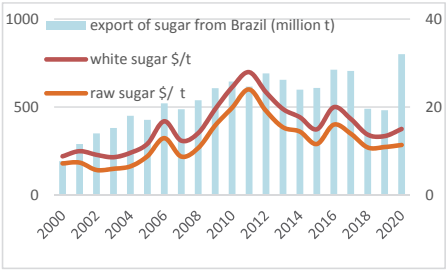
World sugar exporters and importers

Importers	million tonnes 2016/17-2020/21median	Exporters	million tonnes 2016/17-2020/21 median
Indonesia	4.8	Brazil	28.2
China	4.4	Thailand	7.3
USA	2.9	India	4.7
Bangladesh	2.4	Australia	3.6
Algeria	2.3	Guatemala	2.0
Malaysia	2.0	EU	1.5
South Korea	1.9	Mexico	1.3
UAE	1.9	RPA	1.0
Nigeria	1.9	Columbia	0.8
Saudi Arabia	1.4	Russia	0.6

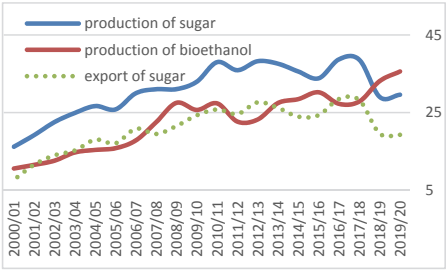
Source: as for Table 1.

Brazil's dominant position as a producer and exporter of sugar in the global market leads to a conclusion that export from this country has an impact on world prices. From 2000-2019, the level of sugar export from Brazil showed a large impact on the quotations of white sugar prices, which was confirmed by a statistically significant correlation (correlation: R=0.74, linear regression R^2=0.54). The share of export in production was approximately 66% during the period analyzed, with a range between 47% and 74%, showing a tendency to increase. Statistically similar values were observed in the case of Brazilian raw sugar exports and the stock exchange quotations of raw sugar prices, and the reasons for their slightly lower values can be found in the effect of the statistical base (correlation: R=0.71, linear regression R^2=0.50). Raw sugar export in the analyzed period accounted for from 71 to 88% of total sugar exports from Brazil, showing an upward trend, while in the last decade it amounted to an average of 80%. The data analysis also showed statistically significant relationships between the total sugar production in Brazil and the stock exchange prices for raw sugar (correlation: R=0.80, linear regression R^2=0.65), and for white sugar (correlation: R=0.83, linear regression R^2=0.69). A stronger correlation between price quotations and the level of production than export prove the decisive role of the supply situation in shaping prices (Figure 2).

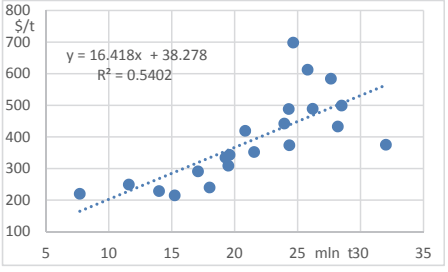
a) total sugar export from Brazil and raw and white sugar prices (ICE), 2000-2020



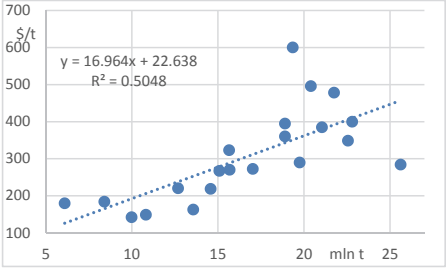
b) production of sugar (and its export) and bioethanol in Brazil, 2000-2020, million tonnes



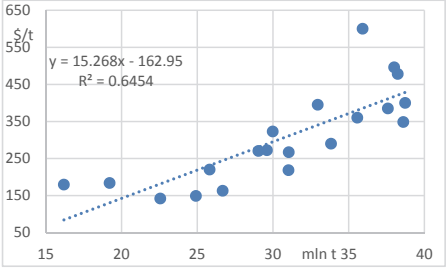
c) relationship of total sugar export from Brazil and quotations of white sugar prices (ICE), 2000-2019



d) relationship of raw sugar export from Brazil and its price quotations (ICE), 2000-2019



e) relationship of sugar production in Brazil and quotations of raw sugar (ICE), 2000-2019



f) relationship of sugar production in Brazil and quotations of white sugar prices (ICE), 2000-2019

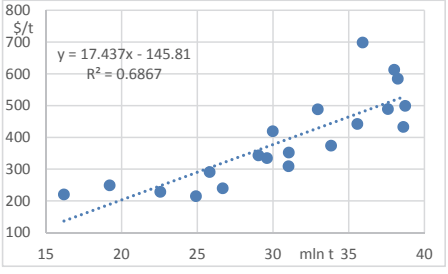
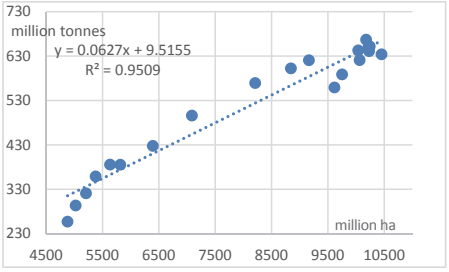


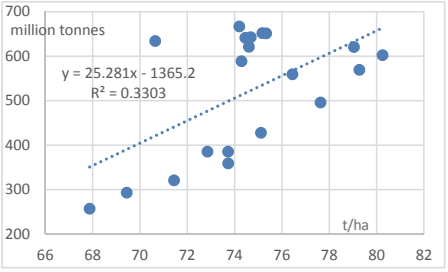
Fig. 2. Sugar and bioethanol production, sugar exports from Brazil and its relationships to quotations.
Source: author's own study based on data from ERS-USDA and USDA-FAS PS&D.

It is worth noting that the amount of sugar cane harvest in Brazil is primarily influenced by cultivation acreage (correlation: R=0.97, linear regression R^2=0.95). Yields do not show a statistically significant impact, and this is due to their relatively small fluctuations (coefficient of variation: V=4.2%). It is similar in the production of sugar and bioethanol, with a greater dependence in the production of bioethanol than sugar (correlation: R=0.91 and R=0.85, respectively; linear regression: R^2=0.85 and R^2=0.74, respectively) (Figure 3).

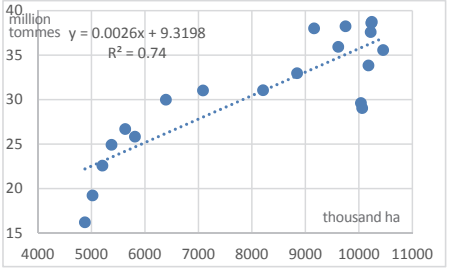
a) relationship of sugar cane cultivation acreage and its harvest in Brazil, 2000-2019



b) relationship of sugar cane yieds and its harvests in Brazil, 2000-2019



c) relationship of sugar cane cultivation acreage and sugar production in Brazil, 2000-2019



d) relationship of sugar cane cultivation acreage and bioethanol production in Brazil, 2000-2019

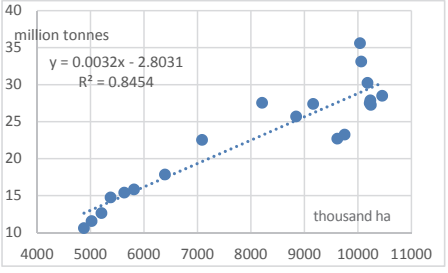


Fig. 3. Cultivation acreage and harvest of sugar cane and its relation to the production of sugar and bioethanol.

Source: as for Figure 2.

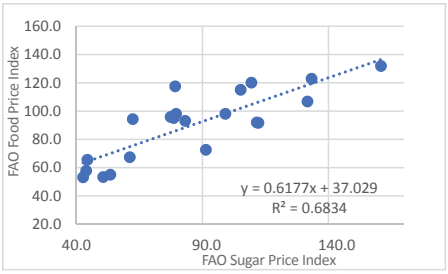
World sugar prices

Sugar is traded on both the spot and futures markets. Due to the nature of spot transactions that are commercially confidential, futures contracts determine prices. Representative sugar quotations on the futures market are Contract No. 11 for raw sugar on the ICE exchange in New York, and Contract No. 5 for white sugar on the ICE exchange in London. White sugar is more expensive than raw sugar because its prices include a refining margin. The difference in price between the quotation of white sugar and raw sugar is referred to as the white sugar premium. The change in the amount of the premium reflects the demand and supply for both types of sugar as well as the current refining possibilities.

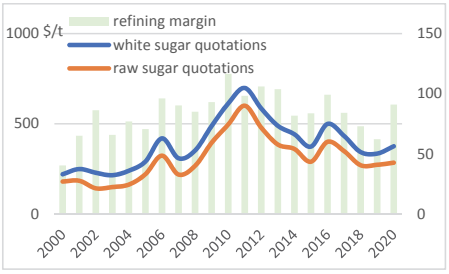
A lot of factors influence world food prices. The most important include the share of inventories in consumption and oil prices, exchange rate differences (Baffes and Dennis, 2013), income growth, climate change, globalization, and urbanization, as well as changes in consumption patterns and the impact of retail sales policy (Braun von, 2007). The impact of energy prices on food is related to the growing share of biofuel production from food raw materials (Baek and Woo, 2009; Nonhebel, 2012; Subramaniam, Masron and Azman, 2019). According to Engel's law, the demand for

food is strongly dependent on income, and with the income growth the flexibility of food spending decreases (Muhammad, Seale Jr., Meade and Regmi, 2011; Femenia, 2019), while in developed countries the demand for food differs for different products, and sugar and sweets belong to the group with the lowest consumption flexibility (Andreyeva, Long, and Brownell, 2010). In turn, given the demand for non-food products, the demand for food is inelastic (Podkaminer, 2017). The volatility of food prices is mainly influenced by the supply and demand situation and stock market speculations, as well as financial crises and energy prices (Tadesse, Algieri, Kalkuhl and Braun von, 2014).

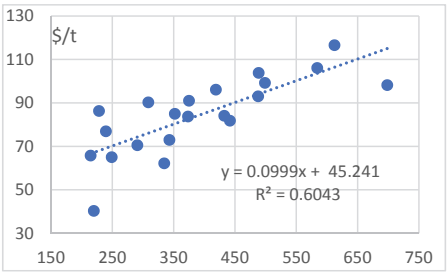
a) relationship of the FAO Sugar Price Index and FAO Food Price Index, 2000-2020



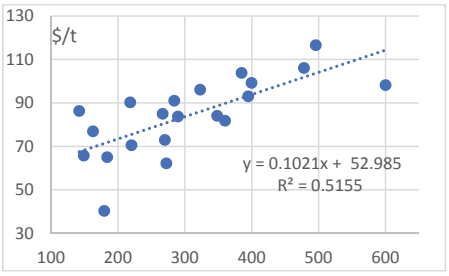
b) white and raw sugar (ICE) quotations and refining margin, 2000-2020



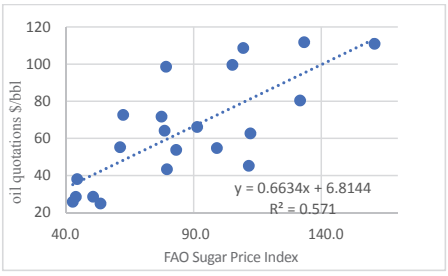
c) relationship of white sugar quotations and refining margin (ICE), 2000-2020



d) relationship of raw sugar quotations and refining margin (ICE), 2000-2020



e) relationship of the FAO Sugar Price Index and oil quotations, 2000-2020



f) relationship of the FAO Food Price Index and oil quotations, 2000-2020

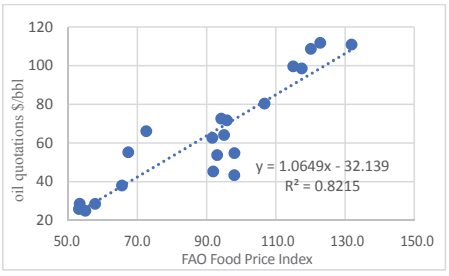


Fig. 4. World sugar prices and refining margin, FAO Sugar and Food Price Indices.
Source: as for Figure 2.

From 2000-2020, world sugar prices showed high volatility. In annual terms, the prices of white sugar ranged from USD 214 to USD 698 per tonne (coefficient of variation: V=34.9%), and for raw sugar from USD 142 to USD 600 per tonne (coefficient of variation: V=40.2%). Sugar prices showed similar trends to change as food prices, which is well illustrated by the FAO Food Price Index and the FAO Sugar Price Index (correlation: R=0.83, linear regression: R^2=0.68)[1]. The analysis showed a greater dependence of food prices (correlation: R=0.91, linear regression: R^2=0.82) than of sugar prices (correlation: R=0.76, linear regression: R^2=0.57) on oil prices, which may be related to energy inputs in individual branches of the food industry and the specificity of logistics.A statistically significant relationship was also noted between sugar quotation and refining margin, with a slightly stronger relationship observed in the case of white sugar (correlation: R=0.78, linear regression R^2=0.60) than in the case of raw sugar (correlation: R=0, 72, linear regression R^2=0.52).

Cultivation of sugar beet and sugar production in Poland

From 2000-2020, the Polish sugar industry was most influenced by integration with the EU (2004), the reform of the EU sugar market (2006-2010) and the complete abolition of sectoral support at the EU level (final elimination of sugar production quotas and minimum prices for sugar beet in 2017). In Poland, there is national support – payment to the sugar beet cultivation area, which is determined annually by the ordinance of the Ministry of Agriculture and Rural Development. As a result, the sugar industry in the country ceased to be constrained by low production limits, but it became more closely related to the supply and demand situation in the EU and in the world. There are currently 17 sugar factories in Poland owned by four concerns: three foreign (German) and one domestic which is a state-owned company. In the 2009/2010 season (the last season of British Sugar Oversees operations in the country[2]) the Herfindahl-Hirschman index (HHI) was 2,509. In the 2020/2021 season, according to author's own calculations of market shares based on the cultivation area and biological yield, the HHI is 2,982, which confirms the development of the concentration process and makes the Polish sugar market too strongly concentrated[3]. The raw material base is located close to the plants on adequately fertile soils.

From 2000-2020, the area of sugar beet cultivation in Poland decreased by 18.9% to 251 thousand ha, with a simultaneous nearly threefold increase in the average plantation. Strong reductions were observed in the case of the number of growers, which decreased by 72.6% to 29.3 thousand, and sugar factories (a decrease by 77.6%). In the analyzed period, the concentration of crops and production resulted in a clear increase in sugar beet yields by 40.9%, as well as a higher sugar production per hectare of crops (the so-called technological yield) by 21.9% and a more than fourfold increase per production plant (Table 5).

[1] It should be remembered that the FAO Food Price Index is an aggregate that also includes sugar prices, thus the FAO Food Price Index also reflects the curve for sugar prices proportionally to the weight of prices in this index.

[2] There were five entities operating on the market at that time.

[3] In line with the guidelines of the US Ministry of Justice (The United State ..., 2021).

Table 5

Sugar sector in Poland

Description	Unit	2020	2020 (2000=100)	Average annual dynamics (%)
Sugar beet cultivation area	thousand ha	251.3	81.1	-1.0
Number of growers	thousand	29.3	27.4	-6.3
Average plantation area	ha	8.6	295.9	5.6
Yields	dt/ha	595	140.9	1.7
Harvest	thousand tonnes	14,946	114.2	0.7
Number of active sugar factories	piece	17	22.4	-7.2
Sugar production	thousand tonnes	1,987	98.7	-0.1
Per-plant sugar production	thousand tonnes	116.9	441.3	7.7
Sugar consumption	thousand tonnes	1,675	105.0	0.2
Export	thousand tonnes	588	137.4	1.6
Import	thousand tonnes	195	354.5	6.5
Balance	thousand tonnes	393	105.3	0.3

Source: author's own study based on *Rynek cukru*..., 2009-2021; Krajowy Związek..., 2021.

Sugar consumption and foreign trade in sugar in Poland

From 2000-2020, the consumption of sugar in Poland increased by 5.0% to approx. 1.7 million tonnes, showing a slow upward trend (by an average of 0.2% annually). At the same time, a change in the structure of domestic sugar consumption is observed. The volume (and share) of individual consumption is systematically falling with the growing consumption of sugar-containing products. Between 2010 and 2020 sugar consumption in the country increased by 7.8% to 43 kg per capita (the average annual rate was 0.8%). Sugar consumption in households varies. The highest consumption is observed among pensioners, and the lowest among the self-employed (*Rynek cukru*..., 2021). Domestic sugar consumption is one of the highest in the world, being twice as high as the global average and by approx. 15% higher than the EU average (Figures 5 and 6).

High sugar import duties that are in force in the EU are an effective barrier to imports from third countries. The EU allows many countries duty-free (or duty-reduced) access to import quotas, but in recent years they have been used to a small extent due to the low price difference, demand from third countries, and high production in the EU. Poland sells sugar both to third countries and to EU partners duty-free. The geographical structure of export changes, depending on the level of production in Poland and the supply and demand situation in the EU and the world.

Between 2000 and 2020, sugar exports from Poland increased by 37.4%, and imports by 254.5% (partly due to the low statistical base). During the analyzed period, exports in production ranged from 10.3% to 40.8% (25.5% on average).

Fortunately, the share in imports oscillated between 3.0 and 18.5% (8.9% on average). This allows to assume that export plays an important role in managing production surpluses, whereas imports play a relatively minor role in supplying.

a) structure of sugar consumption in Poland, 2010-2020 (thousand tonnes)

b) structure of sugar consumption in Poland, 2010-2020 (%)

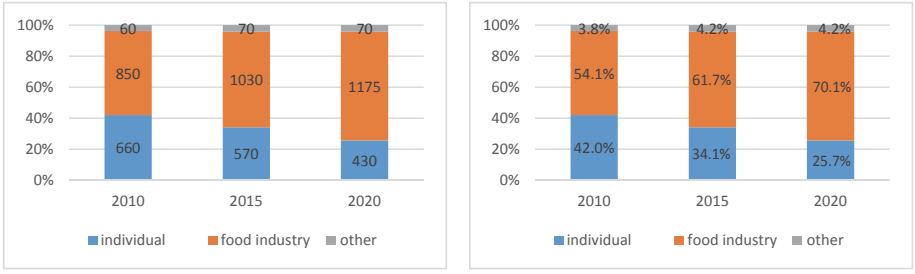
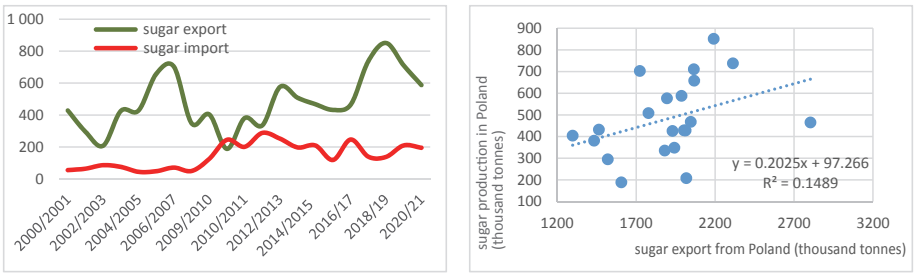


Fig. 5. Sugar consumption in Poland.

Source: author's own study based on *Rynek cukru...*, 2009-2021.

a) Polish sugar export and import, 2000-2020 (thousand tonnes)

b) relationship of sugar export and production in Poland, 2000-2020 (thousand tonnes)



c) relationship of sugar export and consumption in Poland, 2000-2020 (thousand tonnes)

d) average sugar consumption, 2017-2019 (kg / capita)

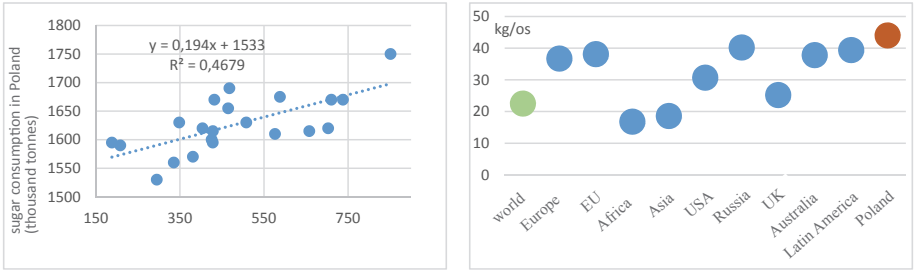


Fig. 6. Foreign trade in sugar in Poland and the structure of global sugar consumption.

Source: author's own study based on data from OECD-FAO, 2020; *Rynek cukru...*, 2009-2021.

Polish foreign trade in sugar was characterized by high volatility, apart from occasional cases, a high positive turnover balance was observed in the analyzed period (on average +337.2 thousand tonnes), which also fluctuated significantly on an annual basis. The abrupt increase in imports observed between 2008 and 2009 was related to the reform of the EU sugar sector, which limited domestic production (the production quota was lower than domestic consumption by approx. 250 thousand tonnes), forcing imports of sugar from abroad. On the other hand, large annual changes in the volume of exports should be related to domestic supply and external demand. The data analysis did not show a statistically significant relationship between exports and production (correlation: R=0.38, linear regression R^2=0.15). Not very strong correlation was observed between the volume of export and the amount of consumption (correlation: R=0.68, linear regression: R^2=0.47), which suggests that neither production nor consumption are significant determinants of exports.

Sugar prices in Poland

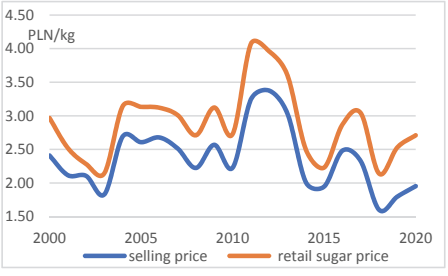
Sugar prices in Poland are influenced by the supply and demand situation in the country, the EU and the world, the balance of foreign trade and the global economic situation. The EU sugar market reform (2006-2010) abolished regulated sugar prices (they were indirectly supported by minimum prices for sugar beet, which were abolished in 2017). The situation on the world sugar market significantly affects the supply and demand in the country through horizontal price transmission (Hamulczuk and Szajner, 2015), a similar relationship can be seen in the case of price quotations on the stock exchange (ICE) and selling prices in the country (Szajner, 2019).

Sugar prices in Poland from 2000-2020 were characterized by relatively high volatility, the coefficient of variation for selling prices was V = 19.8%, and for retail prices V=18.6%. However, the fluctuations were much smaller than the FAO Sugar Price Index (V=38.0%) and the FAO Food Price Index (V=27.1%), which can be explained by the level of production that meets internal needs and protectionist policy in the EU sugar sector. In the analyzed period, the selling and retail prices of sugar in Poland showed a very strong statistical dependence (correlation: R=0.97, linear regression R^2=0.92). The data analysis did not show a statistically significant relationship between domestic and world prices between 2000 and 2020: in the case of the selling price and white sugar quotations, the correlation was R=0.54, and the linear regression was R^2=0.29, in the case of retail prices, the relationships were slightly stronger (correlation: R=0.61, linear regression R^2=0.37), which should be associated with the impact of imports and, to a lesser extent, exports on retail prices in the country.

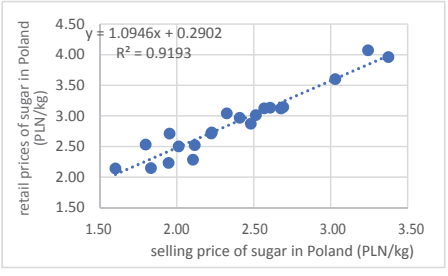
Given the fact that the EU sugar market has been liberalized, it can be expected that with the end of support mechanisms, sugar prices in Poland may show greater dependence on stock exchange quotations. This assumption is confirmed by the econometric data analysis. Between 2000 and 2016, the relationship of domestic sugar prices and quotations of white sugar on the London Stock Exchange,

which are an indicator of global prices, was not statistically significant: for selling prices and quotations in London, the correlation was R=0.57, and the linear regression was R^2=0.32, and in the case of retail prices and stock exchange quotations, the relationships were slightly stronger (correlation R=0.61, linear regression R^2=0.38). At the same time, the data analysis showed the existence of a statistically significant relationship between domestic and world prices between 2017 and 2020. In the case of the selling price and quotations of white sugar, the correlation was R=0.94, and the linear regression was R^2=0.87, while for retail prices and quotations, the relationships were slightly weaker (correlation: R=0.87, linear regression R^2=0.74) (Figure 8).

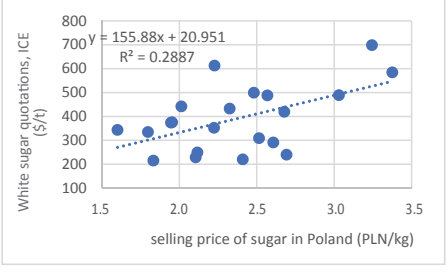
a) relationship of sugar sales prices in Poland and white sugar quotations (ICE), 2000-2016 (PLN/kg, USD/t)



b) relationship of the selling price and retail prices of sugar in Poland, 2000-2020 (PLN / kg)



c) relationship of sugar sales prices in Poland and white sugar quotations (ICE), 2017-2020 (PLN/ kg, USD/t)



d) relationship of sugar retail prices in Poland and white sugar quotations (ICE), 2000-2020 (PLN/kg, USDA/t)

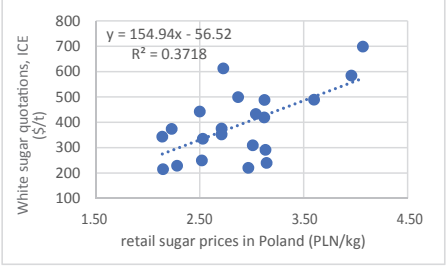
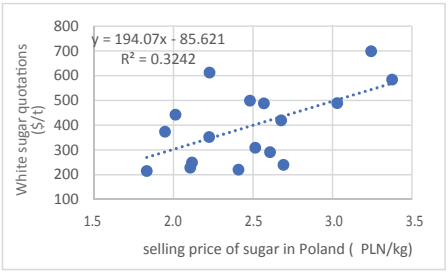
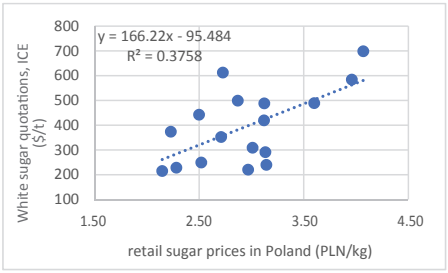


Fig. 7. Sugar prices in Poland and relationships between domestic and world prices.
Source: author's own study based on data from ERS-USDA; unpublished data from Statistics Poland.

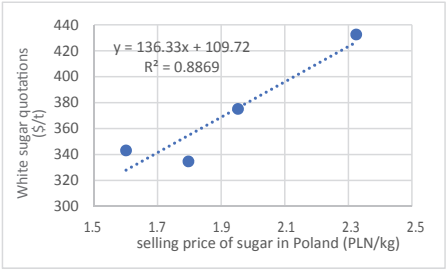
a) relationship of sugar sales prices in Poland and white sugar quotations (ICE), 2000-2016 (PLN/kg, USD/t)



b) relationship of sugar retail prices in Poland and white sugar quotations (ICE), 2000-2016 (PLN/kg, USD/t)



c) relationship of sugar sales prices in Poland and white sugar quotations (ICE), 2017-2020 (PLN/kg, USD/t)



d) relationship of retail sugar prices in Poland and white sugar quotations (ICE), 2017-2020 (PLN/kg, USD/t)

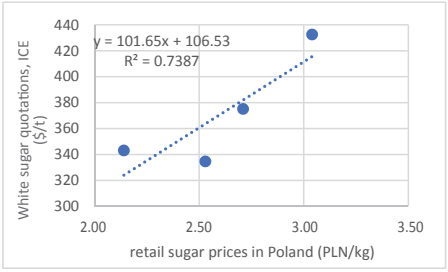


Fig. 8. Relationships of sugar prices in Poland and in the world.
Source: as for Figure 7.

Conclusions

The world sugar market is geographically concentrated, and Brazil's dominant position (the world's second largest producer and first exporter) means that Brazilian sugar exports have a real impact on world sugar prices (for which the ICE quotations are representative). The data analysis showed that between 2000 and 2019, the total sugar exports from Brazil had a significant impact on the quotations of white sugar prices (correlation: R=0.74, linear regression: R^2=0.54).

The reform of the EU sugar market (2006-2010), the result of which may be the abolition of sugar production quotas and minimum sugar beet prices (2017), meant that the Polish sugar sector was no longer constrained by too low production limits, and the surplus was utilized by export. At the same time, the cessation of sectoral support at the EU level meant that domestic sugar prices began to depend on world sugar price quotations.Statistical analysis showed that between 2000 and 2016 (i.e., before the abolition of sugar production quotas) the relationship of domestic sugar prices and white sugar quotations on the London Stock Exchange was not statistically significant. In the case of selling prices, the correlation was R=0.57, and the linear regression was R^2=0.32. However, for retail prices, the correlation

coefficient was R=0.61, and the linear regression was R^2=0.38. At the same time, the analysis showed the existence of a statistically significant dependence between domestic and world prices between 2017 and 2020 (and thus after the abolition of production quotas). In the case of sugar selling prices, it was quite strong (the correlation was R=0.94, and the linear regression was R^2=0.87), while for the retail prices it was slightly weaker (correlation: R=0.87, linear regression: R^2=0.74).

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SYTUACJA PODAŻOWO-POPYTOWA I CENY NA ŚWIATOWYM I POLSKIM RYNKU CUKRU

Abstrakt

Celem artykułu jest prezentacja globalnego i polskiego bilansu cukru oraz sytuacji cenowej. Szczególną uwagę poświęcono kilku zagadnieniom. Po pierwsze, relacji między produkcją cukru i bioetanolu w Brazylii a światowymi notowaniami cen cukru. Po drugie, zależnościom pomiędzy brazylijskim wywozem cukru i bioetanolu a światowymi cenami cukru. Po trzecie, relacjom między cenami cukru w Polsce a światowymi w okresie obowiązywania rynkowych mechanizmów wsparcia na poziomie UE i po ich wygaśnięciu. W opracowaniu wykorzystano między innymi dane GUS, USDA-FAS, FAOSTAT, OECD-FAO. Badanie opiera się na analizie korelacji i regresji liniowej oraz wskaźniku Herfindahla-Hirschmana. Analiza danych wykazała istotną statystycznie zależność pomiędzy produkcją a wywozem cukru z Brazylii, a także między brazylijskim eksportem a światowymi cenami cukru. Analiza pokazała także większą zależność między cenami żywności niż cukru a notowaniami cen ropy. Ponadto zaobserwowano znacznie większą zależność pomiędzy cenami zbytu i detalicznymi cukru w Polsce a światowymi cenami cukru po zniesieniu kwotowania produkcji cukru i cen minimalnych na buraki cukrowe w UE w porównaniu z okresem obowiązywania tych mechanizmów wsparcia.

Słowa kluczowe: cukier, relacje cen cukru, eksport cukru.

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