



**INSTITUTE OF AGRICULTURAL
AND FOOD ECONOMICS
NATIONAL RESEARCH INSTITUTE**

**Situation on the world
market of sugar
and its impact
on the possibilities
of sugar beet cultivation
in Poland**

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**Krzysztof Hryszko
Piotr Szajner**

**COMPETITIVENESS OF THE POLISH FOOD
ECONOMY UNDER THE CONDITIONS OF
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Editor
dr inż. Piotr Szajner

Authors:
mgr inż. Krzysztof Hryszko
dr inż. Piotr Szajner



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This publication was prepared as a contribution to the research on the following subject **Monitoring of agri-food markets under changing economic conditions** within the framework of the research task

Monitoring and assessment of changes on global agricultural markets.

The main objective of the study is an analysis of supply and demand on the world market of sugar and their impact on the sugar sector and possibilities of sugar beet cultivation in Poland.

Reviewer

Małgorzata Juchniewicz, PhD, Professor of the University of Warmia and Mazury in Olsztyn

Proofreader

Joanna Gozdera

Technical editor

Joanna Gozdera

Translated by

Summa Linguae S.A.

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*Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej
– Państwowy Instytut Badawczy
ul. Świętokrzyska 20, 00-002 Warszawa
tel.: (22) 50 54 444
faks: (22) 50 54 636
e-mail: dw@ierigz.waw.pl
<http://www.ierigz.waw.pl>*

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Introduction

The market is a key economic category describing the process leading to the fact that consumers' and producers' decisions are mutually agreed through prices. The market is thus a set of mechanisms enabling consumers and producers to interact. In another perspective, the market is "a tool" for the allocation of rare resources and economic sciences examine the manner in which societies use resources to produce valuable goods and distribute them among particular units. In the institutional economics, the market is understood as an institution which coordinates transactions between social entities. The market is a wide category and may be discussed in three aspects: subjective, objective and spatial. In the subjective aspect, these are exchange relations between participants of the market, namely consumers and producers. In the objective aspect, the market is discussed as a system of supply and demand relations (products, services, work, securities, etc.). Spatial analysis focuses on the range of the market's impact (local, domestic, regional, global). In the age of increasing processes of regional integration as well as globalization, local and domestic markets become elements of the world market. The impact of changes of the economic situation in external markets is more and more visible in internal markets.

The market mechanism solves three basic problems: what to produce, for whom to produce and how to produce. In consequence, the market is attributed with four functions: information, profit-making, effectiveness and balancing. On the basis of market information, participants make economic decisions and market research has become an important element of building competitive advantage. The market creates the possibility for its participants to multiply income but, at the same time, verifies effectiveness. Effective and competitive entities win the competition and take over the economic surplus at the expense of less effective participants of the competition. Market competition forces participants to manage effectively, understood as the possibly most favorable relation of effects to expenses. The balancing function of the market is its ability to automatically restore the balance of demand and supply through prices. Depending on the structure and spatial range of the market, balance may be affected by numerous other factors stabilizing or destabilizing the entire system (e.g. intervention policies).

Sugar is the major sweetener despite the development of sweetening substances (e.g. starch syrups) and has great economic significance. The world sugar market began to shape in the 18th century when large quantities of raw cane sugar were imported to Europe. Sugar production based on sugar beet was developed in Europe in the 19th century and the world market saw the beginning of a rivalry

between cane sugar and beet sugar lasting until this day. The production of sugar from sugar beet in Europe and North America was supported for many years by a protectionist market policy. The economic situation in the world market was always of a large significance for sugar production in Europe. In the age of the liberalization of market policies, especially as a result of market regulation reforms in the EU, the impact of the world market on the EU and the Polish market is even larger. Foreign trade played a key role in stabilizing the domestic and the EU sugar market. Sugar produced in excess of the quota is mainly exported and subsidized export was also implemented in previous years. As a result of the new market regulations, the share of import in the supply of the domestic market increased.

The main purpose of the study is to assess the situation in the world sugar market and its impact on the domestic sugar sector. The comparative analysis covered all elements of the world and the Polish sugar market at all stages of the marketing chain starting from the raw material base to consumption. The subject of analysis was also the evolution of market policies in sugar production since the widely understood regulations exerted a huge impact on the development of the sector. The impact of the convergence of the domestic sugar production with the world market was assessed with the use of the statistical method, first of all, on the basis of the time series of prices, foreign trade and financial results of the sugar industry.

The reform of the sugar market regulations in the EU was not definitively finished and further changes aiming at liberalizing the market and eliminating production quotas are announced in the years to come. The expected reform will probably adapt the EU sugar production to changes in the world trade in agricultural and food products. In consequence, the impact of the economic situation of the world market on the Polish sugar sector will be even greater than previously.

1. Presentation of the sugar sector

1.1. Sugar as a product

Sugars are a group of organic chemical compounds built from atoms of hydrogen, oxygen and carbon which are defined by the name **carbohydrates** (saccharides). The general molecular formula for carbohydrates is the formula $C_nH_{2n}O_n$ but there are known few exceptions to this rule. Depending on the number of sugar molecules, carbohydrates are divided into simple sugars (monosaccharides) and complex sugars (polysaccharides). Glucose, fructose and ribose are simple sugars of a large significance in agriculture and the food industry. The majority of biologically significant monosaccharides has 5 or 6 atoms of carbon and the ability to merge and form complex sugars. Complex sugars which play an important role in agriculture and food processing include: disaccharides (sucrose and lactose) and oligosaccharides (starch, cellulose, inulin, glycogen). Carbohydrates perform numerous functions in living organisms:

- nourishing and power material – mainly glucose and fructose, maltose and lactose;
- reserve material – in plants (starch) and in animals (glycogen);
- building material – in plant organisms (cellulose), in all organisms part of DNA and RNA and constitute a modification of proteins;
- transport function in the organism – sucrose in plants and glucose in animals.

The majority of modern languages defines sugar as a specific sweetening substance. Etymological dictionaries accordingly state that this notion appeared in the European language area from the Persian and the Arabic languages where the words *shakar* and *sukkar* refer to the adjective sweet¹. In ancient times, Greece and the Roman Empire conducted trade exchange with countries from Southern Asia where a sweet substance was made from sugar cane. The conquest of the Iberian Peninsula by the Arabs in the Middle Ages resulted in the fact that this notion directly penetrated Western European languages. The word came into the Polish language from French (*sucré*) or German (*der Zucker*) [Łaziński 2008, p. 46] because Poland had strong economic and cultural connections with these two countries.

Sugar, being the main product of the sugar industry, is **sucrose** which is a crystalline **disaccharide** with molecular formula $C_{12}H_{22}O_{11}$. The molecule of

¹ Online Etymology Dictionary.

sucrose consists of one molecule of glucose and one molecule of fructose [Dobrzycki 1973, p. 64]. During photosynthesis, plants produce glucose $C_6H_{12}O_6$ the molecules of whose are then combined into complex sugars: starch – reserve material or cellulose – building material. Sugar cane (*Saccharum officinarum L.*) and sugar beet (*Beta vulgaris altissima*) have sucrose as the reserve material.

Technological progress in the sugar industry resulted in the fact that today's plants (sugar factories) may produce numerous assortments of sugar. All these final products are produced on the basis of **raw sugar** which is subject to **refinement** in order to acquire **white sugar** [McGinnis 1976], [Nickel 1983]. White sugar is the main product of the domestic sugar sector and the remaining varieties of sugar are a small supplement of the supply. The physical and chemical qualities of white sugar in Poland are determined by the Polish Standard PN-A-74850:1996/Az1:2005. System of the sugar market regulation in the EU also defines which products are considered to be sugar:

- raw sugars are sugars without the addition of aroma, dyeing substances or other substances, with the weight content of sucrose **smaller than 99.5% in the dry condition**, defined using polarimetry;
- white sugars are sugars without the addition of aroma, dyeing substances or other substances, with the weight content of sucrose **99.5% or more in the dry condition**, defined using polarimetry.

White sugar of quality standard needs to have the following properties: maximum content of moisture 0.06%, homogeneous granulated crystals, minimum polarization 99.7°, maximum content of invert sugar 0.04%. Raw sugar of standard quality is sugar from which the output of white sugar amounts to 92%².

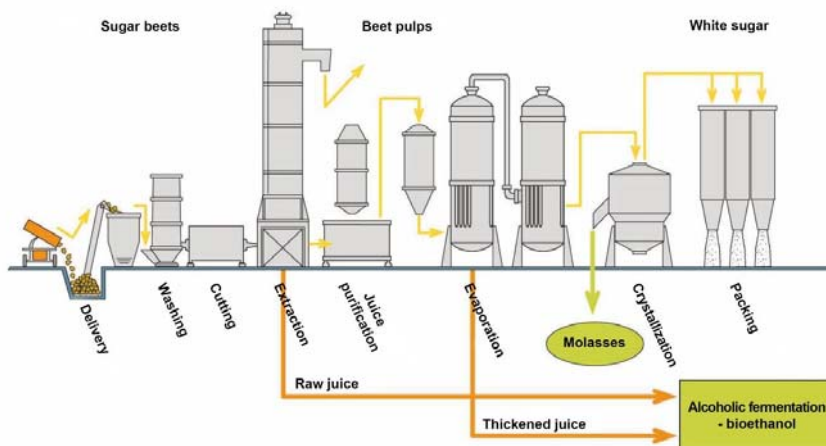
1.2. Byproducts of sugar production

The main byproduct of sugar production, with great economic significance, is **molasses**. Molasses is a dark brown, thick syrup with alkaline reaction. Depending on the raw material from which sugar is produced, beet and cane molasses is distinguished. The composition of molasses primarily depends on the quality and chemical composition of the raw material, the technological process of sugar production and its storage (Fig. 1). According to Polish Standard PN-76 R-64772, the content of dry mass in beet molasses is approx. 80%, including 50% of sugar, the further recovery of which is economically unjustified. The content of sugar in cane molasses is smaller and is approx. 38.5%. Im-

² Council Regulation (EC) no. 318/2006 of 20 February 2006 on the common organization of markets in the sugar sector. Appendix I, Item 2 and 3.

portant components of molasses are mineral compounds, including potassium oxide (approx. 5.5%). The high content of sugar results in the fact that molasses is a sought-after raw material for the production of alcohol, baker's yeast, citric acid and glycerin. Molasses in agriculture is valuable fodder.

Figure 1. Scheme of sugar beet processing



Source: Prepared by the authors on the basis of *Chancen für den Zuckerrübenanbau*, KWS SAAT AG, Einbeck 2007.

Another byproduct in sugar beet processing is also **beet pulp**. Due to the content of sugar and metallic elements, they are valuable fodder for ruminants. The modernization of production lines contributed to the decrease in sugar losses in byproducts and, as a consequence, the nutrition value of beet pulp decreased. The quality requirements for beet pulp are determined by the Polish Standard PN 85-R 64408. Legal regulations in the EU impose the obligation to comply with health safety standards in the following scopes on producers of sugar and farmers: production, transport, silage (conservation) and feeding³. In recent years sugar plants created biogas plants in which beet pulp is subject to the process of methane fermentation.

³ Regulation of the European Parliament and of the Council (EC) no. 1831/2003 of 22 October 2003 laying down requirements for feed hygiene, Official Journal of the European Union L 284/1 of 8 February 2005.

Numerous byproducts are obtained in the production of sugar from sugar cane, apart from molasses. *Bagasse*, however, has the largest economic significance. Due to the content of cellulose, it is a valuable raw material in the paper industry.

Sugar plants with appropriate technological lines may also produce ethanol C_2H_5OH (the so-called **bioethanol**) which is used as an addition to fuels in its dehydrated form. In some countries bioethanol is of great significance in the economy (e.g. Brazil, USA). Changes in power policies of industrialized countries, including also EU member states⁴, resulted in the fact that sugar companies invest in technological lines for the production of ethanol from raw plant materials. The production of bioethanol may be a source of revenue in the case of a large supply of the raw material and the processing of parts of thick juice into bioethanol may contribute to solving the problem of surpluses of sugar supply.

Sugar plants also sell **defecation lime** which is created after the dehydration of milk of lime used in the production of sugar to clean the juice. Defecation lime is a valuable fertilizer with approx. 30% content of pure CaO and may also contain other components desired in fertilizing: phosphorus, potassium and magnesium. The majority of regulations regarding this product is regulated by the Act on fertilizers and fertilizing⁵.

The production of sugar is a technological process which is very energy-consuming which results in the fact that all sugar plants have their own systems generating electricity and thermal energy. The surpluses of generated electricity may be sold to transmission grids and thermal energy may be sold to heat nearby buildings. European sugar companies diversify their business activities by opening biogas plants in which the raw material used for the production of gas is beet pulp.

1.3. Historical outline of the development of world sugar production

The production of sugar from sugar cane has a very long tradition. Historical annals on Alexander the Great's campaign in India from 326 BC state that a sweet substance was produced in these areas which the Greek called "honey without bees" [Meyer 1905]. The native land of sugar cane is the province Bihar on the Ganges River and the region of the town Gur which is called "the town of sugar" [Łyczak 1981, p. 7]. Sugar cane processing on a larger scale was started

⁴ Directive of the European Parliament and of the Council 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources amending and as a consequence repealing Directive 2001/77/EC and 2003/30/EC, Official Journal of the European Union L 140/16 of 5 June 2009.

⁵ The Act on fertilizers and fertilizing of 10 July 2007, Journal of Laws no. 147 of 14 August 2007 item 1033.

by Arabs who tried to grow it on Sicily and the Iberian Peninsula in the 8th-10th centuries [Hobhouse 2001]. Sugar in Arab medicine was treated as medicament. Sugar imported from Arab countries was also used as medicament in the Republic of Venice but it was also a flavor component during the preparation of dishes [Merki 1993, p. 29].

The turning point in the history of the world sugar production took place as a result of the great geographical discoveries and the development of colonial economy. Western European countries with colonies in South and Central America, South Asia and Africa produced sugar from sugar cane in these areas. The development of production was fostered not only by favorable weather conditions but, first of all, by the low costs of production which determined its high competitiveness. A common phenomenon on colonial plantations was using slaves which is indisputably recognized as a dark card in the history of the world sugar production. In the 17th and 18th century the European market received only colonial raw sugar which was subject to refinement. The growing supply made sugar a product more and more available to consumers [Lippmann 1890]. The position of sugar on the English market may be presented figuratively: "1650 – rarity, 1750 – luxury and 1850 – common use" [Minz 1987, p. 179].

The import of sugar deteriorated the balance of foreign trade in countries without colonies which, according to the mercantilistic doctrine of trade exchange and economic development valid back then, was a particularly negative phenomenon [Przyrembel 1927, p. 105]. Research works began in Western Europe on the possibility to produce sugar from native raw plant materials which would make it possible to become independent of import and improve the economy's competitiveness. In 1747 **A.S. Marggraf**, a German chemist, identified sucrose in sugar beet (*weise schlesische Runkelrübe*) and published his first research results on the possibilities of producing sugar from such raw material. Further research work was continued by **F.C. Achard** who built and opened the first sugar factory in 1801 in **Konary** (Cunern) in Lower Silesia. The investment was executed under the auspices of Frederick William II of Prussia [Łuczak 1981]. Special attention should be paid to this fact. European sugar production required strong support from the state administration from the very beginning and such a situation was maintained also in later periods [Merki 1993, p. 106].

The development of the sector in Europe took place during the Napoleonic wars and the industrial revolution. In 1806 Napoleon Bonaparte issued a decree aimed at protecting the market in France and countries under the French

jurisdiction against the import of goods from English colonies⁶. In response, England, the greatest commercial power of the world, blocked French ports. The import of sugar cane significantly decreased which forced the development of growing and processing of sugar beet. In 1811 the French emperor issued a decree⁷ in which he ordered the production of sugar from sugar beet. By virtue of the decree, the area of cultivation amounted to 32,000 ha, licenses were issued authorizing to produce sugar and six experimental schools with sugar specialization were established [Ganser 1922, p. 64].

The dynamic development of sugar production in Europe was observed in the 1830s, namely the period of the industrial revolution. As a result of a drastic decrease in selling prices of corn, root vegetables created an opportunity to increase the income of farms. Growing sugar beet and potatoes made it possible to increase the use of land resources (replacing the three-field system with the four-field system), increase its productivity and caused favorable changes in the fodder economy [Merki 1993, p. 112]. Great progress was made in growing new varieties of sugar beet as well as the intensity of their cultivation. The average root yield in the German area Braunschweig in the season 1875/1876 amounted to 340 dt/ha at sugar content 12.5%. The production of sugar from one hectare of a plantation amounted to 42 dt. In the years preceding World War I root yields increased to 400 dt/ha, polarization to 18% and biological sugar yield to 72 dt/ha [Laur 1920, p. 173]. The intensity of production at that time should be assessed as very high. Polish growers obtained comparable production results in the 1990s⁸ despite a significant technological progress in mechanization, chemical plant protection and mineral fertilizing. The production of sugar in Germany increased more than six times within thirty years up to 2.2 million tons. Austria-Hungary and Russia were also significant producers. A considerable part of the European sugar production took place within the area of today's Poland which was back then under foreign occupation.

The development of the sugar industry in Western Europe was fostered by favorable market conditions, in particular protectionist policies. In the middle of the 19th century cane sugar was taxed with very high customs fees. At the same time, German and French sugar plants were exempt from taxes and benefited from various subsidies (e.g. export subsidies). Relations between the sugar industry and the state administration in Germany may be described as symbiosis

⁶ Décret impérial qui déclare les îles britanniques en état de blocus, N° 398. Bulletin des Loi, N° 123, Au camp imperial de Berlin, 21 November 1806.

⁷ Décret impérial du 25 mars 1811. Décret qui instaure le sucre de betterave sucrière et proscrit le sucre de canne.

⁸ *Rynek cukru. Stan i perspektywy*, no. 5, IERiGŻ-PIB, ARR, MiRW, Warsaw 1998, p. 23.

[Merki 1993, p. 112]. In the 19th century, just like currently, the world market saw strong competition between the producers of beet and cane sugar. The situation is well presented by an allegory showing the French sugar market, namely "the struggle between sugar cane and sugar beet". Sugar cane is clearly winning the struggle and is about to strike the ultimate blow but administration enters between the fighters to save the existence of the French sugar sector (Fig. 2). The first attempts of an international range were made to restrict the protectionist policy towards sugar production in the first years of the 20th century⁹. Signed agreements resulted only in a small balance of competition conditions because the cultivation and processing of sugar beet in Europe and North America were still strongly supported.

Figure 2. Allegory of competition on the world sugar market



Source: Grandville J.J.: *Duell zwischen zwei Raffinierten*, Zucker-Museum, Berlin 1843.

The protectionist policy contributed to an improvement in the international "competitiveness" of the European sugar industry. In the second half of the 19th century the production of beet sugar exceeded the production of cane sugar [Merki 1993, p. 121]. In the 20th century sugar production was strongly supported in all economically developed countries and in countries with centrally planned economies. The value of the index *PSE* (*Producer Support Estimate*) in the nominal perspective presents the total share of all transfers from consumers and taxpayers to agricultural producers measured at the level of an agricultural farm. The share of support referred to above in gross revenues of farms is de-

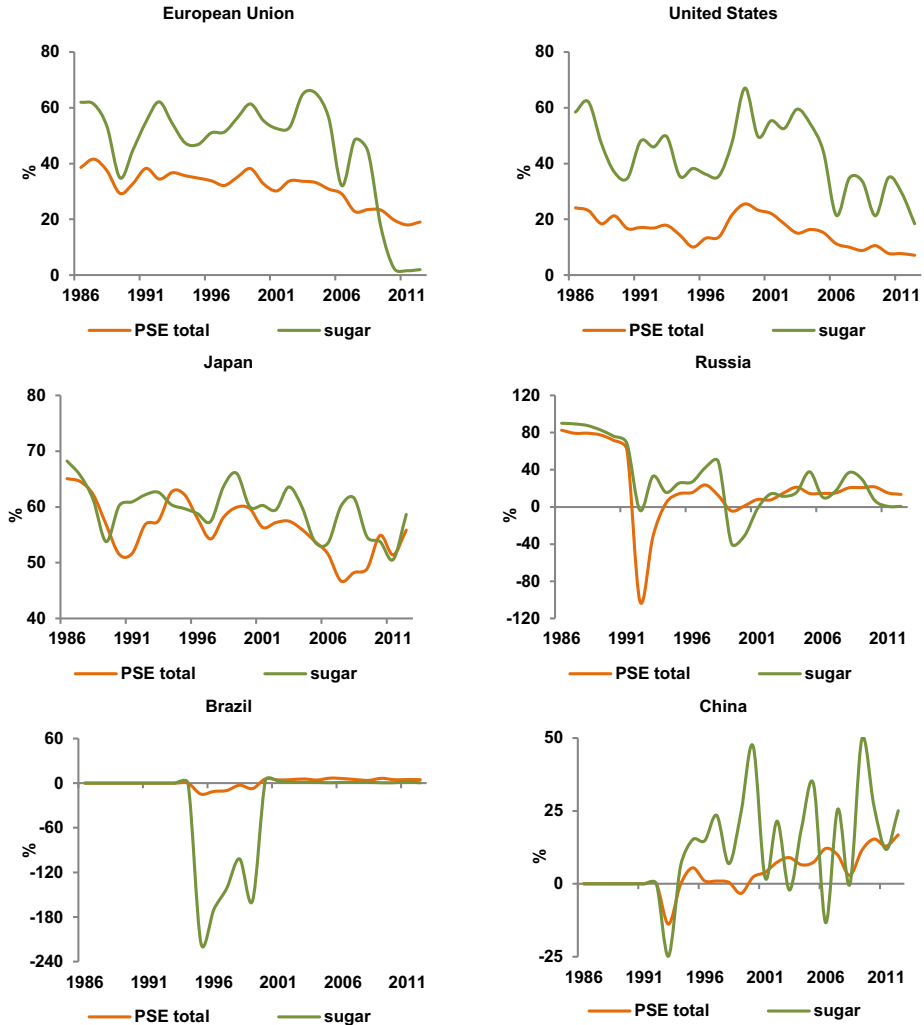
⁹ The Brussels convention of 5 March 1902 was imposing on the signatories the obligation to reduce all production and export subventions in the sugar sector. The provisions of the convention were then prolonged in 1907 and 1912.

defined as percentage *% PSE (Percentage PSE)* and is a commonly used tool to measure the support for agriculture. The index *%PSE* is not a measure of the level of support but only an estimate of the share of aid granted to the agricultural sector in revenues. Changes in its value in years do not need to mean a change in policy since they may result from differences in the level of world and domestic prices and the variability of the currency exchange rate [Wieliczko 2008, p.11].

The analysis of *%PSE* demonstrated large differences in the support of sugar production between economically developed countries and countries with a lower level of economic development (Fig. 3). In industrialized countries (EU, the United States and Japan), the sugar sector received larger support on average than the agricultural sector. The values of *%PSE* were very high and amounted to 40-70%. Detailed OECD data also indicates changes in the structure of support, namely the support of prices *MPS (Market Price Support)* decreased at growing budget transfers *BOT (Budgetary and Other Transfers)*. Changes in the level and structure of support are visible in the EU which reformed the sugar market regulation in the years 2006-2010.

In Brazil, which became the leader of the world sugar market, support for producers was small because the values of *%PSE* were close to zero. In the years 1995-1999 the world prices of raw sugar were lower than prices in the Brazilian market and the index *%PSE* was negative. A similar situation happened in some years in China and Russia. The high productivity of sugar cane cultivation, lower costs of its processing and, first of all, smaller support indicate clear competitive advantages of the production of sugar from sugar cane [Isermeyer 2005, Spörri 2011].

Figure 3. Values of indexes %PSE in agriculture and sugar industry



Source: Prepared by IERiGŻ-PIB on the basis of OECD data, www.oecd.org.

1.4. Economic significance of sugar industry

Sugar is classified as a product which played a significant role in the economic development of the world. This applied to changes in agriculture, the food industry, foreign trade and, first of all, changes in the structure of demand for food. Sugar cane along with cotton, tea, cocoa and potatoes is classified as a plant which changed the world [Hobhuse 2001]. The sugar industry and the spirit industry were the main driving forces which transformed the German economy into a capitalist power. A similar role was played by the metallurgical

industry and the tobacco industry in England because sugar was produced in numerous colonies [Sombart 1983].

The sugar industry contributed to large structural changes in the world agriculture. The popularization of sugar cane cultivation was one of the main factors for the development of numerous countries located in the intertropical climate zone. Sugar cane, apart from the fact that it is a raw material in the sugar industry, is also used in other sections of the economy. Brazil, the leader in the world production of sugar, uses sugar cane for bioethanol production, and the byproducts of processing (the so-called bagasse and molasses) are used in the production of paper [Falkowski 2001 p. 347]. The large significance of sugar cane in the world economy is confirmed by the threefold growth in the area of its cultivation in the years 1961-2012. In the same period, the share of sugar cane in the world gross agricultural production (gross production value) increased from 2.0 to 2.5%. For comparison, the world area of sugar beet cultivation was reduced by 30% and its share in agricultural production decreased from 1.0% to 0.5%.

Sugar beet in European agriculture is still very important economically because it is a plant with the highest productivity from an area unit (more than 100 t biomass from one ha) [Ostrowska 2005, p. 5]. According to agrotechnical recommendations, sugar beet begins the rotation in crop rotation of plants on good soil complexes. Sugar beet should be cultivated on organic fertilizers (20-30 t/ha) but large doses of mineral fertilizers are also required. A good position for spring cereals remains after harvesting [Starczewski 2006, p. 25] and by-product crops are leaves with heads which were considered valuable fodder in the 1980s. Currently the leaves area treated as an organic fertilizer and are less useful in feeding ruminants due to the high content of nitrites and nitrates.

The share of sugar beet in the area of sowing and the value of agricultural production in Poland in the years 1995-2000 amounted accordingly to 4.5% and 5%. As a result of the EU market regulation reform as well as restructuring and modernization processes, the area of cultivation decreased by half. Its share in the area of sowing is currently approx. 2%. The increase in crops and higher buying prices resulted in the fact that sugar beet constitutes approx. 3.5% of agricultural production. In Poland growing sugar beet constitutes a significant source of revenue for approx. 35,000 agricultural farms. In Germany and in France the number of growers is accordingly 32,000 and 26,000¹⁰.

¹⁰ CIBE First Harvest Estimates for 2010/2011, Confederation Internationale des Betteraviers Europeens, D.126/23.03.2011.

The sugar industry remains a significant section of processing of agricultural products despite the decrease of its share in sales revenue, employment and turnover of foreign trade. Sugar is the major sweetener in the majority of sections of secondary food processing. It is also used in other sections of the industry (e.g. the pharmaceutical, chemical industries). The consumption of sugar in the food industry in Poland is estimated at 900,000-950,000 t which is 55-60% of the domestic consumption¹¹. The consumption of sugar in secondary food processing in Germany in 2011 amounted to 2.7-2.8 million tons which constituted 85-87% of the total demand¹². The largest quantities of sugar are used for the production of sweets, non-alcoholic beverages, fruit products, alcoholic beverages and in the milk industry.

Sugar, salt and water are the only substances man may consume in their pure chemical form [Merki 1993, p. 25]. Sugar as a food product is a chemically pure carbohydrate and provides the organism only with energy because it lacks other valuable nutritional components (protein, fat, mineral compounds). Sugar as an ingredient of food products occupies the central place in our diet today. In industrialized countries sugar provides 10-20% of consumed calories and its sweet taste dominates in numerous dishes. According to estimates of GUS, the balance consumption of sugar in Poland is approx. 41 kg per person, including 16.5 kg of sugar in its non-processed form¹³. In households sugar, confectionery products and honey together constitute 6.4% of expenses for food and non-alcoholic beverages, including sugar approx. 2%¹⁴.

The sugar industry and sugar are currently the object of strong criticism for negative socio-economic effects. The authors of the criticism come mostly from two environments: the medical and the ecological environment. Experts in nutrition and diet clearly indicate the negative impact of large consumption of sugar on people's health. For many years sugar has been recognized as a harmful food product and its impact on health is compared to poison [Coda 1957:13]. The consumption of sugar is the cause of numerous *lifestyle diseases*, such as: diabetes, obesity, deep vein thrombosis (including coronary), caries, varicosity, gastric conditions and, indirectly, mental disorders. Sugar demonstrates addictive properties because when it is delivered to the body it releases the production of serotonin responsible for good mood [Dufty 1975]. Industrialized countries

¹¹ *Rynek cukru. Stan i perspektywy*, no. 40, IERiGŻ-PIB, ARR, MRiRW, Warsaw 2013, p. 23.

¹² *Statistisches Jahrbuch über Ernährungswirtschaft, Landwirtschaft und Forsten 2012*, Wirtschaftsverlag NW GmbH, Bremerhaven 2012, p. 230.

¹³ *Rynek cukru. Stan i perspektywy*, no. 40, IERiGŻ-PIB, ARR, MRiRW, Warsaw 2013, p. 23.

¹⁴ *Popyt na żywność. Stan i perspektywy*, no. 13, IERiGŻ-PIB, ARR, MRiRW, Warsaw 2012, p. 17.

reached large consumption of sugar in the 1960s and it remains currently despite being *inferior good* [Azzam 2003, Cubbin 1973]. Sugar does not disappear from the diet of contemporary man and the awareness of its harmful impact on the health and an intensive promotion of food products with reduced content of sucrose (*sugar free, light*) do not change this situation [Merki, p. 262].

In the 1980s ecological environments began to pay attention to the negative impact of agriculture in the equatorial zone on *tropical rainforests* which play a crucial role in the production of oxygen (the so-called *Earth's lungs*). Areas where rainforests were cut are intensively used for the establishment of sugar cane, coffee, cocoa tree, banana tree and coconut palm plantations [Meyers 1985]. The devastation of rainforests by agriculture proceeds on a great scale. The Brazilian government's program aimed at directing human settlements to these areas is particularly unfavorable in its consequences. As a result of agricultural activities, the area of tropical forests decreases and the acreage of crops in the monocultural system increases which adversely affects *the biodiversity*. Settlements result in the fact that large areas are covered by fixed elements of the infrastructure (roads, buildings) and agrotechnical procedures cause hydrological problems, the erosion and salinity of soil [Broeker 2006]. However, it is unfair to claim that the development of agriculture, including also the sugar sector, is the only reason for the devastation of rainforests. Other branches of the economy also hugely contribute to this indisputably alarming process, first of all, the mining, chemical and wood industries.

1.5. Evolution of market regulations in the Polish sugar sector

1.5.1. Market regulations in the inter-war period

After Poland regained independence, the primary objective of the economic policy was to reconstruct industry from damage done by the war and its further modernization. An important area of actions was the unification of the sugar industry under the auspices of one organization. In 1922 the Chief Council of the Polish Sugar Industry (RNPPC) was established which became the only representative **of the sugar cartel** and ran a common trade and financial policy for its members [Łuczak 1981, p. 167]. At the same time, trade associations of sugar beet growers were created and operated dynamically. In 1925 the International Confederation of European Beet Growers (CIBE) was established at the initiative of Polish growers.

The sugar industry in the Second Republic of Poland was strongly cartelized and well-organized. All decisions regarding the production and sale were concentrated in the hands of managers and the Sugar Bank constituted financial support. The state administration was also interested in the development of the sector and the stabilization of the market. The administration attempted to regulate the market in a statutory manner¹⁵. Adopted legal acts constituted framework conditions and, depending on the economic situation, the government defined detailed regulations in consultation with the cartel (e.g. a production quota). The administration's aspiration to greater control over the industry resulted from interests of the state treasury as well as pressure from consumers.

The sugar market in the Second Republic of Poland experienced imperfect competition in its most extreme form, namely monopoly. Economic literature distinguishes the following features of a monopoly: one producer, the product has no substitutes, considerable control of the company over prices as well as advanced marketing methods [Samuelson 2004, p. 265]. The sugar cartel met the role of "the only producer". There were little substitute products (e.g. sucrose) and they were fought by the sugar industry [Merki 1993]. The prices of sugar were high and were decided on by the dictate of the monopoly and a high excise duty (36-70%). The sugar industry conducted promotional campaigns involving public figures (e.g. the slogan *sugar strengthens* coined by M. Wańkowicz). The strong position of the sugar industry is shown by a fourfold growth in production in the years 1920-1930 to approx. 820,000 t. The agrarian crisis, which was the conse-

¹⁵ Act of 22 July 1925 on trade in sugar regulation. Journal of Laws of the Republic of Poland no. 90 item 630 as amended. The decree of the President of the Republic on sugar and beet management regulation of 3 December 1935, Journal of Laws of the Republic of Poland no. 85 item 548.

quence of the Great Crisis in Europe and in the United States (1929), caused a large decrease in prices and the profitability of agricultural production. The production of sugar decreased to 300,000-350,000 t but increased again to approx. 500,000 t in the period of Sanation (1926-1939) [Łuczak 1981, p. 181].

The sugar sector in the Second Republic of Poland experienced numerous negative phenomena which were most clearly visible in the monopolistic plot. High prices of sugar on the internal market resulted in the fact that the sugar industry transferred high costs of restructuring to the consumers. However, it should be remembered that a basic network of sugar plants was shaped by the effort of Polish sugar producers, engineers and scientists under the conditions of a changing economic situation, connections with the base of raw material, the scientific base were additionally strengthened and international cooperation was initiated. All achievements referred to above constituted the basis for the reconstruction and development of the sugar industry after the World War II.

1.5.2. Market regulations in centrally planned economy

After the end of the War World II Poland was placed in the zone of political and economic influence of the USSR. The revolutionary change in the political system was accompanied by deep changes in the field of economy. First of all, in the structure of the ownership of means of production and in the system of organizing and managing the economy. The legal act which caused deep changes in the agriculture was the decree on agricultural reform¹⁶. The Act on the nationalization of key branches of the domestic economy¹⁷ fundamentally changed ownership relations. The state took over the basic domains of industrial production, services and, partially, agriculture which made it necessary to introduce a new management system for the economy. The centrally planning system limited market economy mechanisms and questioned its underlying principles: economic ownership and rational management.

Effects of the reform in the agricultural and food sector were very unfavorable. 6 million ha of land was allocated for the purposes of division, creating 814,000 individual farms. As a result of the division, dozens of small and scattered plantations were established instead of one large-area sugar beet plantation. The number of growers increased from 40,000 in 1938 to 375,000 in 1946. In the years 1950-1965 the number of plantations ranged within 700,000-1,035,000. The effect of the fragmentation of the structure of raw material base

¹⁶ Decree of the Polish Committee of National Liberation of 6 September 1944 on agricultural reform, Journal of Law of 1944 no. 4 item 17.

¹⁷ Act of 3 January 1946 on the State nationalization of basic sectors of the national economy, Journal of Laws of 1946 no. 3 item 17.

was the extensification of production and the decrease in yields (210-265 dt/ha). A considerable part of growers did not have experience in growing which unfavorably affected the quality of the supplied raw material. Changes in the agricultural policy and increasing expenses on agriculture contributed to a growth in yields (300-350 dt/ha) and the number of growers was reduced to approx. 400,000 [Wykretowicz 1997, p. 111]. The scattered structure of plantations resulted in the fact that raw material services in sugar plants were complex. Logistic problems and the low quality of raw material negatively affected the technical and economic effectiveness of sugar factories [Walkenhorst 1998, p. 31].

Five new sugar plants were built in the period of planned economy¹⁸ but, at the same time, several smallest plants were liquidated [Wykretowicz 1997, p. 30]. The number of active sugar plants amounted to 78 but these mostly were old facilities which were built in the years 1850-1913 [Walkenhorst 1998, p. 31].

By virtue of the act on the nationalization of the domestic economy, all sugar plants were recognized as key and were taken over the state administration. The unit coordinating all economic activities in the sector was the Central Board of the Sugar Industry (CZPC) which was transformed into the Union of the Sugar Industry (ZPC) in 1959¹⁹. In 1981 a reform was made which liquidated industrial unions as obligatory structures limiting the independence of companies. In 1982 Zrzeszenie Przedsiębiorstw Przemysłu Cukrowniczego (Association of Companies of the Sugar Industry) "**Cukropol**" was established which executed the state's policy towards the sector. Sugar was classified among strategic goods the prices of which were determined by the government. Working capital loans and investment loans were limited which blocked the development of economically stronger plants [Chudoba 1991]. Sugar plants with smaller economic potential could count on subsidies and tax reliefs. Investments were characterized by low rationality and effectiveness. No positive structural changes took place throughout the period (e.g. increase of processing concentration). The daily processing of sugar beet in an average Polish and Western German sugar plant in the campaign 1949/50 amounted to 1,000-1,500 t. The daily processing of raw material in the campaign 1989/90 in Poland increased to 2,000 t and in Germany to 7,000 t [Walkenhorst 1998, p. 8]. Reforms and policy towards the industry should lead to the sector's development but structures which were built did not cause improvement in the sector's effectiveness just as they did in Western Europe. In the 1980s the basic technical and economic indexes (efficiency of

¹⁸ Werbkowice (1963), Łapy (1971), Krasnystaw (1976), Ropczyce (1979) oraz Gliniojeck (1986).

¹⁹ The unification covered: sugar factories, Sugar Industry Institute, Sugar Industry Project Office "Cukroprojekt" and Plant of Slicing Knives.

sugar from beet, consumption energy, work efficiency) did not improve [Chudoba 1991, p. 57]. Sugar plants were also investing in the social sphere which generated costs and became a huge burden in the face of reforms after the liberalization of the market [Wykrętowicz 1997, p. 68].

Economic voluntarism, understood as the primacy of politics over economics, resulted in the fact that the effectiveness of management did not improve. The state's monopoly eliminated competition between sugar plants which was not replaced by competition promoted by the authorities. The extreme inefficiency of the sector in centrally planned economy was clearly visible on the market because there were periodical shortages of supply and the prices of sugar were detached from the market mechanism. Attempts were made to solve problems with supply using a system of rationing with food cards (e.g. 1952-1953, 1976-1985).

1.5.3. Regulations in the years 1990-2003

Liberalization of the market in the sugar sector took place in March 1990 when Cukropol's organizational structure was liquidated [Wykrętowicz 1997]. Sugar plants obtained the status of independent companies (restoration of legal personality) and success or failure were now to depend on the autonomous decisions of companies. The subsequent years saw the beginning of integration with the EU²⁰ and the Uruguay Round GATT (RU GATT) ended. During the first years of market economy, the supply and demand situation on the domestic market of sugar was variable and the lack of market balance resulted in large variability of prices which negatively affected the financial situation of the sugar industry²¹. The perspective of the accession to the EU, changes in commercial regulations and the need for structural reforms were the main reasons for introducing market regulations. The statutory regulation of the sugar market and ownership transformations in the sugar industry²² became effective as of October 1, 1995 and coincided with the introduction of the provisions of RU GATT/WTO²³. Market regulations were modeled on the system valid in the EU but similarities related only production quotas: A – for the supply of the domes-

²⁰ Europe Agreement Establishing an Association between the Republic of Poland and European Communities, signed on 16 December 1991, and, after ratification by the parliaments of Poland, member states and the European Parliament, became effective on 1 February 1994.

²¹ *Rynek cukru. Stan i perspektywy*, no. 8, IERiGŻ-PIB, ARR, MRiRW, Warsaw 1995, pp. 19-25.

²² Act of 26 August 1994 on ownership transformations in the sugar industry. Journal of Laws No. 98 item 473. Act of 20 November 1996 on amendment to the Act on sugar market regulation and ownership transformations in the sugar industry. Journal of Laws No. 125 item 724.

²³ The Agreement on Agriculture, www.wto.org/english/docs_e/legal_e/14-ag_01_e.htm.

tic market and B – for export with subsidies. Quota A was determined by the Council of Ministers until August 1 of the year preceding the sugar campaign and the Ministry of Agriculture determined what quantities of sugar could be introduced into the domestic market in particular quarters. In the years 1995-2003 quota A was determined at the level of 1,520-1,650 t and quota B corresponded to the WTO quota and was reduced to 104.4 t (Tab. 1). Financial funds for export subsidies came from fees collected during the sale of sugar for the domestic market (approx. 7% of the sales price) which were transferred to the Agency for Restructuring and Modernization of Agriculture (ARiMR). Production above the determined limits was defined as sugar C and should be exported without transportation refunds. Foreign trade regulations included customs protection which resulted from GATT/WTO negotiations. Customs rates were high and amounted to no less than EUR 430/t. Import on preferential terms (EUR 170/t) regarded the so-called quota of access to the market which was 5% of consumption and amounted to EUR 170/t. High customs rates effectively protected the market against the import of cheap sugar from the world market.

An important element of the regulations was the minimum sales price of sugar determined for each season which was to guarantee the profitability of production. Statutory regulations constituted the legal basis and determined the privatization manner of the sugar industry. In the light of the provisions of the act, certain sugar plants were to be privatized in the grower-employee formula which aimed at integrating processing with the base of raw material.

Table 1. Support for export of sugar and molasses in RU GATT

Specification	1995	1996	1997	1998	1999	2000-2004
Agricultural products in total (USD million)	736.7	689.5	642.8	595.7	548.7	499.6
Sugar – export with refunds (thousand t)	127.5	122.9	118.3	113.7	109.1	104.4
Sugar – transportation refunds (USD million)	47.0	44.0	41.0	38.0	35.0	32.0
Molasses – export with refunds (thousand t)	303.7	292.7	281.7	270.7	259.7	248.6
Molasses – transportation refunds (USD million)	15.0	14.0	13.1	12.1	11.2	10.2

Source: *WTO: Schedule LXV – Poland*; Part IV – Agricultural products – Commitments limiting subsidization; Article 3 of the Agreement on Agriculture, Section II: Export Subsidies: Budgetary Outlay and Quantity Reduction Commitments, www.wto.org.

Market regulations were amended in 2001²⁴ and two reasons determined this amendment. First, previous regulations did not guarantee stabilization on the market. Producers did not fulfil the obligation to export sugar C and the internal market experienced a surplus of supply. Sales prices and retail prices decreased below the minimum price. Market imbalance was manifested in the variability of processing margins and negatively affected the financial results of sugar

²⁴ The Act of 21 June 2001 on sugar market regulation. Journal of Laws No. 76 item 810.

plants. Buying prices of sugar beet were stable but resulted in the decrease in the profitability of cultivation under conditions of inflation [Nowak 2002, p. 19]. The second reason was the approaching accession to the EU and the need to introduce such regulations so that the industry could prepare for functioning on the EU market. The amended act introduced the following changes:

- settlement period (sugar season) – from 1 July to 30 June, previously it was the period from 1 October to 30 September,
- the intervention price of sugar replaced the minimum sales price,
- minimum buying prices for sugar beet for the production of quota A and B were introduced,
- production fees paid by producers and growers of sugar replaced fees collected from buyers during the sale,
- the possibility to classify part of sugar C as quota production in the next season,
- subsidies for the consumption of sugar for non-food purposes,
- The Agricultural Market Agency (ARR) administered the sugar market (as well as the market of isoglucose and insulin syrup).

Market regulations in the Polish sugar industry in the years 1990-2003 were ineffective. The supply and demand situation was characterized by large variability and the market often experienced surpluses or shortages of supply (large stock) resulting in high price fluctuations. Sugar prices dropped below the minimum price and negatively affected the financial result of the sugar industry. Restructuring processes proceeded very slowly. 76 sugar plants were functioning in 2001. Some plants conducted one-day campaigns so as not to lose their production quotas which were used by other sugar plants from the same concern. Privatization of the sector was not finished because some plants still belong to the State Treasury. The scattered structure of the raw material base and sugar production were the reason for the low effectiveness of management and high variability of the financial situation [Urban 2004, p. 85].

1.5.4. Regulations in the European Union and their impact on the market's functioning

Regulations for the sugar market in the EU were introduced in 1968²⁵ as an element of the Common Agricultural Policy (CAP). The purpose of the policy was to stabilize prices guaranteeing the profitability of growing sugar beet and the profitability of sugar production as well as to guarantee self-sufficiency as an element of *food security*. Until that time the majority of Western European countries were importers of sugar. The protectionist policy resulted in the fact that the EU became a large producer and exporter of sugar. Until 2006 the general principles of regulations did not change much because CAP's MacSharry reform (1992) and Agenda 2000 did not introduce significant changes in the sugar regime [Purgał 2010]. Small changes applied to foreign trade and were the result of the accession of new member states to the EU. In 1975 Great Britain joined the EU. This country had business relations with India and the African, Caribbean and Pacific Group of States (ACP)²⁶. A commercial agreement was valid in the sugar sector²⁷ which made it possible for former colonies to export approx. 2 million t of raw sugar on preferential terms. Great Britain's accession caused the need to take into account these determinants in the EU market regulations. In a later period, Portugal (1986) and Finland (1995) joined the EU. They refined raw sugar and the regulations needed to take into account the supply for traditional refineries. The WTO agreement for agriculture, signed in 1992 and effective as of 1995, obliged the EU to reduce subsidized agricultural and food export by 21% and the value of support by 36%. The reduction in customs rates amounted on average to 36% and the minimum reduction in each tariff item was 15%. The multilateral sales agreement provided for a gradual growth in quotas of minimum access to the market so as to reach 5% of consumption from the base period in 2000. Customs protection as part of the quotas was not specified and WTO members determined it at the level of 30-50% of basic customs rates [Kawecka and Wyrzykowska 1995].

In the years 2000-2006 market regulations included the following instruments²⁸:

²⁵ Council Regulation No 1009/67/EEC of 18 December 1967 on the common organisation of the market in sugar (Official Journal of the European Union 308 of 18 December 1967).

²⁶ Barbados, Belize, Ivory Coast, Republic of Congo, Fiji, French Guyana, Jamaica, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Saint Kitts and Nevis-Anguilla, Surinam, Swaziland, Tanzania, Trinidad and Tobago, Uganda, Zambia, Zimbabwe.

²⁷ British Commonwealth Sugar Agreement.

²⁸ Council Regulation (EC) No. 1260/2001 of 19 June 2001 on the common organization of the market in sugar (Journal of Laws L 178 of 30 June 2001).

- Sugar production quotas: A – for the supply of the EU market and B for export with subsidies or for the supplementation of supply on the internal market. Production above quotas A and B constituted *out of quota sugar*. The methods for managing out of quota sugar were restrictive: obligation to export outside the area of the EU without transportation refunds until the end of the campaign (season), consumption for non-food purposes, classification of the surplus for quota production in the next season, the European Commission could also enable sales on the EU market. During accession negotiations Poland gained quota A – 1,580,000 t and quota B – 91,900 t which constituted, accordingly, 10.7% and 3.4% of the EU production limit.
- Official prices included the minimum buying price for sugar beet with standard content of sugar 16% and the intervention price of sugar. The minimum buying price for raw material for the production of quota A was EUR 47.67/t and quota B – EUR 32.43/t. The difference in the level of prices constituted financial funds for subsidies for the export of sugar. The intervention price of sugar amounted to EUR 631.9/t and was higher than prices on the world market. Producers paid fees in the amount of 2% of the intervention price of quota A+B and additionally 37.5% of the intervention price for sugar quota B which were used to finance subsidies to export.
- Foreign trade regulations related to the market's protection, support for export as well as monitoring of turnover (licenses). Subsidized export of EU member states allowed by WTO amounted to approx. 1.3 million t of sugar and the value of support EUR 497 million. The EU market was protected by high customs duties (EUR 419/t of white sugar) as well as non-tariff tools (e.g. quantitative and technical barriers). Sugar was imported mostly as part of preferential quotas:
 - no-customs quota for ACP countries (1,294 t per white sugar)²⁹ and India (10,000 t) which was included by WTO to the quota of minimum access to the EU market,

²⁹ Lomé conventions, trade and development agreements concluded between the EU and ACP. The aforementioned states may use trade facilitations and financial aid, can export their products without customs problems (except for some agricultural products) to the EU, and, at the same time, protect their internal markets by customs duties system. The first convention was signed in Lomé on 28 February 1975, and they were prolonged a few times along with time. To execute the convention, the Council of Ministers, the Committee of Ambassadors and the Parliamentary Assembly were created.

- no-customs quota 98,100 t granted to the least developed to LDC (*Least Developed Countries*) in the world³⁰ as part of the EBA agreement (*Everything But Arms*)³¹,
- preferential quota 85,500 t of raw sugar for the supply for traditional refineries which applies to Brazil and Cuba, for a reduced customs rate EUR 98/t.
- Actions increasing demand on internal EU market, e.g. refunds for consumption of sugar for non-food purposes (e.g. beekeeping).
- Buying-in of surpluses of sugar supply.

The characteristic feature of the sugar market regulations was self-financing of the system and high effectiveness. Support for export was paid from premiums collected from growers and producers. In the case of other agricultural and food products, export refunds were paid from budget funds. The effectiveness of regulations was depicted by the balance of supply and demand, stable prices and the lack of the need for intervention buying³². However, the regulations were criticized for high prices on the internal market and small price competitiveness on the international market, they also did not encourage the growers and producers to reduce costs and improve the effectiveness of management [Chudoba 2004, p. 32]. Subsidized export from the EU increased the supply on the world market. The world prices of sugar were low which negatively affected the economic situation of developing countries. In 2005 WTO, at the request of Australia, Brazil and Thailand, questioned the EU export subsidies in the sugar industry³³. The European Commission, taking into account the need to improve competitiveness, WTO's position as well as interests of the food market participants introduced a reform of the market regulations³⁴.

³⁰ Angola, Benin, Burkina Faso, Burundi, Cape Verde, Central Republic of Africa, Chad, Comoros, Republic of Congo, Djibouti, Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi Mali, Mauretania, Mozambique, Niger, Rwanda, Saint Tome and Principle, Senegal, Sierra Leone, Somalia, Sudan, Tanzania, Togo, Uganda, Zambia, Afghanistan, Bangladesh, Bhutan, Cambodia, Laos, Maldives, Myanmar, Nepal, Timor, Yemen, Kiribati, Western Samoa, Solomon Islands, Tuvalu, Vanuatu, Haiti.

³¹ EBA Initiative – in 1995 economically developed WTO countries undertook to open their markets for exports from LDC. The EU resumed the initiative in February 2001 to give LDC full, duty and quota-free access to the EU market for all products, except for weapons. However, an exclusion (derogation) is binding, including sugar, bananas and rice.

³² In the dairy sector limiting supply has been in place since 1984 but it was necessary to conduct intervention buying-in of skimmed milk powder and butter.

³³ *European Communities – Export Subsidies On Sugar, AB-2005-2, WTO, 28 April 2005.*

³⁴ Council Regulation (EC) No. 318/2006 of 20 February 2006 on the common organization of the market in sugar (Official Journal of the European Union L 51/1, 28 February 2008). Council Regulation (EC) No. 319/2006 of 20 February 2006 amending Regulation (EC) No.

- Quotas A and B were combined and reduced. The production quota from season 2009/2010 is 13,300 t per white sugar as compared to 17.4 million tons in season 2005/2006. In the first period of the reform producers were offered "the purchase" of an additional production quota 1.1 million t for a single fee of EUR 730/t. Sugar companies used this opportunity. The financial effectiveness of this investment was doubtful due to the long period of return. In addition, production quotas were reduced as soon as in the following year.
- The minimum buying price for sugar beet was reduced by 40% to EUR 26.29/t. Lower buying prices resulted in the decrease in the income of growers which was compensated by sugar payments not related to production in approx. 60%. In the years 2007-2014 the EU allocated EUR 1,542 million annually for sugar payments. The intervention price of sugar was replaced with the reference price and was reduced by 36% to EUR 404.4/t (Tab. 2).
- In order to encourage the reduction in production by producers characterized by the lowest competitiveness, a restructuring system was introduced which consisted in renouncing production quotas for financial assistance. The restructuring fund was supplied by producers with decreasing restructuring fees. Then, the raised funds were paid to producers so as to alleviate the economic and social effects of stopping production. Approx. 10% of funds from assistance for restructuring was reserved for growers and entities providing services for growers. Regions particularly affected by restructuring could count on the so-called assistance for diversification.
- The reform introduced small changes regarding foreign trade: reduction in the export of sugar out of quota, transportation refunds and, first of all, increase in the share of import in supply for the market.
- Instruments supporting the maintenance of market balance were not changed. The buying-in may be no more than 600,000 t of sugar. The intervention price is 80% of the reference price. In addition, the fol-

1782/2003 establishing common rules for direct support schemes for farmers under the common agricultural policy and establishing certain support schemes for farmers (Journal of Laws L 58/32 28 February 2008). Council Regulation (EC) No. 320/2006 of 20 February 2006 establishing a temporary scheme for restructuring of the sugar industry in the Community and amending Regulation (EC) No. 1290/2005 on the financing of the common agricultural policy (Official Journal of the European Union 58/42, 28 February 2008).

lowing actions remain: transferring produced surpluses for the following season and support for private storage.

Table 2. Selected elements of sugar market regulation reform in the EU

Specification	2006/07	2007/08	2008/09	2009/10
Production quota (thousand t of white sugar)	17440.5 ^{a)}	16599.1	13468.8	13336.7
Reference price of white sugar (EUR/t)	631.9	631.9	541.5	404.4
Reference price of raw sugar (EUR/t)	496.8	496.8	448.8	335.2
Minimum buying price of beet (EUR/t)	32.86	29.78	27.83	26.29
Production fee (EUR/t of sugar)	-	12	12	12
Restructuring fee (EUR/t of sugar)	124.6	173.8	113.3	-
Restructuring assistance (EUR/t of sugar)	730	730	625	520
Sugar payments (EUR million)	907	1542	1542	1542

^{a)} *Basic quota but, due to the market situation, the quota was once reduced to 15,047,700 t. Regulation of the Commission (EC) No. 493/2006 dated March 27, 2006 laying down transitional measures within the framework of the reform of the common organization of the markets in the sugar sector, and amending Regulations (EC) No. 1265/2001 and (EC) No. 314/2002, Official Journal of the European Union L 89/11 dated March 28, 2006.*

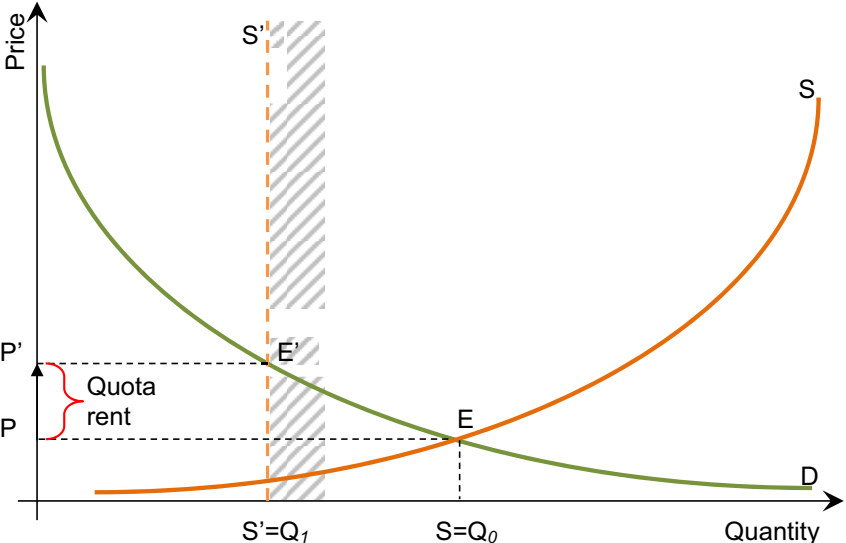
Source: Prepared by the author, Council Regulation (EC) No. 318/2006.

The reform of the sugar market regulation ended in 2010 and had both negative and positive effects. A critical assessment of the reform is formulated, first of all, by the sugar industry and growers. The profitability of growing sugar beet decreased as a result of a decrease in buying price which was not fully compensated by sugar payments [Skarżyńska 2011]. The sugar industry critically assesses the reform due to the high costs of restructuring. In the case of certain member states, including Poland, the value of paid restructuring premiums was higher than the obtained assistance [Szajner 2012, p. 452]. One of the negative effects of the reform was the deterioration of the foreign trade balance because the EU became a net importer. The purpose of the reform was also to decrease sugar prices on the EU market as well as to improve cost and price competitiveness of the sugar industry. For this purpose, the minimum buying price and the reference price were reduced. During the reform, world prices which were significantly lower than those in the EU for many years increased and importing at low prices became impossible. The purpose of the reform regarding the drop in sugar prices and improvement in price competitiveness was not achieved. In the years 2009-2012 the prices of sugar on the world market were exceptionally high and they decreased significantly no sooner than in 2013.

The EU market policy in the sugar industry is interference in market laws. The principle of administrative restriction of supply may be graphically depicted using the law of *supply and demand* [Samuelson 2004]. Supply curve S and demand curve D determine the market balance E. If the determined balance price P is low and does not guarantee the profitability of production and the supply Q

is high and there are problems with its management, then the administration may decide to introduce supply limits. The production quota is "a rigid curve of supply" S' . Introducing smaller production limits Q' should solve the problem of low prices and surpluses of supply. The production quota and the unchanged demand curve determine the new market balance E' and the growth in prices P' ("quota pension") (Fig. 4).

Figure 4. Impact of production quotas on market on functioning

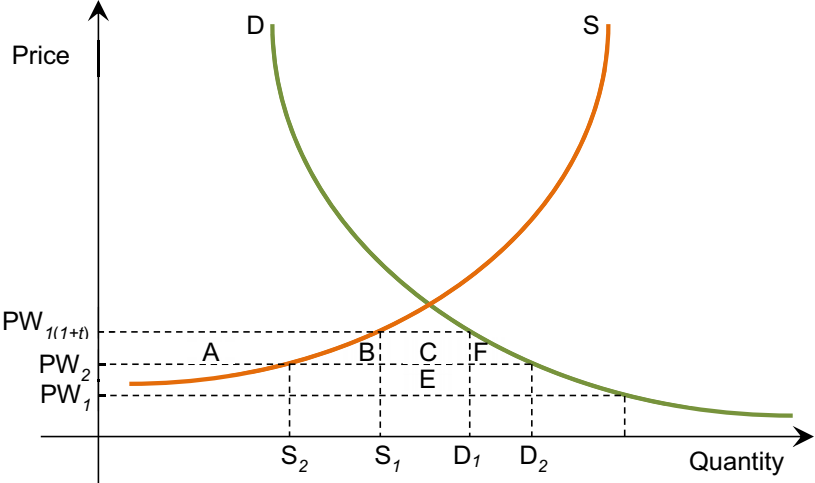


Source: Prepared by the author.

The economic reality, however, is more complicated because markets do not function under autarkic conditions. The economic situation on the international market has a large impact on the supply and demand situation on the internal market. If world prices are lower than prices on the internal market, then introducing production quotas is economically justified only when high customs duties are maintained. The effectiveness of production quotation thus depends on other instruments of market regulation. Protectionist policy towards sugar production in the EU as well as in other industrialized countries guarantees maintaining production but has negative impact on the situation on the world market. Customs protection is a key element of the regulation. The impact of trade liberalization and market regulations on welfare in economically developed countries being net importers may be graphically depicted in a simple manner (Fig. 5). Prices on the internal market PD_1 result from the relation between demand D_1 and supply S_1 , while market balance is guaranteed by import D_1-S_1 . Domestic prices are higher than world prices PW_1 which is determined by

customs duties t and transport costs. In simplification, domestic prices correspond to world prices increased by customs duties $PD_1 = PW_1 + t$. The reduction in customs duties causes reactions on the supply and demand side because the effect is a decrease in domestic prices to PD_2 . Lower prices cause a reduction in supply S_2 because ineffective manufacturers will not generate profit. The decrease in prices will contribute to an increase in demand D_2 and import $D_2 - S_2$. Changes in the supply and demand situation are ambiguous in the micro-economic perspective. Reducing the producer surplus is shown graphically by area A. At the same time, the increase in consumer surplus is shown by the sum of areas $A+B+C+F$. The decrease in revenues from customs duties $C+F$ negatively affects the budget situation. Effects for the entire economy are reflected by the sum of areas $C+E$ which constitute benefits for consumers decreased by producers' losses and lower budget receipts. The conducted theoretical discussion indicates the fact that economic effects of market liberalization are ambiguous.

Figure 5. Impact of liquidation of customs tariffs on market situation

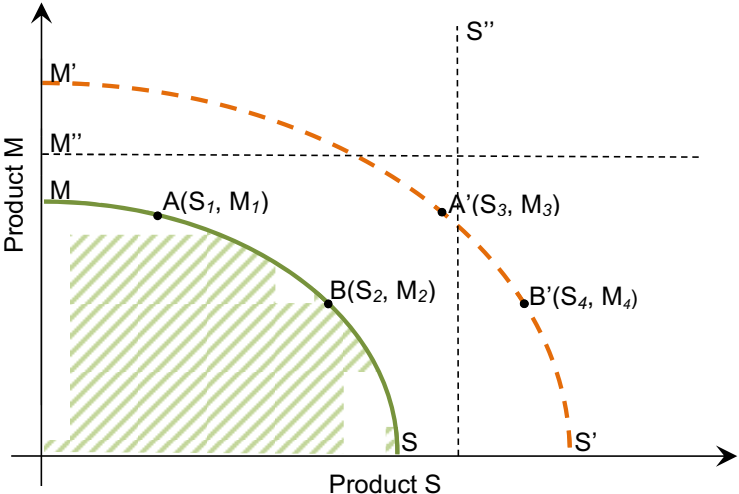


Source: Prepared by the author on the basis of OECD: *Sugar policy reform in the European Union and in World Sugar Market*, Paryż 2007, p. 45.

Production quotas result in numerous other problems which may have fundamental significance in the context of efficiency of management at the micro- and meso-economic level which is the necessary condition for building permanent competitive advantages [Kulawik 2007, p. 25]. Efficiency is understood as the maximization of production resulting from a proper allocation of resources (work and capital). Referring to the concept of welfare, an economy is

considered efficient if it is impossible to increase the welfare of a unit, without deteriorating the economic situation of someone else [Samuelson 2004, p. 26]. An efficient allocation of resources is shown graphically by *the production frontier SM*. The curve of production capacities shows the maximum production which may be generated by the sector with available resources of factors and technical knowledge, as well as depicts a set of goods and services available for the society (Fig. 6). The economy is efficient if increasing the production of product S requires reducing the production of product M. The growth in the production of products S requires larger expenditures and smaller resources remain which may be spent on the production of goods M. Technological progress and restructuring make it possible to shift the production frontier (S' , M'). Then, it is possible to increase the production of all products due to managing resources which were previously used inefficiently. This process may be limited by the administrative determination of supply limits (S'' , M'') which is used in certain systems regulating food markets in the EU. Production quotas determined at a level lower than the production frontier reduce the efficiency of economic activities. When business entities are adapting to new conditions they are forced to conduct restructuring, often deep and expensive, and its effects will be visible after some time. This may result in the disorder of market mechanisms and imperfect competition is intensified under such conditions. The economy's efficiency increases if relations on a given market are getting closer to the condition of perfect competition [Varian 2002].

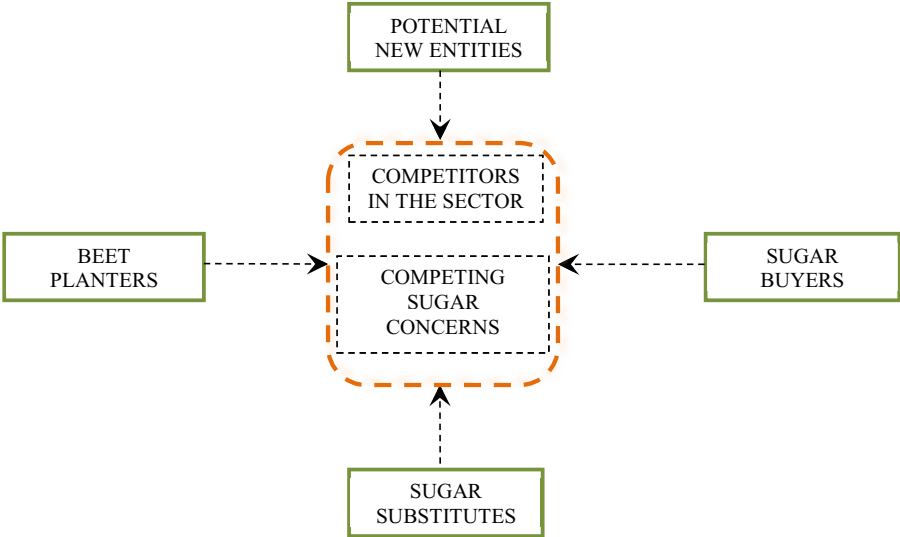
Figure 6. Production frontier in the context of production quotas



Source: Prepared by the author on the basis of Samuelson P.A., Nordhaus W.D.: *Ekonomia*, Warsaw 2004, pp. 34-39.

Competition is the main force arranging the economy by ensuring the allocation efficiency of the use of rare resources (*the invisible hand of the market*). The intensity of competition is not an issue of coincidence but mainly results from the market's structure as well as from the policy conducted towards the sector. Competitiveness is the result of *five competitive forces*: rivalry between the sector's entities, the suppliers' bargaining power, the buyers' bargaining power, hazards from substitutes as well as the threat of the entry from new entities [Porter 2006, p. 24]. Market regulations in the EU sugar sector have a huge impact on the effect of competition forces. Production quotas are allocated to producers and limit the hazard of new entities entering the sector. High customs rates limit import to preferential quotas which is not competition for producers. The buyers' and the suppliers' bargaining powers are poor. Relationship with growers are regulated by cultivation agreements and the sugar oligopoly results in the fact that farms have little possibilities to select the recipient. The demand for sugar, which is the main sweetener, is stable and non-flexible which is favorable for the producers. The threat from substitutes is small despite the developing market of starch syrups (e.g. isoglucose) and low-calorific sweeteners (e.g. saccharine, aspartame, acesulfame potassium) (Fig. 7).

Figure 7. Competition intensity forces on the example of the sugar sector



Source: Preparation on the basis of Porter M.E.: *Competition strategy. Metody analizy sektorów i konkurentów*, MT Biznes, Warsaw 2006.

The sugar market in the majority of industrialized countries, including the EU, is characterized by an oligopolic structure and is dominated by several world

concerns. An oligopoly is a market structure and a form of imperfect competition in which there are several producers of a specific product (service) which are associated with a large number of consumers. Producers may compete with one another to a various degree but they may also mutually understand their strategic interests. In general, two models of the oligopoly's behaviour are distinguished: plot (cartel, trust, syndicate) as well as interactions between its participants. Plots between producers which negatively affect market competition and have unfavorable consequences for consumers are forbidden by the law³⁵. Interactions between the oligopoly's participants are based on the theory of games. A company making strategic decisions regarding prices or the sales volume as the first one is defined as the leader and needs to expect responses from other producers (followers). If the followers know the leader's decisions, then a sequential market game takes place. When the leader's decisions are not known and they are guessed at, then a simultaneous market game takes place. Such a simplified classification generates four models of the oligopoly's functioning:

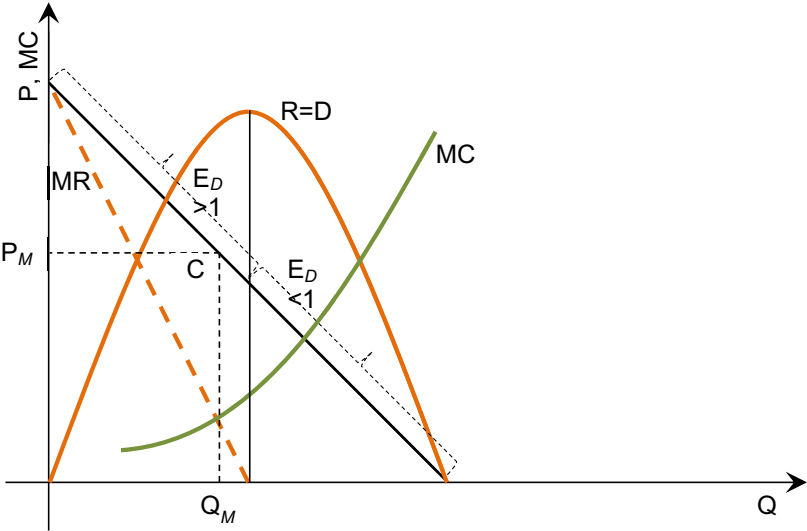
- quantitative (supply) leadership – Stackelberg model – the leader appoints the supply volume but takes into account the response from other producers (followers),
- price leadership – the leader appoints the price of his products but also takes into account the followers' decisions, what their supply will be at a fixed price,
- simultaneous determination of quantity (supply) – Cournot model – each participant of the oligopoly selects production at such a level so as to maximize his profits at given expectations regarding the competitors' decisions,
- simultaneous determination of price – Bertrand model – each producer selects the sales price for his products or services at such a level so as to maximize his profits at given expectations regarding the competitors' decisions [Varian 2002, p. 511].

The oligopoly's behaviour may be illustrated graphically on the example of the Cournot model [Köster 2010, p. 130]. The function of production (reve-

³⁵ The Sherman Antitrust Act (Sherman Act, July 2, 1890, ch. 647, 26 Stat. 209, 15 U.S.C. §§ 1-7). Hart-Scott-Rodino Antitrust Improvements Act of 1976, (Public Law 94-435, Title 3, Sec. 305(a), 90 Stat. 1383 at p. 1397. Council Regulation (EC) No. 1/2003 of 16 December 2002 on the implementation of the rules on competition laid down in Article 81 and 82 of the Treaty (Text valid for EEA), L 1/1 of 4 January 2003 Council Regulation (EC) No. 139/2004 of 20 January 2004 on the control of concentration between undertaking (the EC Merger Regulation) (Text valid for EEA), L 24/1 of 29 January 2004.

nues) of oligopoly R is at the same time the function of demand D . The oligopoly's participants may obtain the maximization of revenues (financial result) by determining sales prices or the supply volume. If the oligopoly decides to raise product prices, then it needs to be prepared for changes in the demand curve. Changes in supply will result in the determination of a new market balance and changes in prices. Producers thus consider decisions regarding supply which will provide maximum revenue. Therefore, it is necessary to compare the marginal revenue MR with marginal costs MC . As long as the marginal revenue is higher than marginal costs, it is justified to increase supply which, in the end, will result in reducing prices and the marginal revenues will be smaller and smaller. If the supply is defined at the level Q_M and the marginal revenue is equal to marginal costs, the market price will amount to P_M . Point C , located in the flexible part of the chart $E_D > 1$, corresponds to the price determined on the chart of the function of demand D . The oligopoly will increase production only under conditions of flexible demand which is clearly reflected by the course of the revenue function curve R and it is identical to the consumer expense curve (Fig. 8).

Figure 8. Functioning of the oligopoly on the market



Source: Prepared by the author on the basis of Köster U: Grundzüge der landwirtschaftlichen Marktlehre, Munich 2010.

The sugar market structure in the EU, including Poland, is characterized by all features of a classic oligopoly. The number of sugar concerns is small and their main product has standardized properties. The oligopoly's functioning

model, however, is determined to a significant extent by the system of market regulations. Production quotas, the minimum buying price of the raw material and the reference price of sugar make sugar companies able to compete to a small degree using prices and the sales volume. In consequence, there are no models of the market game based on price and quantitative leadership. The strategy of competing between the oligopoly's participants focuses, first of all, on the leading position in terms of total costs. The remaining two types of competitive strategies: diversity of the offer (distinction) and focus on a specified segment of the market may be implemented to a smaller degree which is determined by the homogeneous product and groups of target recipients (households and the food industry) [Porter 2006, p. 60].

2. World sugar market

2.1. Raw material base for the sugar sector

2.1.1. Sugarcane

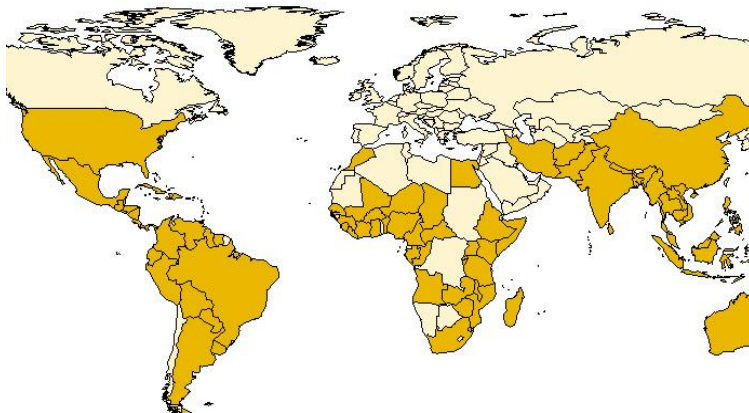
The beginnings of growing sugar cane for sugar are dated to the period ca. 8,000 BC, when the inhabitants of New Guinea were probably the first to discover this plant's properties. In further ages, the cultivation of sugar cane spread to the region of Polynesia and to the Asian continent (India, China) [Lippmann 1890, p. 31]. The first references to sugar cane and sugar made from it in Europe date back to the 3rd century BC, but larger quantities of sugar were imported no sooner than in the age of the Roman Empire (ca. the 11th century). For a long period of time, cane sugar was a luxury in Europe and it was often used as medicine. Along with the discoveries of Christopher Columbus and the development of cultivations within the Caribbean, sugar began to be more available in European countries. However, no sooner than in the 19th century, along with the reduction in customs and tax burdens for the sugar trade at that time, did it become a common product. Relations in the colonies and the struggle for influence between Great Britain and France caused the suspension of the deliveries of cane sugar for the entire Europe and sugar beet was gradually being used more and more often in cultivations. At the end of the 19th century, the production of beet sugar exceeded the quantity of sugar available in Europe from the refinement of sugar cane. However, the supply of cane sugar in the world was gradually being increased. A breakthrough in the significance of cultivation and production of sugar from sugar cane took place in the 20th century and at the end of the 1980s it exceeded the production volume of beet sugar. Currently, more than 180 million t of sugar (per raw sugar) is produced in the world, more than 80% of which is sugar made from sugar cane³⁶.

Sugar cane (*Saccharum officinarum* L.) belongs to perennial plants. The grass reaches a substantial height (even up to 6 m) and is cultivated between 30°N and 30°S (Fig. 9). It requires a tropical or a subtropical climate with annual precipitation amounting to at least 600 mm/m² and good, hardly permeable soils. Sugar is obtained mainly from stems rich in juice in which the content of sucrose ranges from 13 to 20%. Sugar cane is planted manually from saplings (less frequently from seeds) which contain at least one bud. Harvest time (*zafra*) takes place usually twice a year, by cutting the stems near the ground manually or mechanically. The remaining stems grow back producing subsequent crops but the

³⁶ *World Sugar Balances 2004/05-2013/14.*, F.O. Licht's "International Sugar and Sweetener Report", Germany, 2013.

following crops are usually poorer. Harvesting takes place 2 to 10 times between subsequent plantings. Apart from the acquisition of sugar, sugar cane is also widely used in other branches of the economy, e.g. it is used for the production of rum, ethanol and in the pharmaceutical industry, the paper industry or in the construction industry.

Figure 9. Presence of sugar cane cultivation



Source: Prepared by IERiGŻ-PIB on the basis of FAO data.

The world area of sugar cane cultivations amounted to 25.8 million ha in 2012 and was 1.6% larger than in the previous year (Tab. 3). In the relative perspective, the average annual growth rate in cultivation area was determined using the formula of compound percentage [Luderer 2010, p. 34]. The mathematical transformation of the formula makes it possible to determine the average annual dynamics of the analyzed phenomenon (2-1). The area allocated for plantings of this plant grew on average annually in the last 50 years by approx. 2.1% and its dynamics was higher in the years 1961-1990 than in the last two decades. Cultivation developed mainly in South-Eastern Asia and in South America where it grew annually in the examined period by 3/2-3.5% and its current share in the geographic structure of cultivation exceeds 80%. Only Middle and Western Africa was characterized by a higher dynamics of the growth in sugar cane cultivation but this region has a minute share in the world area. The growth in cultivation was determined in the initial period by the growing consumption of sugar along with the economic development of numerous regions of the world. In the last dozen or so years the development of technology and the possibilities to use sugar cane for the production of bioethanol, used in the fuel sector, played an important role. The share of arable land used for the cultivation of sugar cane in the total cultivation area in the world increased in the examined period from

0.7 to 1.8% but this cultivation is currently of major significance for the agriculture and economies of numerous countries. In Caribbean countries (e.g. the Bahamas, Barbados, Martinique) and countries in South-Eastern Africa (Swaziland) and on islands of the South-Western Indian Ocean (Mauritius, Reunion) sugar cane cultivation constitutes from 30% to more than 70% of total cultivation.

(2-1)

$$K_n = K_0 \cdot \left(1 + \frac{r}{100}\right)^{n-1} \Rightarrow r = \left(\sqrt[n-1]{\frac{K_n}{K_0}} - 1\right) \cdot 100$$

where:

K_0 – value of feature in the initial period (the first year)

K_n – value of feature in the final period (year n)

r – return rate – average annual return rate

Table 3. World area, yields and harvests of sugar cane

Specification	Area of cultivation	Yields	Harvest
	million ha	tons	million tons
	average annually in periods		
1961-1970	9.7	51.6	504
1971-1980	12.3	54.6	676
1981-1990	15.8	59.9	946
1991-2000	18.6	63.3	1 179
2001-2010	21.6	68.3	1 480
2010	23.6	71.7	1 689
2011	25.4	70.9	1 800
2012	25.8	68.8	1 774

Source: Prepared by IERiGŻ-PIB on the basis of FAO data.

Sugar cane yields, with the improvement in agricultural techniques and used varieties, increased in the examined period from approx. 50 t/ha to the average of 70 t/ha, namely by approx. 0.6% annually. In numerous countries, however, yields are much higher than the average and exceed 100 t/ha, and with favorable weather conditions and relatively young plantations – even 130 t/ha (Salvador, Peru, Columbia, Ethiopia). Recent years, however, saw the reduction in the volume of yields as a result of too large precipitation or periodical droughts, an increased presence of pests and losses caused by ground frosts. The consequence of the above is the acceleration of works on the introduction of genetically modified (GMO) sugar cane for cultivation, mainly with an increased tolerance for water deficits and an increased content of sugar. In 2013 Indonesia³⁷, as the first country in the world, approved the use of a variety of GMO sugar cane at the level of food and environmental safety which makes it possible

³⁷ Indonesia. *Agricultural Biotechnology Annual. Gain Report – Global Agricultural Information Network*, no ID 1338, USDA Foreign Agricultural Service, July 2013.

to start commercial cultivation in the nearest future. Brazil also conducts field tests with the use of a variety of sugar cane resistant to herbicides and pests.

Higher yields made world harvest of sugar cane grow at a faster rate than their area. In the years 1961-2012 they increased on average by 2.7% annually, namely from the level of 448 million t to 1,774 million t. The largest producer of sugar cane is still Brazil where harvest in 2012 amounted to 671 million t and was almost two times higher than in the next country – India (Tab. 4). Sugar cane cultivation and crops are very concentrated. The five largest producers have a 73% share in the world supply of this raw material and more than 50% of share in the world production of sugar.

Table 4. Main producers of sugar cane

Years	Brazil			China			India			Thailand			Pakistan		
	a)	b)	c)	a)	b)	c)	a)	b)	c)	a)	b)	c)	a)	b)	c)
	average annually in periods														
1961-1970	1.6	44.5	71	0.3	33.4	10	2.4	45.1	110	0.1	37.4	3	0.5	35.9	19
1971-1980	2.1	50.2	108	0.5	35.8	18	2.7	50.7	140	0.3	44.8	15	0.7	36.4	25
1981-1990	3.8	61.1	231	0.8	53.5	44	3.1	59.3	186	0.6	47.0	27	0.8	40.3	34
1991-2000	4.5	66.4	303	1.1	62.8	70	3.9	68.7	268	0.9	52.9	48	1.0	45.4	45
2001-2010	6.6	75.3	502	1.5	66.2	99	4.4	66.3	291	1.0	62.3	62	1.0	49.5	51
2010	9.1	79.0	717	1.7	65.7	111	4.2	70.0	292	1.0	70.3	69	0.9	52.4	49
2011	9.6	76.4	734	1.7	66.5	114	4.9	69.2	342	1.2	76.2	96	1.0	56.0	55
2012	9.4	71.3	671	1.8	68.8	123	5.1	68.3	348	1.3	74.2	96	1.0	55.5	58

a) area (million ha), b) yields (t/ha), c) harvest (million t)

Source: Prepared by IERiGŻ-PIB on the basis of FAO data.

2.1.2. Sugar beet

The first references to plants belonging to the family of beet date back to ca. the 4th century BC but until 1600 they were mainly grown as garden plants and were fodder for animals. Beet leaves were often eaten. With time, the roots of red beet commonly referred to as beetroot, started to be used. The chemical composition of beet roots was determined no sooner than in the middle of the 18th century and their cultivation started on an industrial scale at the beginning of the following century.

Sugar beet (*Beta vulgaris L.*) is a plant from the Amaranth family (the goosefoot family) with the period of vegetation 6-7 months. It is a biennial plant. In the first year the beet produces a storage root and in the next year – the flower branch with seeds. It is cultivated in a moderate climate and requires good and very good soils (quality class I-IIIb) with a high content of organic matter [Ostrowska 2005] (Fig. 10). Sugar beet is a valuable plant in crop rotation, leaving a very good position for subsequent plants and is characterized by the highest production of oxygen among cultivated plants. Plantings are made from seeds

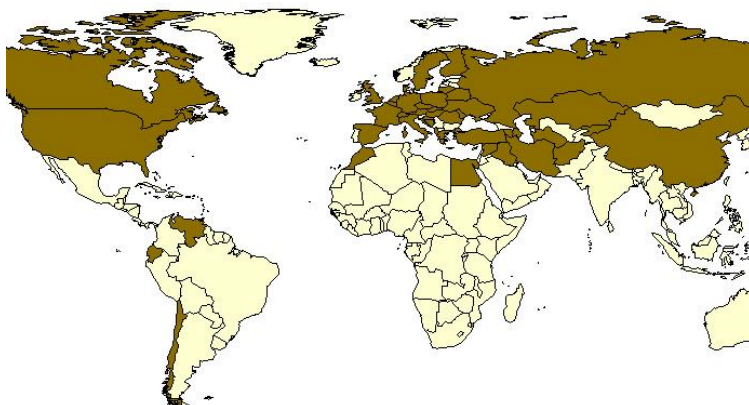
which are present in several hundred varieties, differing from one another in size and stability of yields, the leveling of roots, the date of sowing and the resistance to numerous diseases and pests related to the phytosanitary condition of position intended for cultivation [Starczewski 2006]. The main product obtained from beet are roots in which 75% is water and 25% is dry mass, with the prevailing share of sucrose (up to 20%)³⁸. Sugar beet is mostly used for the production of sugar but, as in the case of sugar cane, the demand from the fuel industry and bioethanol production is growing. Waste products of the sugar industry (molasses, beet pulp) as well as beet leaves are valuable fodder, especially for cattle. Molasses is used to obtain many chemical products, e.g. bioethanol, glycerin and citric acid.

Sugar beet, just like sugar cane, has become the object of numerous research and tests aiming at the production of new GMO varieties. Three genetically modified varieties are currently approved in the USA, Canada and Japan for cultivation and to be used as an ingredient of fodder. These varieties are resistant to herbicides. The EU conducts several dozen field tests with the use of GMO varieties which are characterized by the resistance to the use of glyphosate and viral diseases (*rhizomania*).

In 2012 sugar beet was grown on 4.9 million ha in total which constituted 0.3% of the world acreage of arable land. Plantation areas are located, first of all, in Europe – currently approx. 70% of the planting area referred to above, including in the EU – approx. 33%. The share of the remaining continents in the cultivation area of sugar beet is: Asia 16%, North America 9%, Africa 4% and South America 1%. Sugar beet in particular countries has a small share in the planting structure in total (1-3%), and exceeds 5% only in several cases (Belgium, the Netherlands 7-8%).

³⁸ *Sugar Beet. White Sugar, Agribusiness Handbook*, FAO, 2009.

Figure 10. Presence of sugar beet cultivation



Source: Prepared by IERiGŻ-PIB on the basis of FAO data.

The world area of sugar beet planting was increasing gradually until the middle of the 1970s, reaching the maximum number of 9.4 million ha and was kept within the boundaries of 8.5-9.0 million ha in the subsequent two decades (Tab. 5). In the later period, the area of sugar beet cultivation was gradually reduced. This resulted mainly from the deep restructuring of the sugar sector in Central-Eastern Europe and the sugar market regulation reform in EU countries (e.g. reduction in production quotas). At the same time, the cultivation and production of sugar was systematically being concentrated, the technological efficiency of the sugar industry improved which affected the reduction in the demand for this raw material necessary for the production of the required quantity of sugar. Plantation areas were concentrated in regions with the most favourable soil-weather conditions and an appropriate structure of farms. All countries also experienced an improvement in the level of agricultural techniques through an increase in the mechanization of harvest, the popularization of modern planting technologies, an improvement and rationalization of fertilizing and the use of plant protection products.

As a result, the yields of sugar beet increased on average annually in the years 1961-2012 by 1.7%, namely from 21 t/ha to 55 t/ha. Under convenient agro-climatic conditions and with an adequate selection of seeds, fertilizing and chemical protection, they may exceed 80-90 t/ha (France, Belgium, Spain, Chile). The increase in yields largely compensated the decrease in the area of planting observed from the beginning of the 1990s. In consequence, harvest remained at the level of 230-270 million t in the last two decades.

The production of sugar beet in recent years increased most rapidly in Russia where the growing area of cultivation was accompanied by a rapid increase in efficiency (Tab. 6). Russia's share in the world production of sugar beet in the period 2002-2012 increased from 6% to 17%, overtaking France (13%), the USA (12%), Germany (10%) and Ukraine (7%)³⁹. The sugar market regulation reform in the EU resulted in the fact that plantation areas in regions with the most favorable agro-climatic conditions were gradually concentrated from 2006. At the same time, production was completely stopped in the least competitive regions (Bulgaria, Latvia, Ireland, Portugal and Slovenia). The acreage of cultivation in numerous member states was reduced by 40-60% (Greece, Spain, Italy). Turkey (6% of share) and Poland (5%) still play a significant role in the production of sugar beet among other European countries. In Asia, the largest number of cultivations is located in China, while production in Africa is rapidly developing in Egypt where it doubled in the years 2006-2012.

Table 5. World area, yields and harvest of sugar beet

Specification	Area	Yields	Harvest
	million ha	tons	million t
	average annually in periods		
1961-1970	7.65	26.4	202.4
1971-1980	8.62	30.1	260.3
1981-1990	8.79	33.4	293.8
1991-2000	7.51	36.0	267.6
2001-2010	5.24	46.4	240.7
2010	4.70	48.7	228.7
2011	5.07	53.9	273.5
2012	4.88	55.1	269.1

Source: Prepared by IERiGŻ-PIB on the basis of FAO data.

Table 6. Main producers of sugar beet

Specification	Russia			France			USA			Germany			Ukraine		
	a)	b)	c)	a)	b)	c)	a)	b)	c)	a)	b)	c)	a)	b)	c)
	average annually in periods														
1961-1970	-	0.14	-	0.37	0.40	15.1	0.52	0.39	20.2	0.51	0.36	18.2	-	0.23	-
1971-1980	-	0.15	-	0.54	0.44	23.6	0.52	0.45	23.3	0.63	0.39	24.5	-	0.28	-
1981-1990	-	0.19	-	0.49	0.60	29.5	0.48	0.46	22.2	0.63	0.44	27.6	-	0.27	-
1991-2000	1.00	0.17	17.1	0.45	0.70	31.3	0.57	0.48	27.4	0.51	0.52	26.6	1.19	0.19	22.6
2001-2010	0.83	0.27	22.8	0.39	0.80	31.2	0.50	0.58	28.8	0.41	0.60	24.6	0.61	0.26	15.2
2010	0.92	24.1	22.2	0.38	83.0	31.9	0.47	62.1	29.1	0.37	65.0	23.8	0.49	27.9	13.7
2011	1.22	39.2	47.6	0.39	96.9	38.1	0.49	53.4	26.2	0.40	62.8	25.0	0.51	36.3	18.7
2012	1.10	40.9	45.1	0.39	86.5	33.7	0.49	65.6	32.0	0.40	69.4	27.9	0.45	41.1	18.4

a) area (million ha), b) yields (t/ha), c) harvest (million t)

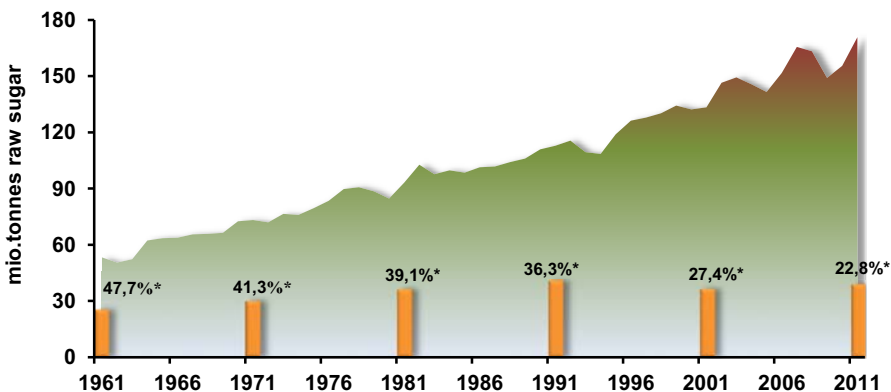
Source: Prepared by IERiGŻ-PIB on the basis of FAO data.

³⁹ Before the fall of the Soviet Union, its share in the world sugar beet production exceeded 30%.

2.2. Production of sugar

In 2011 the world production of sugar, according to FAO data, amounted to 170.8 million t, while production calculated in the marketing year (October 1, 2011 to September 30, 2012) by F.O. Licht was slightly higher (175.3 million t) (Fig. 11). Preliminary data and estimates regarding the volume of production in two subsequent seasons indicate an increase to above 182 million t⁴⁰. Therefore, the production of sugar in the world in the years 1961-2011 was increasing by 2.4% or 2.2 million tons annually. The supply of sugar produced from beet was increasing until the beginning of the 1990s, exceeding the level of 40 million t but its share in the world production of sugar was systematically decreasing from approx. 50% to 35%. Sugar production increased strongly in the subsequent two decades as a result of the development of cultivations in South America and Asia which resulted in the decrease in its share in the structure to approx. 20% with a slight decrease in and stabilization of beet sugar production.

Figure 11. World production of sugar



* share of sugar from sugar beet in the world production of sugar

Source: Prepared by IERiGŻ-PIB, FAO data, F.O. Licht's "Sugar&Sweetener Report".

The production of cane sugar increased within the last 50 years on average by 2.9% annually and it is estimated at 147 million t in the season 2013/14. At the beginning of the 1960s it slightly exceeded 30 million t and this value was doubled within two decades. The dynamics of growth did decrease in the following years but the production of cane sugar in terms of quantity still increased very quickly. At the beginning of the 1990s it exceeded 80 million t and 100 million in the first decade of the 21st century. A further rapid growth in production was recorded in the following decade but its great variability was observed at the same

⁴⁰ World Sugar Balances 2004/05-2013/14., F.O. Licht's "International Sugar and Sweetener Report", Germany, 2013.

time. Fluctuations in the production volume between particular years reached up to 20% and resulted mainly from the weather conditions during vegetation as well as from the level of prices on world markets which affects the increase or decrease in the acreage of cultivation by farmers.

The largest quantity of sugar per raw sugar is produced in Asia which currently holds an approx. 36-37% share in the world supply. This region is also characterized by the highest pace of production growth with dynamics exceeding 4% annually in the years 1961-2011. The scale of production growth in South America was slightly lower (approx. 26.5% of the world supply) but its volume in recent years was more stable than in Asian countries and was not subject to high fluctuations. The development of sugar production in these regions of the world and their increasing significance on the world market took place mainly at the expense of European producers. The share of European countries in the world production decreased within the analyzed years from approx. 35-40% to 13-16%, including the EU from approx. 20 to 9-12%. The stabilization of sugar production in North America also resulted in reducing its importance in world production (from 8 to 5%). Plantations and processing were simultaneously systematically moved from the Caribbean to Central American countries as a result of the growing competition from South American countries despite an increasing access to the European market on the basis of preferential quotas. The systematic development of sugar production in Africa at the level of approx. 2.5 % annually made it possible to maintain the significance of this region in the world production within 6-7%, while the share of Oceania (mainly Australia) decreased from 4% to 2%. The production of sugar increases only in countries and regions classified as economically developing which currently hold approx. 78% of share in the world supply. The pace of growth in sugar production was quicker in importing countries (by 3.5% annually) than in exporting countries (increase by 2.3%) within the last decade. This may confirm the growth in the level of self-sufficiency by countries characterized by its deficit. Despite a higher dynamics of production growth in importing countries, their share in the production of sugar is still lower in total than that of exporting countries (49% and 51% accordingly). Countries with substantial deficits of sugar create 75% of the world demand.

Brazil is still the main producer of sugar in the world. It was overtaken by India only at the turn of the 1980s (Tab. 7). It is estimated that the production of sugar in this country in the season 2014/2013 will exceed 40 million t and will constitute more than 22% of the world supply. The average annual growth in production in this country amounted to nearly 4.8% within the last fifty years

which means that it grew by approx. 0.6 million t in a year. The highest growth in production, however, took place in the last decade when it increased more than 2 times. The main factor stimulating the development are high prices of sugar and crude oil which affects the growing interest in cultivations for energy purposes. In addition, there still is a considerable difference between the price of white sugar and raw sugar the main producer of which is Brazil. In consequence, its export for refinement grows dynamically. The production of sugar in Brazil currently exceeds the domestic consumption by more than 3.3 times. The growth in production in Brazil is affected not only by the systematic growth in the consumption of sugar in the world due to the growing number of people but also the improvement in the economic situation of numerous regions included as developing regions (mainly Asia and the Middle East).

The production of sugar in Asia is concentrated in four countries – India, China, Thailand and Pakistan which jointly have an approx. 85% share in the supply of this continent and an approx. 33% share in the world production. India has the largest production traditions. At the beginning of the 1960s production there exceeded 3 million tons annually. It was relatively low in the remaining countries and in Pakistan it practically did not happen. The development of production in particular regions was diverse. At the beginning, it increased most rapidly in Thailand where it doubled every 5 years on average. This country has shown the largest growths in the production of sugar in the last decade from the level of approx. 5 million t in the season 2005/2006 to more than 11 million t in the current campaign which exceeds the domestic demand by more than 3.2 times. The production of sugar in Pakistan stabilized in recent years within the range 3.5-5.5 million t annually and its fluctuations depend mainly on changes in the area of cultivation. Strong fluctuations have been observed in India in recent years which negatively affects the market situation in this region and in the world. This production doubled in the years 2006-2007 to nearly 31 million t and in 2009 it shrank to only 16 million t. High prices on the world market resulted in a further growth in the acreage of cultivation and sugar production to approx. 28 million t in the season 2013/2014.

The largest quantity of sugar among European countries is produced in Russia, Germany and France where it is approx. 4.0-5.0 million t annually in recent years as well as in Turkey, Poland and Ukraine (2.0-2.5 million t). The market regulations reform in the EU resulted in the fact that production quotas were reduced to 13.3 million t but the actual production amounts to 15-18 million t. The production of sugar in the USSR until the moment of its dissolution in 1991 ranged from 8-9 million t annually which constituted approx. 30% of the

supply in Europe. At the end of the 1990s Russia itself produced only 1.5-2.0 million t of sugar and production exceeded 3.0 million t only in the years 2006-2010. It grew in the subsequent two years to 5 million t due to the rapid growth in the acreage of cultivation and yields of sugar beet (by approx. 33%).

Table 7. Main producers of sugar

Specification	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2009	2010	2011
	million t, average annually in periods							
World	61.6	81.4	101.6	121.6	150.2	149.1	155.5	170.8
South America	7.6	12.0	13.6	20.6	37.8	42.8	47.3	45.3
Brazil	4.2	7.1	8.6	14.4	29.8	34.6	39.9	37.6
Asia	9.8	15.9	26.0	40.5	53.3	48.8	52.4	64.0
India	3.2	4.9	8.4	15.3	21.0	15.9	20.6	26.6
China	1.2	2.1	5.0	7.6	11.7	11.7	11.4	12.5
Thailand	0.2	1.2	2.7	5.0	6.4	7.2	6.9	9.6
Pakistan	0.3	0.6	1.5	2.9	3.7	3.5	3.4	4.3
Africa	3.8	5.8	7.5	8.0	9.9	10.0	10.2	10.2
Europe	22.0	26.1	30.2	27.1	24.1	23.5	21.4	27.7
Russia	-	-	-	1.9	2.7	3.3	2.8	4.7
France	2.1	3.5	4.4	4.7	4.2	4.3	4.0	4.7
Germany	2.4	3.3	4.1	4.4	3.9	4.2	3.6	4.8
North and Central America	15.9	18.3	20.3	20.4	19.8	19.1	19.4	19.6
USA	4.8	5.5	5.8	7.2	7.5	7.6	8.1	7.7
Mexico	2.0	2.8	3.3	4.4	5.4	5.0	4.8	5.4
Oceania	2.4	3.3	3.9	5.1	5.2	4.8	4.7	3.9
Australia	2.1	3.0	3.5	4.6	4.9	4.6	4.5	3.7

Source: Prepared by IERiGZ-PIB on the basis of FAO data.

The production of sugar in Africa is concentrated in two regions. Egypt dominates in the north of the continent (approx. 2 million t) where sugar is produced both from beet and sugar cane, while the south is dominated by cane sugar produced in the Republic of South Africa (approx. 2.5 million t). However, this branch of the industry for numerous smaller producers is one of the bases for the functioning of the export economy (among others, Mauritius, Swaziland, Mozambique, Zambia).

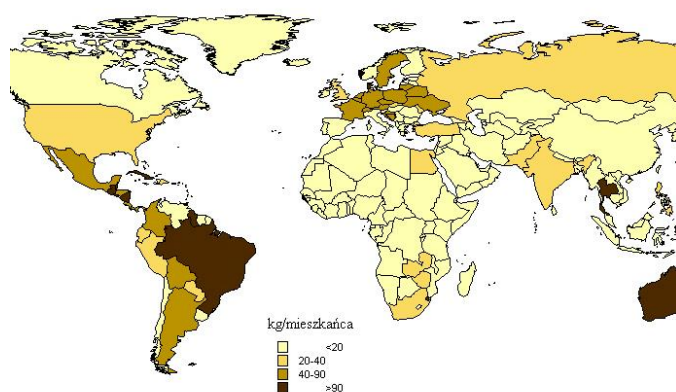
The largest producer of sugar in North and Central America is still the United States (approx. 7-8 million t) and Mexico where production according to the recent estimates exceeded 7.2 million t in the season 2013/2012, namely almost 40% more than in the previous campaign. More than one million t of sugar is produced annually also in Guatemala (approx. 2.0-3.0) and in Cuba (1.1-1.7 million t).

The production of sugar in Australia grew in the last three seasons to more than 4 million t after its significant reduction in the period 2005-2011

(from 5.3 to 3.7 million t) as a result of the decrease in cultivation areas but it still exceeded the domestic demand to a significant extent.

In 2011 the production of sugar per capita in almost fifty countries in the world exceeded unit consumption. In numerous regions, mainly on small islands off the eastern coast of Africa and in the Caribbean, these differences amounted to 5-8-times. In the case of Swaziland, the production of sugar per capita was more than 500 kg and was 21 times higher than the average consumption in that country. Such a situation among large producers of sugar is observed, e.g. in Brazil, Australia, Thailand, Cuba and Denmark where production amounts to 100-200 kg/per capita (Fig. 12).

Figure 12. Production per raw sugar in 2011, kg/per capita



Source: Prepared by IERiGŻ-PIB on the basis of FAO data.

OECD-FAO forecasts for the years 2013-2022⁴¹ anticipate an insignificant decrease in the dynamics of growth in the world production of sugar to approx. 1.8% annually, namely to 212 million t. It will still develop mostly in Brazil and in South-Eastern Asia (India, China, Thailand). Within the examined period, it will increase in these countries in total by almost 22% to 110 million t. The highest dynamics of growth in the production of sugar will be observed in Thailand (nearly 4% annually) and in absolute numbers – in Brazil (by 6.5 million t to 48.2 million t).

2.3. Consumption of sugar

The demand for sugar consists of two main elements, namely direct consumption in households and consumption in secondary food processing and in

⁴¹ OECD-FAO *Agricultural Outlook 2013-2022, Chapter 6 – Sugar*, OECD-FAO 2013, p. 151-170.

other sections of the economy. The world consumption of sugar per raw sugar is estimated in the season 2014/2013 at the highest historical level, namely 175 million t and it will amount to 24.42 kg per one inhabitant of Earth. The consumption of sugar has been increasing at the pace of approx. 2.0% or 2.9 million t annually from the season 1989/90 and is higher than the population growth in the world. Thus, the quantity of sugar consumed by a statistical inhabitant systematically increases by almost 0.7% annually. The growth in demand, apart from the increasing number of people, is affected by growing income and the changing consumption model in developing countries, defined as *the westernization of diets*, namely adopting nutrition patterns from Western European and North American societies [Pingali 2007]. This results in the growing consumption of processed food products containing sugar. Consumption remains on a steady level in highly-developed countries and sugar is a product with a high degree of demand saturation. Thus, growing income does not determine its growth at a low flexibility of demand. Regions of the world where the ageing process takes place experience the reduction in consumption due to increased care for health properties of consumed products. The world demand is also strongly affected by the changing macro-economic situation of particular regions of the world and geopolitical groups. Developing countries demonstrate a high pace of economic development and, along with improvement in living conditions, generate an increased demand for sugar, as opposed to European countries struggling with an economic crisis in recent years.

However, the share of sugar for consumption is systematically decreasing with the growing significance of use for other purposes. Under favorable economic conditions, sugar may be used for the production of bioethanol (the fuel industry and the spirit industry) or in other branches of the industries (the pharmaceutical, chemical industry) or in agriculture (e.g. feeding bees, addition of fodder). The share of such sugar in the world distribution exceeds approx. 15% (in 2009), while at the beginning of the 1990s it amounted to not more than 3%. The percentage of sugar used for non-food purposes in highly-developed countries is usually small, e.g. in the EU it is approx. 4% and in the USA – 1%. It amounts to approx. 65-70% in Brazil, 60% in China and approx. 50% in small island countries. India is an exception among large producers because all sugar is used for consumption.

The largest quantity of sugar is used in Asia. It is estimated at 80.9 million t in the season 2013/2014 which is 46.2% of the world demand, more than half of which may be attributed to two countries: India (26.1 million t) and China (16.2 million t). This region is also characterized by the highest growth dynam-

ics in the consumption of sugar which is annually 3.2% on average from the season 1989/90 but in some periods it even exceeded 7% (seasons 2006/07 and 2007/08). The index of self-sufficiency in the sugar sector in Asia is approx. 85%, mainly as a result of the deficit of sugar in countries such as China, Iran, Japan, Indonesia. Countries with surpluses, on the other hand, include: Thailand, India and Pakistan (Tab. 8),

Table 8. World consumption of sugar

Specification	1989/90-1993/94	1994/95-1998/99	1999/00-2003/04	2004/05-2008/09	2009/10-2013/14	2011/12	2012/13	2013/14 estimate
million t per raw sugar, average annually in periods								
World	110.9	120.4	135.1	153.2	167.8	167.6	172.1	175.2
South America	12.8	14.6	16.2	18.7	21.1	21.2	21.5	21.8
Asia	39.3	45.6	55.2	67.7	76.3	76.2	78.9	80.9
Africa	9.3	10.5	12.5	14.7	18.0	18.1	18.7	19.3
Europa	32.1	31.3	31.4	31.0	30.7	30.6	30.8	30.8
North America & Central America	16.3	17.1	18.3	19.4	20.0	19.7	20.5	20.8
Oceania	1.1	1.3	1.5	1.7	1.7	1.7	1.7	1.7

Season from 1 October to 30 September of the following year.

Source: Prepared by IERiGŻ-PIB, on the basis of data from F.O.Licht's "Sugar&Sweetener Report".

The consumption of sugar in Africa is also increasing at a pace of more than 3% annually (19.3 million t) but it is still one of the lowest in the world per capita. The production of sugar on this continent covers demand in approx. 65% and this index was deteriorating over the recent dozen or so years, mainly due to the limited possibilities of increasing the acreage of the cultivation of sugar plants. The largest quantity of sugar among African countries is consumed in Egypt (3.4 million t in the season 2013/14) as well as in Algeria, the Republic of South Africa, Nigeria and Sudan (1.3-1.9 million t) and the production covers the domestic demand with a surplus only in South Africa.

The consumption of sugar in Europe is stable and ranged in the last 20 years between approx. 30-32 million t annually, including in the EU – approx. 18.5 million t. Until the reform of the sugar market in 2006, member countries had a permanent surplus exceeding the demand by approx. 15-20%. After the end of the reform and the sector's restructuring numerous member states became net importers and the EU index of self-sufficiency dropped to 85%. The main consumers of sugar in Europe include: Russia, Germany, France, Great Britain and Turkey in which the total consumption in the season 2013/14 was estimated at 16.4 million t (53% of the consumption in Europe).

The consumption of sugar in America in the season 2013/14 is estimated at approx. 42.6 million t roughly half of which is in North and Central America

(20.8 million t) and the remaining 50% in South America (21.8 million t). The demand for sugar is growing definitely faster in South American countries where it increased by nearly 30% in the last ten years as compared to 10% of growth recorded in North America. South America has the largest production surpluses, exceeding the demand 2.2 times (mainly Brazil) but several countries (Chile, Peru, Venezuela) need to partially satisfy the demand by import, although to a much smaller degree than a dozen or so years ago. At the beginning of the 1990s the production of sugar in South America exceeded the consumption by only 10-20%. The largest quantity of sugar in both Americas is currently used in Brazil (13.1 million t, increase by 25% in the period of 10 years), the USA (10.7 million t, increase by 20%) and Mexico (5.0 million t decrease by 11%).

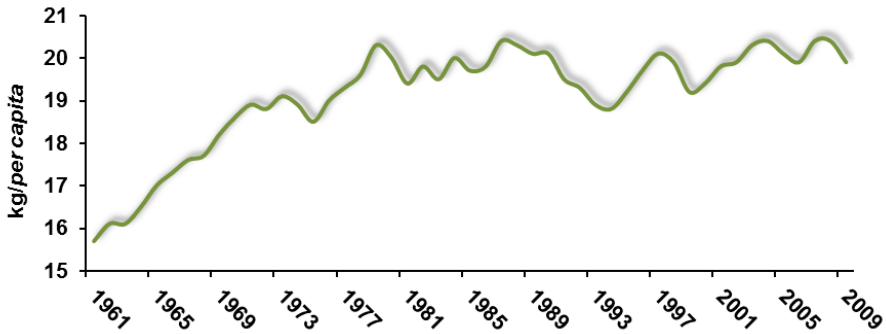
The consumption of sugar in Oceania shows a poor increasing tendency. It is estimated at 1.7 million t in the season 2013/14 as compared to 1.6 million t observed a decade ago. Nearly 80% of sugar is consumed in Australia where the production exceeds the demand by approx. 3 times.

The direct consumption of sugar by the average inhabitant of Earth in 2009, according to FAO data, amounted to 19.9 kg and it increased by 0.5% annually on average as compared to 1961 (Fig. 13). The highest growth in consumption was observed until the end of the 1980s when it exceeded 20.4 kg/per capita and then ranged between 19-20 kg. Consumption was growing, first of all, in Asia with dynamics of 2.3% annually which means that it increased 3 times over nearly 50 years. However, this region, along with Africa, is one of the regions with the lowest consumption of sugar per capita (14.5 kg). It is approx. 2.5 times higher in both Americas, Europe and Oceania and amounts to 33-39 kg/per capita. The last dozen or so years, however, saw a systematic reduction in the consumption of sugar in the majority of regions of the world and these countries where it is still growing experience a clear decrease in the pace of this growth. The consumption of sugar in Europe decreased from 41 to 35 kg/per capita, in Oceania – from 50 to 40 kg/per capita and in South America - from 44 to 36 kg/per capita.

The largest quantity of sugar among particular countries is consumed within the Caribbean (Barbados, Trinidad and Tobago) and in Central America (Costa Rica) as well as in numerous highly-developed countries (Switzerland, Malta, Belgium, New Zealand) where it exceeds 50-55 kg/per capita. The structure of sugar consumption in developed countries, however, is different than in developing countries. Approx. 70% of sugar in EU countries is used for the industrial production, among others, of food products and only 30% is consumed

in its non-processed form⁴². The consumption of sugar in its pure form is still dominant in countries with a lower level of economic development.

Figure 13. Consumption of sugar in the world



Source: Prepared by IERiGŻ-PIB on the basis of FAO data.

The smallest consumption is observed in Eastern Asia where in 2009 it amounted to only 7.3 kg/per capita on average (China, North Korea) as well as in Central-Eastern Africa (approx. 10-11 kg/per capita). The low level of consumption, however, does not apply only to poorly-developed countries. Japan consumes only 17.2 kg of sugar, while at the beginning of the 1970s the consumption exceeded 30 kg/per capita. The decrease in demand in the first period was affected by high world prices. In consequence, the demand for traditional sweeteners grew (honey, gluten) and they later permanently entered diets. The society's care for health properties of consumed products currently limits the consumption of sugar not only in Japan.

According to estimates from OECD-FAO⁴³, the world consumption of sugar will be growing until 2022 at a slightly slower pace than previously, namely by 1.8% annually and will reach 204 million t. Demand will still be developing, first of all, in developing countries (by 2.4% annually) as a result of growing income, progressing globalization processes and the increasing number of people. In consequence, the share of those countries in the world consumption will increase by 4 percentage points to 75.2%. The demand for sugar in industrialized countries will remain at the level of approx. 50 million t with the growing significance of other sweeteners (fructose syrups), various kinds of low-calorific sweeteners (aspartame, acesulfame potassium, sucrose) and natural sweetening substances (e.g. ste-

⁴² *EU Sugar Annual Report. Gain Report – Global Agricultural Information Network*, no E70018, USDA Foreign Agricultural Service, April 2012.

⁴³ *OECD-FAO Agricultural Outlook 2013-2022, Chapter 6 – Sugar*, OECD-FAO 2013, p. 151-170.

via). The expected consumption of sugar in the three largest consumers (India, China and Brazil) in 2022 may amount to 61.8 million t, namely 22% more than at present.

2.4. Foreign trade in sugar

Foreign trade in sugar belongs to those areas of international exchange with the highest system of protectionism and state intervention [Spörri 2011]. Almost all countries subsidize or protect their own markets using various instruments in order to increase the competitiveness of export or to strengthen the position of the domestic sugar industry and agricultural producers by import barriers. Both these factors are present on the sugar market because it belongs to primary agricultural products and is produced practically in all parts of the world. An expansive trade policy in developing countries exporting their agricultural products is the basis for economic growth and alleviation of possible social tensions. On the other hand, the direction and selection of measures governing trade exchange in industrialized countries are often affected by strong groups of interest. These determinants disturb the functioning of market mechanisms to a large extent, contributing to the manipulation of prices and the destabilization of the market. Limitations in using subsidies are the main priority in shaping the world economic policy in recent years, e.g. as part of WTO negotiations.

Approx. 35% of the world production of sugar has been the object of international trade in recent years. The import of sugar per raw sugar in the season 2013/14 is estimated at 61 million t and export – at 63.4 million t (Tab. 9). The trade volume has been increasing from the beginning of the 1990s at a pace of approx. 2.5% or 1.4 million t annually and fluctuations between particular seasons from -6% to +12% and is very strongly positively correlated with the volume of production ($R = 0.95$).

The share of raw sugar for refinement systematically increases in the structure of commodity trade at the cost of the final product, namely white sugar. Numerous developing countries do not have the technological possibilities to produce white sugar. As a result, large quantities of sugar are refined in other countries. Europe has numerous traditional refineries. In addition, certain sugar plants conduct refinement between campaigns in order to improve the use of resources and the efficiency of management. The share of raw sugar in trade exchange in the season 2013/14 is estimated at nearly 58%, namely by 8 percentage points less than in the beginning years of the 21st century.

Table 9. Volume of world foreign trade in sugar

Specification	1989/90-1993/94	1994/95-1998/99	1999/00-2003/04	2004/05-2008/09	2009/10-2013/14	2011/12	2012/13	2013/14 estimate
	million t per raw sugar, average annually in periods							
Import	32.9	38.4	45.5	52.4	61.3	59.9	63.2	61.0
Export	33.7	39.8	47.7	55.6	62.8	60.5	66.1	63.4
Share in production*	29.4%	31.1%	33.3%	34.7%	35.9%	34.3%	35.2%	34.2%

Season from 1 October to 30 September of the following year.

* average volume of import and export,

Source: Prepared by IERiGŻ-PIB, data from F.O.Licht's "Sugar&Sweetener Report".

The dynamics of growth in the value of the world sugar trade in the years 1989-2011 was twice as much as compared to the volume. Growing prices at international commodity exchanges resulted in an increased interest in the cultivation, first of all, sugar cane and in the growth in export of sugar and the economic development of deficit countries stimulated the growth in import. The value of trade exchange in sugar in 2011 amounted to approx. USD 38 billion (average value of import and export) and was approx. 3 times higher than at the beginning of the 1990s. However, the significance of sugar in the trade in agricultural and food products was being systematically reduced and is presently approx. 2.7-2.8% of the world exchange (Tab. 10). This means that other agricultural and food products were characterized by a higher dynamics of trade turnover (cereals, oilseeds, dairy products).

Table 10. Value of world foreign trade in sugar

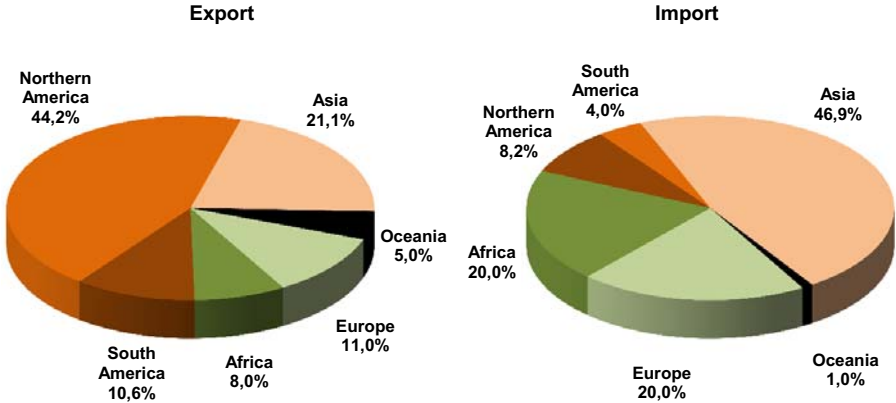
Specification	Export	Import	Balance	Share of sugar in world trade in agricultural and food products
	USD billion, average annually in periods			
1961-1970	2.0	2.1	-0.1	4.9%
1971-1980	8.1	8.6	-0.5	5.9%
1981-1990	11.0	12.1	-1.1	4.5%
1991-2000	10.8	11.5	-0.7	2.7%
2001-2010	16.6	17.7	-1.1	2.3%
2009	21.9	23.1	-1.1	2.3%
2010	29.8	30.0	-0.2	2.7%
2011	36.8	39.3	-2.5	2.8%

Source: Prepared by IERiGŻ-PIB on the basis of FAO data.

South America is the main region from where sugar is exported. Its share in the world export systematically increased from approx. 26% in the season 2000/01 to more than 44% in the season 2013/14 and is estimated at nearly 28 million t (Fig. 14). The growth in export was observed, first of all, in the first decade of the 21st century when it doubled. Brazil has been the largest exporter of sugar in the world since 1994 (Tab. 11). Until that time, for the period of sev-

eral dozen years, Cuba was the leader on the market but it lost its position due to the breakdown in cultivation and sugar production at the beginning of the 1990s and in the first decade of the 21st century (in total, by 80%). Despite the fact that the area of South America is characterized by the largest surplus of sugar as compared to demand, only Argentina, Guyana and Bolivia have a positive balance of foreign trade apart from Brazil. Brazilian sugar reaches, first of all, the markets in China (2.4 million t in the season 2012/13), the United Arab Emirates and Algeria (1.9 million t each), Russia and Indonesia (1.6 million t each), the European Union (1.4 million t) Egypt, India and Malaysia (1.3 million t each) as well as Canada, Morocco, Bangladesh and Iran (approx. 1 million t each).

Figure 14. Geographical structure of foreign trade in sugar (season 2014/13)



Source: Prepared by IERiGŻ-PIB, data from F.O. Licht's "Sugar&Sweetener Report".

A similar situation takes place in Asia the share in the world export of which is more than 21%. Export is executed mainly recently by Thailand, the United Arab Emirates and India but only Thailand is a net exporter as well as India and Pakistan, periodically, under the conditions of large production. In consequence, the Asian area is the largest importer of sugar in the world with 47% of share (mainly Indonesia, China, Malaysia, the United Arab Emirates, Bangladesh, Japan, South Korea). The United Arab Emirates for many years have been the largest processor of imported raw sugar in this region and a re-exporter of white sugar to other markets. Indonesia and China demonstrate the largest deficit in sugar trade.

Table 11. Main importers and exporters of sugar

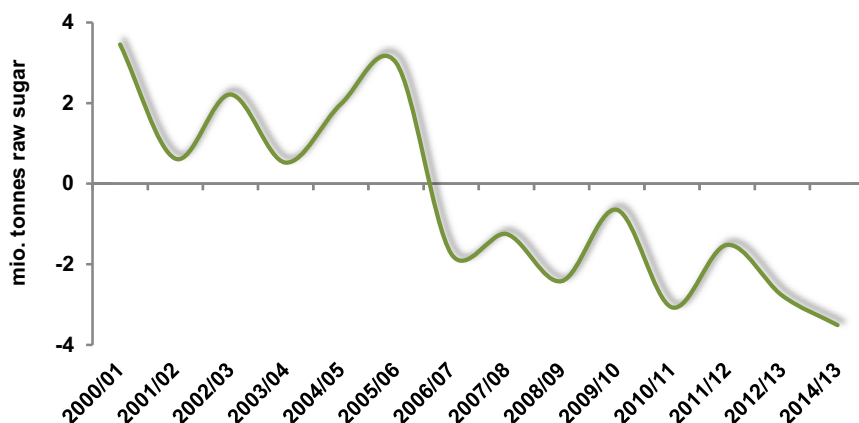
Specification	2000/01	2005/06	2010/11	2011/12	2012/13	2013/14 estimate
	million t per raw sugar					
Import	44.0	54.3	60.0	59.9	63.2	61.0
Indonesia	1.4	1.6	3.1	2.8	3.8	3.6
USA	1.4	3.2	3.3	3.3	3.0	3.0
Malaysia	1.1	2.0	1.7	1.9	2.1	2.1
Russia	5.2	3.4	2.5	0.7	0.8	1.3
Export	45.3	55.6	61.3	60.5	66.1	63.4
Brazil	10.0	16.9	27.1	22.0	29.7	26.7
Thailand	3.5	2.1	6.1	7.3	6.1	7.0
Australia	3.1	3.9	2.1	2.6	3.1	2.8
Guatemala	1.4	1.5	1.4	1.7	2.1	2.1
France	3.4	3.0	2.4	2.6	1.9	2.0
Cuba	2.9	0.7	0.5	0.8	0.7	0.9

Season from 1 October to 30 September of the following year.

Source: Prepared by IERiGŻ-PIB, data from F.O. Licht's "Sugar&Sweetener Report".

The reform of the sugar market in EU countries affected considerable shifts in foreign trade in this product. These countries have turned into large net importers from exporters at a considerable intensification of trade exchange (Fig. 15). Production surpluses above the determined quotas, despite an adequate demand inside the community, need to be exported to markets in third countries to a considerable extent and limited supply is supplemented with imported sugar. The import of sugar increased from 6-7 million t in seasons 2000/01-2004/05 to 9-10 million t during the reform. Export mainly depends on weather conditions during vegetation and the production volume exceeding the determined quotas. It ranges from 6 to 8 million t in the last seasons. The largest importers of sugar in the EU include Italy, Spain and Great Britain, while the largest exporters include France and Germany. Intra-community deliveries dominate both in export and import. They recently constituted 62-74% of the volume, accordingly. Larger quantities of sugar from outside EU states were imported, first of all, on the basis of quotas for APC and LDC countries (among others, Mauritius, Mozambique, Swaziland, Zimbabwe) and from Brazil. Export is dominated by white sugar (95% of the volume), while the share of raw sugar and white sugar in import is approx. 50%. Raw sugar was imported mainly to Great Britain, Finland, Spain, Romania and Portugal, while white sugar – to Italy. Only Serbia and Turkey have a surplus in foreign trade among other European countries and the largest deficit is recorded in Russia (import mostly from Brazil and Belarus).

Figure 15. Balance of volume of foreign trade in sugar in the EU



Season from October 1 to September 30 of the following year.

Source: Prepared by IERiGŻ-PIB, data from F.O. Licht's "Sugar&Sweetener Report".

A large deficit of sugar the supply of which needs to be supplemented with import is observed in African countries. The demand for sugar is rapidly increasing along with the growing number of people and growing income limiting the scale of poverty, and the supply of sugar from own production is not able to cover that. In consequence, the net import of African countries doubled in the last decade and amounts to approx. 7.5-8.0 million t annually. The largest quantity of sugar is imported to Algeria, Nigeria and Egypt (approx. 1.3-1.8 million t each) and to Morocco (0.9 million t). These countries have a well-developed sugar industry and the object of import is mainly sugar for refinement. The finished product is imported to the remaining countries, characterized by a deficit, where there is no adequate infrastructure for refining sugar – the largest quantity to Sudan. The Republic of South Africa and Swaziland as well as island countries (mainly Mauritius) have surpluses.

Significant exporters of sugar are countries in the Caribbean (Cuba, the Dominican Republic), Central America (Guatemala, Mexico, Salvador) as well as Australia which jointly sell approx. 9.0-9.5 million t on the world markets which is approx. 14-15% of the world trade, with a large deficit of sugar in North American countries which receive approx. 4.2 million t. Sugar from Australia is exported mostly to South Korea, Japan, Indonesia and Malaysia. On the other hand, the supply on the American market is supplemented with import from Central and Southern American countries.

2.5. World sugar balance

The average annual growth in the production of sugar over the last 25 seasons (by 2.2%, namely by 3.01 million t) exceeded the growth rate of its consumption (by 2.0%, namely by 2.93 million t). In consequence, the market surplus was systematically increasing. Closing stocks exceeded 80 million t in the last season and were more than 2.5 times higher than those at the beginning of the 1990s when they amounted to slightly above 30 million t. An increased demand as compared to the supply and the decrease in the volume of closing stocks were observed only under exceptionally adverse economic or agro-climatic conditions (e.g. seasons 2008/09-2009/10). The growing stocks influenced market behaviours and balance to a relatively small extent. Periodical drops in production and stocks rather destabilized the market and resulted in a rapid growth in prices on the world markets than the growing surpluses. Sugar also became one of the investment products in recent years and an increasing part of it is not reflected in the actual, physical demand, while the prices are exposed to speculative actions from financial institutions.

It is estimated that the closing stocks of sugar in the season 2013/14 will constitute 46.3% of its world consumption and will increase by 1.7 percentage points as compared to the previous season (Tab. 12). The largest stocks of sugar are currently found in Asian countries (44% of world stocks), mainly in India, China, Thailand as well as Indonesia, with the tendency for further growths. Large stock of sugar are also observed in EU countries (13.0 million t) where the relation of stocks to consumption reached a previously unrecorded high level and is approaching 70%. Good production results, with a stable demand, limited export possibilities and limitations of the market regulation reform resulted in the fact that the stocks of sugar increased by 40% over the last three years. In some countries where the production does not cover the demand, maintaining stocks probably results from the assumptions of internal food safety policies (e.g. Spain, Italy, Great Britain) or is the background for processing and foreign trade (e.g. the Netherlands, Germany).

A relatively low coefficient of stocks to consumption is observed in North and Central American and in Africa (37-41%). The larger stocks in Africa are recorded only in richer countries such as Egypt, the Republic of South Africa where they constitute 60-80% of the annual consumption and in regions with a large surplus of sugar (Mauritius, Swaziland, Mozambique). This condition is mostly affected by the situation in the USA and in Canada where stocks secure only 10-15% of needs at a high level of sugar consumption which cannot be covered by the supply from own production. The large role of cultivation and sugar

production in the agricultural and food economy of Central America and Caribbean islands makes it possible to maintain the volume of stocks above the annual consumption, with a simultaneous high export.

Table 12. World sugar balance

Specification	1989/90- 1993/94	1994/95- 1998/99	1999/00- 2003/04	2004/05- 2008/09	2009/10- 2013/14	2011/12	2012/13	2013/14 estimate
	million t per raw sugar, average annually in periods							
Initial stocks	35.3	43.6	61.4	67.9	65.7	61.3	68.4	76.7
Production	113.1	125.7	139.7	155.4	173.0	175.3	183.4	182.0
Import	32.9	38.4	45.5	52.4	61.3	59.9	63.2	61.0
Consumption	110.9	120.4	135.1	153.2	167.8	167.6	172.1	175.2
Export	33.7	39.8	47.7	55.6	62.8	60.5	66.1	63.4
Closing stocks	36.7	47.5	63.7	66.9	69.4	68.3	76.7	81.1
Closing stocks as compared to consumption (%)	33.1%	39.4%	47.1%	43.7%	41.4%	40.7%	44.6%	46.3%

Season from 1 October to 30 September of the following year.

Source: Prepared by IERiGŽ-PIB, data from F.O. Licht's "Sugar&Sweetener Report".

The stocks of sugar in South America remain at a stable level of approx. 50% of annual consumption (they constitute approx. 10-12 million t as compared to 20-22 million t of annual demand). Production surplus are, first of all, in Brazil (7-9 million tons) and Argentina (1.2-1.8 million tons). Constant sugar stock at the level of approx. 2-3 million tons is recorded also in Australia, where the self-sufficiency ratio exceeds 300%, and closing stock exceeds the national demand by 60%.

The OECD estimates indicate the possibility of restricting the volume of sugar stock in the world in the next seasons (by approx. 5%) under the effect of a slightly lower pace of production growth in relation to growing import and consumption, mainly in Asian countries.

2.6. Sugar prices on the world market

The market is a mechanism through which the buyer and the seller affect one another to set the price and quantity of good (service). The market mechanism solves three key economic problems. Firstly, which goods should be produced – it is determined by daily consumer decisions with regard to purchases. The second problem solved by the market is the way of generation of goods and services – determined strongly by competition between producers. Finally, the market decides for whom goods are produced [Samuelson 2004, p. 60]. Four key functions in the economy are attributed to the market: information, income-generating, efficiency and balancing. On the basis of the information about the market game results, business entities make decisions on current activities as well as investments which will permit efficient and competitive operation in the

future. Market information and its adequate use have become an element of building competitive advantages. The market is treated also as an instrument of income multiplication (e.g. trade operations at commodity exchanges and stock exchanges). Efficient and competitive business entities win the rivalry and take over economic surplus, but, at the same time, some of the market participants suffer losses. Competition forces management efficiency on market participants, understood as possibly most beneficial ratio of effects to investments. The market mechanism is thus a verifier of entities' management efficiency. The balancing function of the market is defined as the ability of restoring automatically the balance between demand and supply through prices. Depending on structure and spatial range of the market, the balance may be affected by many other factors stabilizing and destabilizing the whole system (e.g. intervention policy) [Rembisz, Kowalski 2007, p. 15]. The market consists of three basic elements: demand, supply and prices that are the determinants of the demand-supply relations and reflect the market balance.

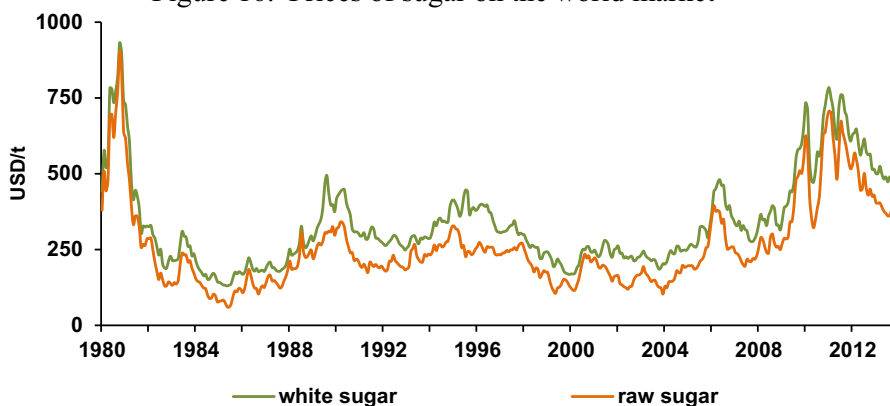
At the world commodity exchanges, prices of two types of sugar, raw and white, are quoted. The most representative and most widely used in market analyses are the quotations of raw sugar at the commodity exchange in New York⁴⁴ (contract no. 11) and of white sugar at the commodity exchange in London⁴⁵ (contract no. 5). Sugar has a high share in the turnover at international commodity exchanges, as from among agricultural and food products most futures contracts are concluded for sugar (35%), rubber (17%), corn (11%) and soya oil 10% [Jerzak 2013, p. 55].

In the years 1980-2013, the world sugar prices were characterized by great volatility, with slight upward trend (Fig. 16). The white sugar prices were ranging from 130 to 932 USD/t and the raw sugar prices were ranging from 60 to 905 USD/t. The volatility coefficient values were 0.45 and 0.55, respectively. The arithmetic mean and the median are positive, which results from presence of the trend in the time series. The values of kurtosis and skewness also are greater than zero, thus the series do not have a normal distribution. The results of the Jarque-Bera test confirm that the distributions of world sugar prices are not similar to the normal distribution. Positive skewness values indicate a right-side asymmetry of time series, and positive values of kurtosis indicate high concentration of series values around central values (Tab. 13).

⁴⁴ The New York Mercantile Exchange (NYMEX).

⁴⁵ London Commodity Exchange (LCE), London International Financial Futures and Options Exchange (LIFFE).

Figure 16. Prices of sugar on the world market



Source: Data of ERS USDA, F.O. Licht's "Sugar&Sweetener Report".

The world sugar prices, like the prices of other agricultural products on commodity exchanges, were determined under the effect of many various factors. It is practically impossible to examine the strength and direction of impact of each of them, as respective experiments are not possible. The statistical and economical analysis methods permit, however, identification of past interrelations between prices and their determinants. A correct interpretation of the examined cause and effect regularities may contribute to preparing more apt forecasts (modeling) that are often the basis for economic decision-making. Another analytical approach is based on the assumption that the prices reflect supply and demand relations and the impact of other factors (e.g. market policy changes). As a result, the analytical process is focused on changes in prices that are a result of impact of various determinants.

Table 13. Descriptive statistics of world sugar prices

Specification	Levels of monthly sugar prices USD/t			First differences of sugar price logarithms	
	white sugar	raw sugar	price difference	white sugar	raw sugar
Number of observations	406	406	406	405	405
Average	337.77	259.19	78.58	0.0003	0.0002
Median	294.93	227.69	73.61	0.0007	-0.0018
Minimum	129.96	60.35	14.03	-0.275	-0.323
Maximum	931.72	905.07	220.16	0.379	0.371
Gap	801.76	844.72	206.13	0.654	0.694
Standard deviation	152.92	141.54	31.15	0.073	0.097
Volatility coefficient	0.453	0.546	0.395	240.12	447.49
Skewness	1.346	1.636	0.829	0.188	0.305
Kurtosis	1.494	2.809	1.0405	2.711	0.993
Jarque-Bera distribution normality test	$JB = 160.3$ $p = 1.6e-035$	$JB = 314.5$ $p = 5.0e-069$	$JB = 79.7$ $p = 4.5e-018$	$JB = 12.4$ $p = 3.6e-028$	$JB = 22.9$ $p = 1.1e-005$

Source: Calculations of IERiGŻ-PIB, data of ERS USDA, F.O. Licht's "Sugar&Sweetener Report".

The price volatility is analyzed predominantly in time, and a sequence of information organized in time is a time series (stochastic process). Regularities of changes included in a time series structure may be either regular (systematic) or random. Any changes in prices are made around long-term trends, determined by a trend function chart $T_t=f(t)$. Medium- and long-term changes in the value of the examined variable along the trend line are determined as cyclical fluctuations C_t . The period of cyclic fluctuations may have various length, which is a difference in time between two return points (maximums or minimums). In many economy sectors, particularly in the agricultural and food sector, climate and natural conditions cause regular periodical changes within one year (season). Seasonal fluctuations S_t differ largely from cyclical fluctuations that include long-term periods. The last type of changes distinguished in a time series are irregular random (accidental) fluctuations I_t that reflect the impact of incidental or unpredictable factors. The distribution of a time series into particular elements is called decomposition. The aforementioned elements of the time series structure can occur between each other in two models of relations: additive or multiplicative. The additive model is used assuming that the values of a time series are the sum (alternative) of elements of its structure, which are independent from one another (2-2). The multiplicative model of time series is the product (conjunction) of elements of its structure (2-3). In the additive model, seasonal fluctuations do not depend on the value of observed variable in time. In other words, seasonal effects undergo deviations from the average value in the year by a constant value (expressed in time series units). In the case of multiplicative seasonality, greater values of the variable resulting from the trend cause a greater amplitude of seasonal fluctuations. In practice, multiplicative models are used predominantly [Aczel 2005].

$$Y_t = T_t + C_t + S_t + I_t \quad (2-2)$$

$$Y_t = T_t \cdot C_t \cdot S_t \cdot I_t \quad (2-3)$$

where:

- Y_t – time series values
- T_t – trend values
- C_t – cyclic component value
- S_t – seasonal fluctuations values
- I_t – random (accidental) fluctuations

The decomposition of the time series of white and raw sugar prices was conducted using the multiplicative model and a 12-month moving average. The chart of moving average (trend-cycle) TC_t shows price changes without seasonal and random fluctuations. The seasonal component S_t was determined as a quo-

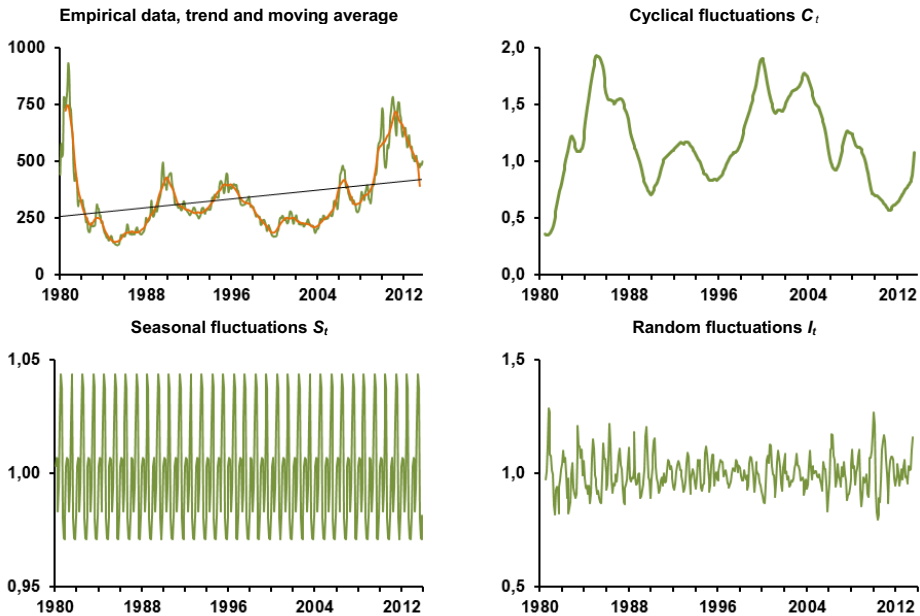
tient of empirical data Y_t and corresponding values of the moving average TC_t , and then averaged for different months. The world white sugar prices showed small seasonal fluctuations. Seasonally, the highest prices were recorded in July and August and were by 4 p.p. higher than the long-term trend. The lowest prices were recorded in November-December and were by 2 p.p. lower than prices designated by the long-term trend. Seasonal fluctuations reflect the campaign character of production of sugar from sugar beets in Europe. The sugar season covers the period from 1 October to 30 September and seasonal growth in prices in the months preceding the campaign is a result of supply drop (stock reduction). In November and December, sugar concerns market sugar from the started campaign or end sales of stock from the previous season (Fig. 17).

Setting cyclical fluctuations started from the estimation of the trend function using the simple linear regression $T_t = 0.4105t + 254.24$. The trend function chart is characterized by a small inclination ($tg\alpha = 0.41 = 22^\circ$) and weak match with the empirical data ($R^2 = 0.10$). The cyclical fluctuations C_t were determined as a quotient of the moving average value TC_t and the upward trend value T_t . The ratios of cyclical fluctuations show the dimension of price changes which, in some periods, were growing twice as compared with the long-term trend. The economic cycles on the world sugar market cover periods of 5-6 years, exceptionally a long cycle (11-year) covered the period 1980-1990⁴⁶. The periodicity of world sugar prices was thus a result of cyclical changes in sugar cane production. Sugar cane is cultivated on long-term plantations whose acreage decreases in the periods of low sugar prices. If the world sugar prices are at a low level for a longer period, it may be assumed that they cover low costs of production (200-300 USD/t) in developing countries [Isermayer 2005, p. 7]. Only drop in supply from countries where costs of cultivation are higher may lead to growth in prices and change in the cycle phase.

The random fluctuations I_t were determined as a residual value, which is a quotient of empirical data, moving average (trend-cycle) and seasonal fluctuations. The values of random fluctuations (± 30 p.p.) show clearly periods when random determinants had a strong impact on prices. Summing up the results of decomposition of a the time series of world white sugar prices, it should be stated that cyclical fluctuations had the greatest impact on prices. Random factors and seasonal fluctuations had an expressly smaller impact on prices.

⁴⁶ OECD: *Sugar Policy Reform in the European Union and in World Sugar Market*, Paris 2007, p. 26.

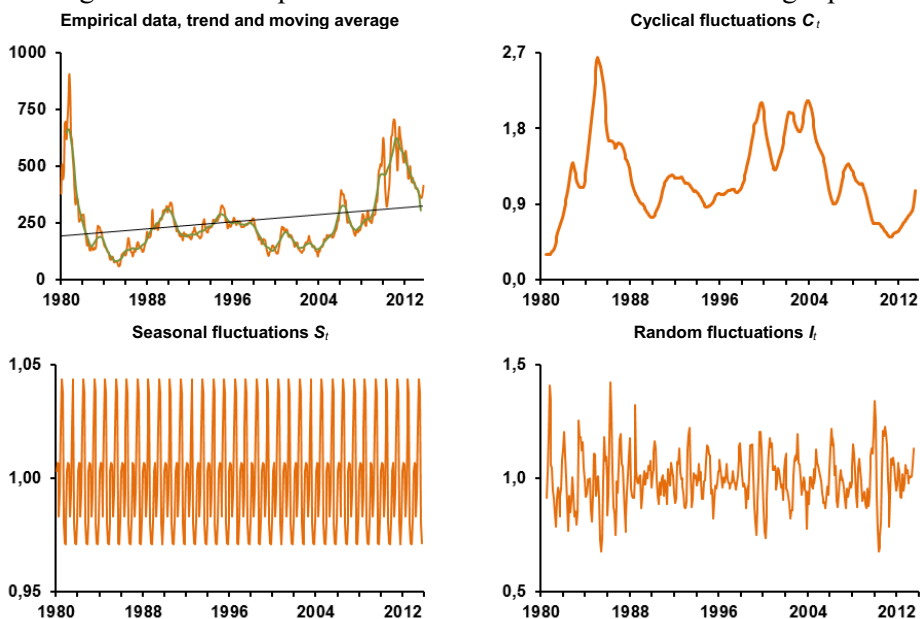
Figure 17. Decomposition of the time series of world white sugar prices



Source: Calculations of IERiGŽ-PIB, data of ERS USDA, F.O. Licht's "Sugar&Sweetener Report".

The world raw sugar prices showed similar growth trends as white sugar prices. The raw sugar prices are, however, lower since refining, like every technological process, involves specific costs. The difference in the level of prices (refining bonus) is variable in time and affects, to a large extent, the profitability of refining. The chart of the function of the world raw sugar prices $T_t = 0.3269t + 129.65$ is characterized by even smaller inclination ($tg\alpha = 0.33 = 18^\circ$) and also a weak match with the empirical data ($R^2 = 0.07$). Decomposition of the time series showed that also cyclical fluctuations C_t had the greatest impact on prices. The amplitude of cyclical fluctuations of the world white sugar prices was greater than of white sugar prices. In some years, prices were almost three times higher from the level determined by the long-term trend. Raw sugar prices were under a greater impact of random factors since the values of ratios of random fluctuations I_t reached the values of ± 40 p.p. The seasonal fluctuations of raw sugar prices were small and had a minute impact on prices. The greatest seasonal price growth (1-3 p.p.) was recorded in the first quarter, since on the southern hemisphere crops (*zafra*) and processing of sugar cane begin in that period. Seasonal drop in prices is recorded in the subsequent quarter (by 2-4 p.p.) since it is a result of a large supply from the completed crops (Fig. 18).

Figure 18. Decomposition of the time series of world raw sugar prices



Source: Calculations of IERiGŻ-PIB, data of ERS USDA, F.O. Licht's "Sugar&Sweetener Report".

2.7. Volatility of world sugar prices

The world sugar prices showed in the long term a great volatility, which is confirmed by descriptive statistics and the results of decomposition of time series. The economic variables are often characterized by the dominant trend overlapped by seasonal fluctuations. In the time series analysis, an important element is assessment of stationarity whose assumption is vital in testing hypotheses. The variable is considered stationary, if its values do not change in time. The presence of non-stationary variables in the model can lead to incorrect results of statistical reasoning [Gruszczyński 2004].

Assessment of stationarity begins from the graphic analysis of time series (raw data). If from the chart it is possible to read a clear long-term upward trend, it can be assumed that the series is non-stationary. The world sugar prices show long-term upward trend, identified at the time series decomposition. To confirm the presumptions, a Dickey-Fuller unit-root test (*ADF*) was conducted, in which the hypothesis H_0 assumes non-stationarity of a time series. The test results confirmed clearly that the time series of world sugar prices cannot be considered as stationary. As a result, to make it possible to conduct prices volatility analyses, it was necessary to transform time series into a stationary form. For this purpose, the logarithms of natural prices and their first differences (2-4) were used and

were subjected to *ADF*. The values of *DF* statistics, much lower than the critical value, and low values *p* constitute the basis for rejecting the hypothesis about non-stationarity and it can be assumed that the series were integrated in the first degree $Y_t \sim I(1)$ [Gruszczyński 2004].

$$r_t = \ln(P_t) - \ln(P_{t-1}) = \ln\left(\frac{P_t}{P_{t-1}}\right) \quad (2-4)$$

where:

P_t – price in the period *t*

P_{t-1} – price in the period *t-1*

Table 14. Results of ADF test of world sugar prices

Time series	Test type	Critical value $\alpha - 1 = \delta$	Dickey-Fuller test statistics	Value <i>p</i>	Decision
World white sugar prices					
Levels of prices	without intercept	-0.004	-0.893	0.340	
	with intercept	-0.022	-2.258	0.186	
	with intercept and trend	-0.027	-2.661	0.253	
First differences in logarithms	without intercept	-0.803	-11.068	2.40e-022	<i>I(1)</i>
	with intercept	-0.803	-11.055	1.27e-022	<i>I(1)</i>
	with intercept and trend	-0.809	-11.110	1.92e-024	<i>I(1)</i>
World raw sugar prices					
Levels of prices	without intercept	-0.006	-1.214	0.207	
	with intercept	-0.028	-2.612	0.090	
	with intercept and trend	-0.322	-2.939	0.150	
First differences in logarithms	without intercept	-0.755	-10.652	3.23e-021	<i>I(1)</i>
	with intercept	-0.755	-10.638	2.88e-021	<i>I(1)</i>
	with intercept and trend	-0.760	-10.683	1.29e-022	<i>I(1)</i>

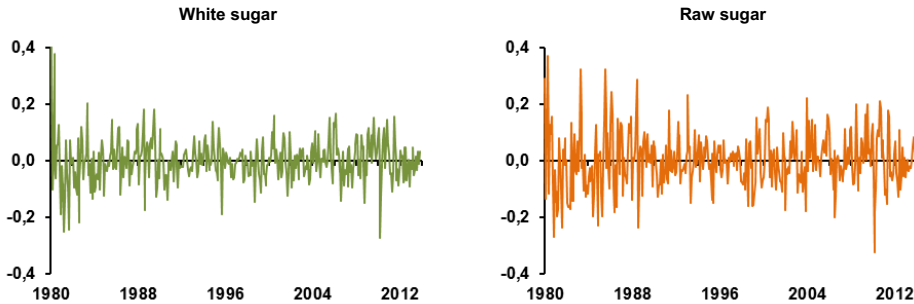
Source: Calculations of IERiGŻ-PIB, data of ERS USDA, F.O. Licht's "Sugar&Sweetener Report".

First differences of natural price logarithms may be used also in the price volatility analysis. Differences in price logarithms correspond to growth logarithms of these price that are defined as logarithmic rates of return. An advantage of this approach is that growth logarithms multiplied by 100 illustrate percentage changes. Logarithmic rates of return on white sugar demonstrated a smaller volatility than on raw sugar. Maximum changes of raw and white sugar prices reached approx. 38 p.p., but the gap of fluctuations between the highest and the lowest values was 69.4 p.p. and 65.3 p.p., respectively (Fig. 19).

A consequence of high volatility is a difficult price risk assessment, which is important for all sugar market participants. In the conditions of high volatility, price risk assessment may be overestimated and, on this basis, business entities can make inappropriate decisions (e.g. investment decisions). However, we should remember that business entities with great market experience are able to

identify the character of price changes, i.e. they differ deterministic changes (long-term trend and cyclical fluctuations) from seasonal fluctuations.

Figure 19. First growths in logarithmic sugar prices in the world



Source: Calculations of IERiGŻ-PIB, data of ERS USDA, F.O. Licht's "Sugar&Sweetener Report".

The world white and raw sugar prices are strongly correlated and show similar volatility. The white sugar prices are higher than the raw sugar prices, since they include costs of transport and refining (refining bonus) and in some cases also customs fees (Fig. 20). Price differences reflect also short-term changes in supply and demand in both segments of the world sugar market [Isermeyer 2005, p. 7]. In the long term, the difference between these prices was very volatile, because in the years 1980-2013 it was ranging from 14 to 220 USD/t (Tab. 13). If the white sugar price increases in respect of refining bonus, many countries may increase import for the purposes of refining. An important factor influencing the profitability of refining are costs of transport that are volatile depending on geographical directions of import. Costs of transport of sugar between the Eastern African and Northern European ports are estimated at approx. 50 USD/t. In transit from the Asian ports, costs amount to approx. 75 USD/t and are highest in the transport from South and Central America (approx. 130 USD/t) [Isermeyer 2005, p. 33].

The profitability of refining is of critical importance in assessment of competitiveness and the future of the European sugar industry. The costs of white sugar production in ACP and LDC countries, increased by the costs of transport of sugar and other fees, are the main point of reference in the assessment of price competitiveness of beet sugar. The costs of cane sugar production (together with cost of transport to port) in developing countries are very diverse:

- 300-400 USD/t – Ethiopia, Brazil, Mozambique, Sudan and Zimbabwe,
- 500-600 USD/t – Bangladesh, Cuba, Senegal, Malawi and Tanzania,

- 600-700 USD/t – Mauritius, Madagascar, Burkina Faso,
- above 800 USD/t – Jamaica, Barbados and Congo [Isermeyer 2005].

High cost differences among particular countries determine prices and geographic directions of import, and, as a consequence, profitability of refining. If prices paid in import (e.g. from Brazil) are approx. 200 EUR/t and are increased by costs of transport and refining (together approx. 150 EUR/t), then, in the conditions of duty-free or preferential import, white sugar prices on the EU market would amount to approx. 350 EUR/t. Total costs will be thus lower or comparable with the reference price of 404.4 EUR/t and significantly lower than selling prices (approx. 710 EUR/t). This simple comparison confirms cost and price competitiveness of cane sugar and demonstrates large importance of customs protection of the EU market. Further liberalization of the world agricultural and food trade, whose expression would be reduction in duties and export subsidies, will make most likely the European sugar beet hardly competitive towards import.

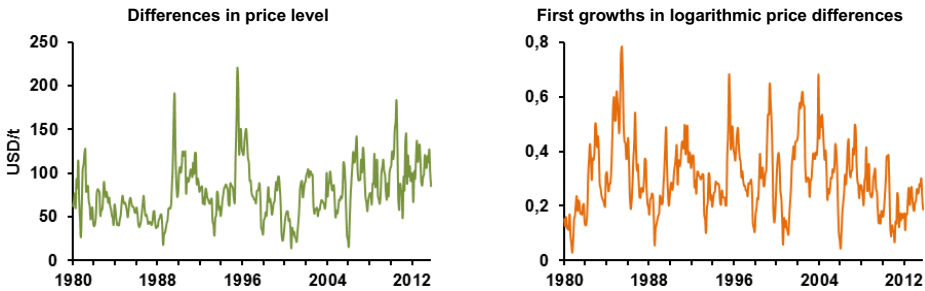
The statistical evaluation of interrelations between prices of raw sugar and white sugar was conducted using a classic least square method. The analysis uses the first differences of price logarithms. The growth in white sugar prices was adopted as dependent variable Y_t , and the growth in raw sugar price as independent variable X_t . The regression analysis demonstrated that the growth in raw sugar prices by 1 p.p. resulted in growth in white sugar prices by 0.6 p.p., and the independent variable explained in approx. 58% changes in the dependent variable (Tab. 15).

Table 15. Analysis of interrelations between world white sugar and raw sugar prices

$Y_t = 0,5699 \cdot X_t + 0,0001$	
Standard error:	
dependent variable	0.0026
intercept	0.0243
<i>t - Student:</i>	
dependent variable	23.41
intercept	0.0762
Value p:	
dependent variable	3.74e-077
intercept	0.9393
Determination coefficient R^2	0.5763
$F(1, 404)$	548.1195
Durbin-Watson statistics	1.8078

Source: Calculations of IERiGŻ-PIB, data of ERS USDA, F.O. Licht's "Sugar&Sweetener Report".

Figure 20. Difference in world white sugar and raw sugar prices



Source: Calculations of IERiGŻ-PIB, data of ERS USDA, F.O. Licht's "Sugar&Sweetener Report".

2.8. Determinants of sugar prices on the world market

The long-term analysis of world sugar prices demonstrated that the prices were characterized by a great volatility, which was determined, to the greatest extent, by business cycles and, subsequently, acts of God and seasonal fluctuations. In the recent years, the world prices of agricultural raw materials and food have been increasing significantly. We may come up with a basic question about the reason for growth in prices of agricultural and food products.

The synthetic ratio of business situation and price volatility on the world market is Food Price Index (FPI). The current Index values were calculated with reference to the base period 2002-2004. In the years 2003-2008, food prices demonstrated an upward trend and the total price index value increased from 98 to 200. High prices were strongly correlated with good economic situation. In the years 2003-2007, the world GDP was growing in real terms from 3.8% to 5.2% annually. In 2008, the symptoms of economic slowdown appeared, which, in 2009, was transformed into economic crisis. Decreasing GDP was accompanied also by decrease in the value of food price indexes. An exception were only sugar prices. In the years 2010-2011, the world economy returned to the growth path, as the world GDP was growing in real terms by 4.0% and 3.7%. The price index decomposition shows that in the years 2007-2012 the prices of cereals, oil plants and white sugar demonstrated greater dynamics than total food. Sugar prices were characterized by the greatest growth dynamics from among all food products (Tab. 16).

It can be stated with all the certainty that there is no reason for high prices on the market of agricultural and food products. The price growth was a result of the cumulated impact of many factors with diverse nature: demographic, economic, sociological and natural [Abbott 2008, p 8]. In market economics, the main factors determining prices are supply and demand relations. Growing

world demand for food in the conditions of small elasticity of agricultural production (in a short term) is indisputably the main factor stimulating price growth. Growing demand is also a result of dynamically growing number of population and improving income situation in developing countries. In the years 2000-2013, the world population increased from 6118 million people to 7186 million people⁴⁷. Population grew on most continents: North America (27%) Africa (26%), Oceania (23%), South America (18%), and Asia (13%). In particular regions, population grew as a result of various factors. In North America and Oceania, the crucial role can be attributed to emigration, and in Africa and Asia to population growth rate. An exceptional situation occurred only in Europe, where population decreased over that period by 0.4%.

Growth in the world demand and changes in its structure are also a result of many economic and social changes. The growth in population was accompanied by economic development of developing countries (e.g. in Asia and South America)⁴⁸. As a result of the processes of globalization and foreign direct investments, in developing countries industry and urbanization processes developed. The consequence of these changes was growth in the net income that made it possible to increase consumption and change the consumption model (e.g. a greater share of animal protein, processed products) (*westernization of diets*) [Pingali 2007].

Table 16. Ratios of world food prices and GDP

Years	Total food	Cereals	Oils and fats	Sugar	World real GDP
	2002-2004 = 100				
2003	98	98	101	101	3.8
2004	112	107	112	102	4.9
2005	117	103	104	140	4.7
2006	127	121	112	210	5.4
2007	159	167	169	143	5.2
2008	200	238	225	182	3.1
2009	157	174	150	257	-0,7
2010	185	183	193	302	4.9
2011	228	247	252	369	3.7
2012	212	241	225	306	-

Source: Data of FAO, FAO Food Price Index, www.indexmundi.com.

⁴⁷ International Data Base. U.S. Department of Commerce. The U.S. Census Bureau.

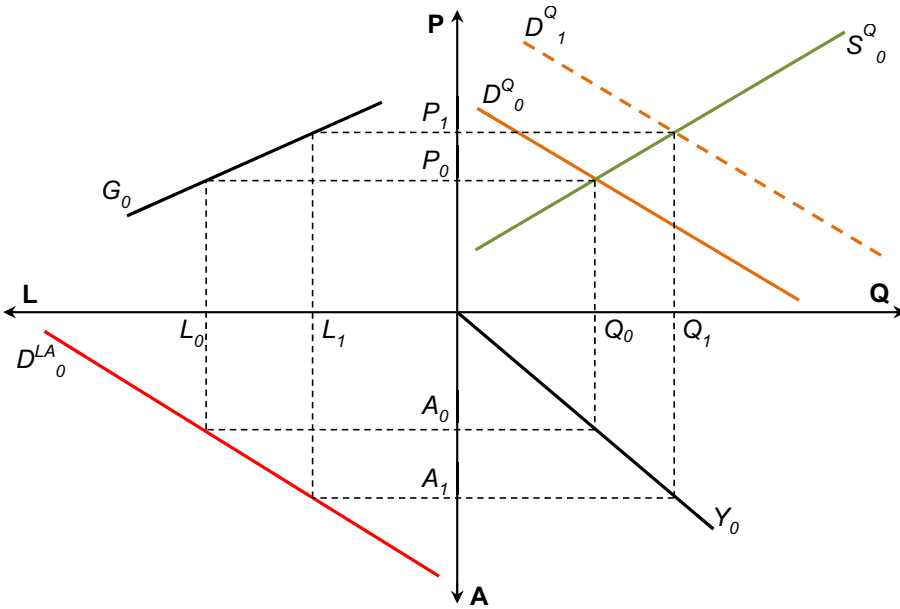
⁴⁸ According to the World Bank data in the period 2000-2012, Gross National Income (GNI) expressed in Purchasing Power Parity (PPP) per capita increased: in Brazil from USD 6 820 to USD 10 150, in China from USD 2 340 to USD 6 810 and in India from USD 2 340 to USD 3840.

The agricultural production depends on weather conditions during the vegetation period. World climate changes lead to more and more frequent weather anomalies (droughts, floods, typhoons, etc.) which affect adversely yields and crops, and, as a consequence, supply of food products. Large supply changes of major exporters and importers result in price changes on the international market.

Due to progress in IT and telecommunication technologies, capital became the most mobile production factor. Capital resources may move quickly between distant regions [Szymański 2002]. High prices of food were a convenient opportunity enabling capital, looking for possibly highest rates of return, to join the game at international commodity exchanges [Szajner 2013, p 139].

Energy prices are reflected directly in the prices of agricultural and food products through expenditures (e.g. mineral fertilizers, mechanization, transport). In the recent years, a factor strengthening the presented above correlation was growing consumption of agricultural raw materials for production of biofuels, and a stimulator of this process was the power and agricultural policy in the United States, Brazil, and EU. The consumption of agricultural raw materials for production of biofuels generates a greater demand for cereals, oil plants and sugar cane. Growing demand involves a number of economic and environmental consequences that are visible not only on the agricultural and food market. Growing demand can be depicted as a shift of the demand function line from the location D^Q_0 to D^Q_1 (Fig. 21). The production and supply of agricultural products S^Q_0 in a short term show small elasticity and are determined by long production cycles and limited soil resources. Growing demand in the conditions of relatively smaller growth in supply determines a new point of market balance and growth in prices from P_0 to P_1 . A greater demand at a specified land factor productivity Y_0 results in a greater demand for agricultural land that can be depicted as a shift from the point A_0 to A_1 . Growing demand for land in agriculture D^{LA}_0 reduces its resources from L_0 to L_1 , which are used in the sectors of economy. The presented above simple model may be presented in other options of setting the market balance (e.g. simultaneous shifts in demand and supply curves). However, it does not change the fact that effects of generating biofuels from agricultural raw materials and higher land input are visible in the entire economy. The relation between prices of agricultural products and availability of land resources for non-agricultural purposes is depicted by the line G_0 .

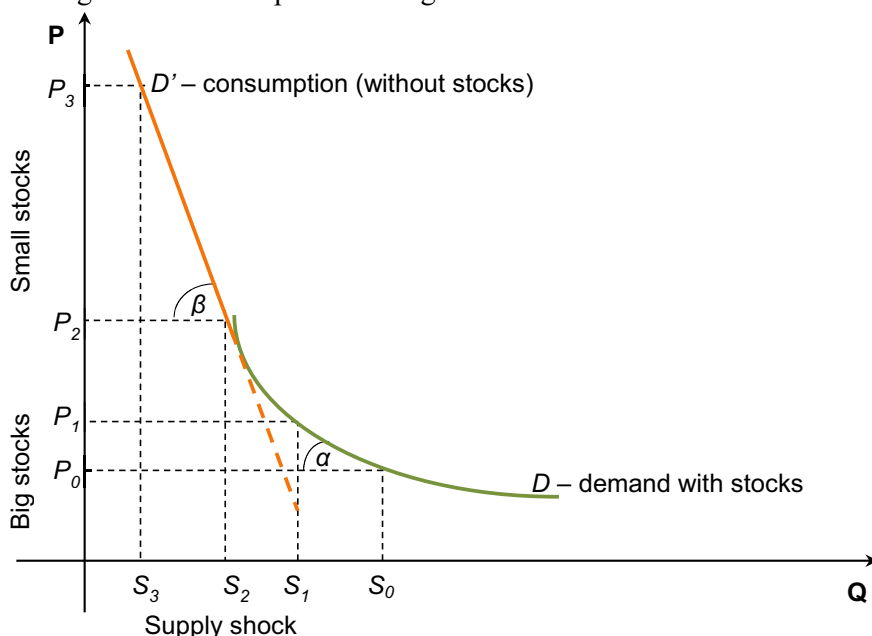
Figure 21. Impact of production of biofuels on the agricultural and food sector



Source: Tokgoz S., Zhang W., Msangi S.: *Biofuels and the Future of Food: Competition and Complementarities*, Agriculture 2, 2012, p. 416.

The consumption of agricultural products for power purposes increases demand, but economic effects are visible also on the supply side. The supply of agricultural products includes crops in a given season and closing stock from the previous season. Stock plays an important role in balancing the market situation. The ratio of closing stock to consumption, which is a synthetic market balance ratio, is often presented in market balances. Reduction in stock resulting from processing of agricultural raw materials to bioethanol and biodiesel may be depicted (Fig. 22). In the conditions of high stock and stable production, consumption is depicted by a decreasing D demand function curve, whose elasticity and inclination are relatively small ($tg\alpha$). Reduction in supply from S_0 to S_1 may lead to a relatively small growth in prices from P_0 to P_1 . A different situation occurs when stock is small and a similar scale of decrease in supply results in a significantly larger price growth from P_2 to P_3 . Clear changes are visible also on the demand side, whose function D' is characterized by a much greater elasticity and inclination ($tg\beta$).

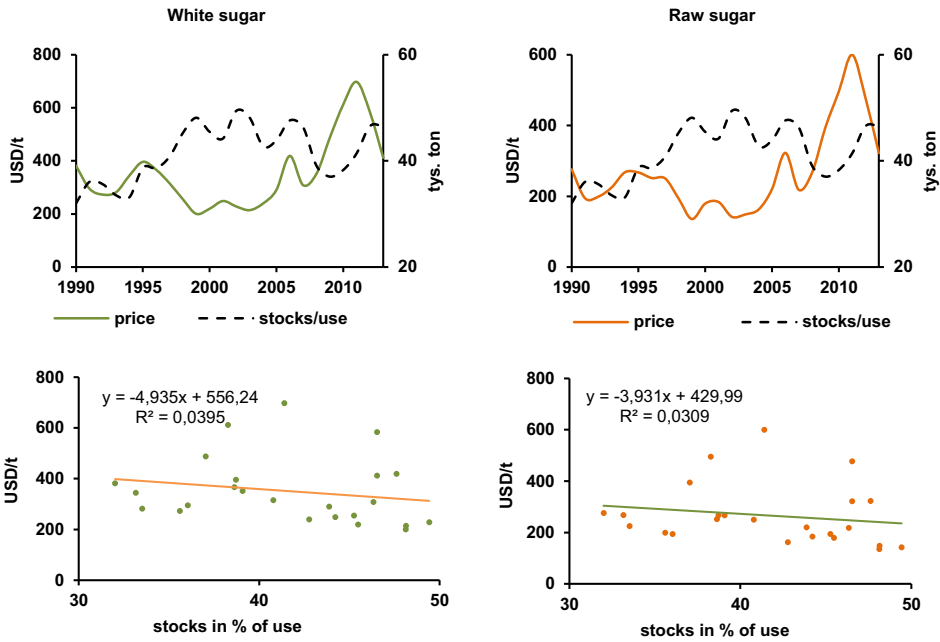
Figure 22. The impact of change in stock on the market balance



Source: Wright B., Cafiero C.: *Grain reserves and food security in the Middle East and North Africa*, Food Sec. 3, 2011, s. 67.

In the years 1990-2013, in the world sugar balance, closing stock was volatile and accounted for 32-49% of consumption (Fig. 23). The comparative analysis of closing stock and white and raw sugar prices demonstrated, however, a small statistical dependence. The world white and raw sugar prices were correlated negatively with closing stock, and the values of Pearson's correlation coefficients amounted to $R = 0.12$ and $R = 0.18$ and were irrelevant statistically. Growth in closing stock caused only a small decrease in world prices. On this basis, it may be concluded that the sugar price level, apart from the supply and demand situation, was affected by many other factors.

Figure 23. Closing stock to consumption and world sugar prices

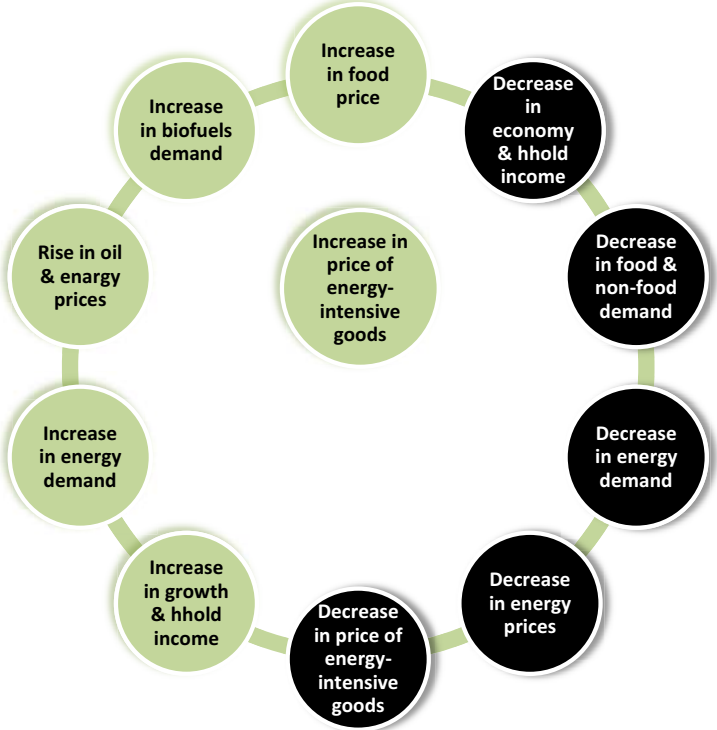


Source: Calculations of IERiGŻ-PIB, data of F.O. Licht's "Sugar&Sweetener Report".

Prices of energy raw materials and energy are translated into prices of goods and services and play a crucial role in economic cycles. In the theory of economic cycles, four basic cycle phases are distinguished: recession, depression, recovery and prosperity. In contemporary cycles, two phases can be distinguished: recession and recovery [Baryczk 2006]. Impact of energy price changes on the economic situation may be presented using a closed cycle (Fig. 24). Slowdown in economic growth and, further, recession result in reduction in households' income and, as a result, decreasing demand, including for food and energy. Later on, prices of energy and prices of energy-consuming goods decrease. Low prices result in growth in the demand and the economy starts slowly its transition in the recovery phase, whose symptoms are growing income of households. The economic growth and improvement in the purchasing energy of consumers result in a greater demand for energy. It results in increase in prices of energy and energy raw materials, which are reflected in prices of goods and energy-consuming services. High prices of energy and limited resources of fossil energy raw materials make the economies of particular countries start generating energy from renewable sources, including from agricultural raw materials. High prices of energy and food products foreshadow that the economy is approaching another sloping economic cycle phase. In the presented cycle, the leading role is

played by the market mechanism, but, if considerations are limited to agricultural products and to production of biofuels, also the impact of economic policy (e.g. energy, agricultural) is very important.

Figure 24. Changes in energy prices and economic cycle

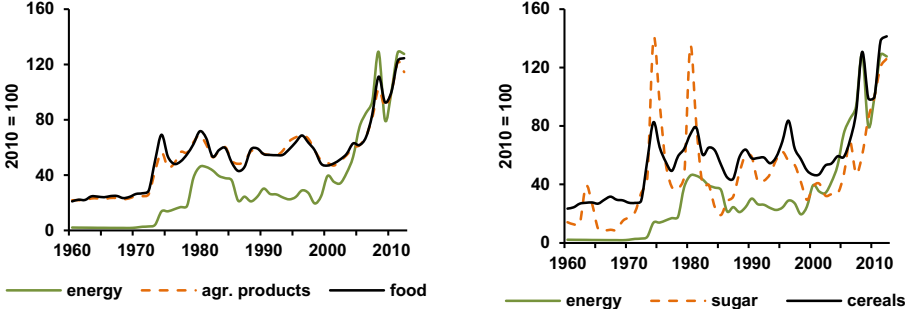


Source: Msangi S., Tokgoz S., Zhang W.: *Biofuels, Agriculture and Food Security: Key Connections & Challenges*, Environment & Production Technology Division, IFPRI, Washington 2012.

In the years 1960-2012, indexes of world prices of energy and agricultural and food products demonstrated very similar trends. Until 2004, prices on the agricultural and food markets were characterized by greater dynamics than energy prices. In the next period, the price dynamics leveled and the convergence of the market of energy and agricultural products, food and energy increased. The main reason for this is a growing demand for agricultural raw materials, including also production of energy. Sugar belongs to food products whose prices have been for many years strongly correlated with fuel prices. In Brazil, which is one of the largest world sugar producers, large volumes of sugar cane (approx. 40%) are processed into bioethanol. Energy crises at the turn of the 1970s and 1980s, resulted in a high growth in energy prices, but growth in prices of sugar and cereals was significantly greater. In the years 2008-2012, the prices of energy,

sugar and cereals were increasing to a similar degree, since the consumption of cereals for the production of bioethanol was increasing (Fig. 25).

Figure 25. Indexes of world prices of energy and agricultural and food products



Source: Data of The World Bank, www.worldbank.org.

A long-term evaluation of the relation between world sugar prices and energy was conducted using the co-integration analysis. The concept assumes that between prices of comparable products short-term disturbances can occur, however, in the long run balance is maintained between them. In the case of co-integration between the analyzed prices, these markets can be identified as integrated [Aczel 2005]. Testing co-integration of time series of average annual sugar and energy price indexes in the years 1960-2012 was preceded by the assessment of their stationarity. The results of Dickey-Fuller tests did not enable rejecting the hypothesis H_0 about series non-stationarity. The first differences in price index logarithms created time series that were stationary and integrated in the first degree $Y_t \sim I(1)$. The co-integration of sugar and energy price indexes was conducted using the Engle-Granger test. Indexes of world sugar prices were adopted as dependent variable Y_t and energy prices were explanatory variable X_t . The test results indicated a long-term relation between sugar and energy prices, but the independent variable described to a small degree the dependent variable ($R^2 = 0.10$). Growth in energy prices on the world market by 1 p.p. resulted in growth in sugar prices by 0.31 p.p. (Tab. 17).

Table 17. Results of co-integration tests of world sugar and energy prices

Test	Critical value $\alpha - I = \delta$	Dickey-Fuller test statistics	Value p	Decision
Unit root:				
sugar price indexes Y_t	-1.078	-6.148	5.22e-008	$I(1)$
energy price indexes X_t	-0.945	-4.809	4.43e-005	$I(1)$
DF residues	-1.193	-6.142	5.08e-007	$I(1)$
Co-integration equation:	$Y_t = 0,315 \cdot X_t + 0,0098$			
Variable X_t				
standard error		0.0838		
<i>t - Student</i>		3.7620		
value p		0.0004		
Intercept				
standard error		0.0228		
<i>t - Student</i>		3.4281		
value p		0.6704		
Determination coefficient R^2		0.1010		
Durbin-Watson statistics		1.9258		

Source: Calculations of IERiGŽ-PIB, data of The World Bank, www.worldbank.org.

3. Structural transformations in the Polish sugar sector

3.1. Production of sugar beet

In the years 1990-2003, structural transformations in the Polish sugar sector were running slowly, in spite of valid, from 1995, statutory regulation of the sugar market and ownership transformations in the sugar industry [Urban 2004]. This process accelerated clearly no sooner than after the integration with the EU, first of all, as a result of reforms of the market regulation system in the period 2006-2010. Restructuring of the domestic sector included two parallel processes, which were concentration of cultivation and processing of sugar beets and ownership transformations in the sugar industry [Szajner 2009, p. 186].

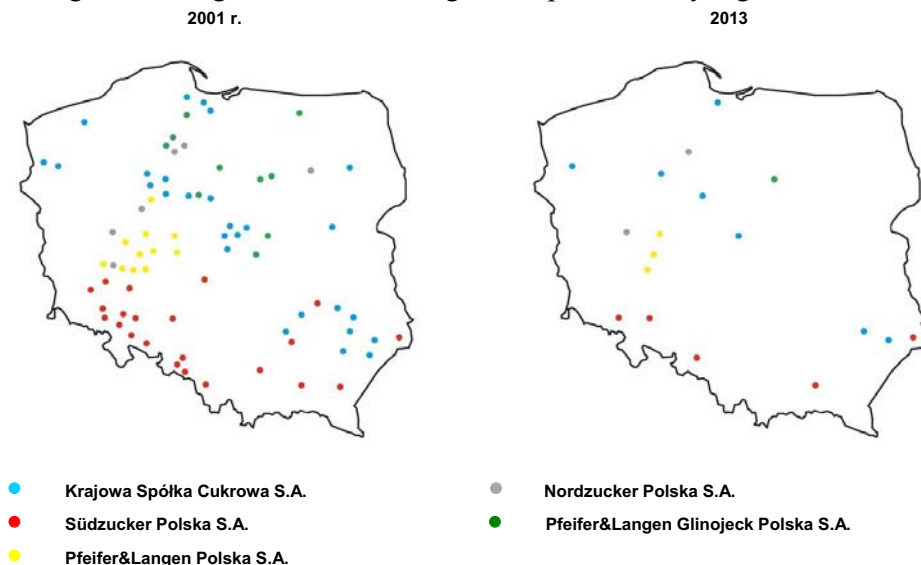
Structural transformations in the sugar industry resulted in deep changes in cultivation of sugar beets. In the sugar campaign 2000/2001, 76 sugar factories were operating, i.e. only two less than in the centrally planned economy, and sugar beet plantation regions were distributed throughout the whole country. One of the main goals of the sector restructuring was improvement in its competitiveness, since the basis for building permanent competitive advantages is growing management efficiency [Kulawik 2007, p. 25]. The basic goal of the reform of market regulation in the EU was limiting cultivation of sugar beets to the regions characterized by the most beneficial ground and climate conditions. Agricultural farms can produce effectively sugar beets only in the case of high yields that can be obtained on the best soils [Ostrowska 2005]. As a result of reduction in the number of sugar factories to 18, the cultivation of sugar beets was concentrated in regions of the country with the large share of soils with the highest quality. Plantation areas are located in the neighbourhood of sugar factories so that raw material transportation costs would be possibly low (Fig. 26).

According to the data of industry associations,⁴⁹ the acreage of sugar beets in Poland in the period 1995-2012 decreased nearly by half, from 384 thousand ha to 193 thousand ha, and in 2013, further decrease was recorded, to 185 thousand ha. According to the data of the Central Statistical Office (GUS), reduction in the acreage was smaller – to approx. 200-210 thousand ha. The acreage is focused in five voivodships: Wielkopolskie (43 thousand ha), Kujawsko-Pomorskie (38 thousand ha), Lubelskie (31 thousand ha), Dolnośląskie (19 thousand ha) and Opolskie (15 thousand ha), which have approx. 75% share in the domestic area. In Lubuskie, Małopolskie, Podlaskie, Śląskie and Warmiń-

⁴⁹ The Association of Sugar Beet Planters, the Sugar Industry Engineers Association, the Association of Sugar Producers in Poland.

ko-Mazurskie Voivodeships, sugar beets are cultivated on a very small area⁵⁰. The sugar beets acreage decreased to a greater extent than the total sown area. Consequently, the share of sugar beets in the sowing structure decreased from 3% to only 1.8%. Decrease in the share of root crops⁵¹ in the crop rotation is unfavorable from the point of view of agronomy and agricultural techniques [Starczewski 2006] and affects negatively biodiversity.

Figure 26. Sugar factories and sugar beet plantation by regions



Note: In 2001, no sugar factories were running one-day campaigns. In 2009, the concern British Sugar Overseas withdrew from Poland and the sugar factories were taken over by Pfeifer&Langen Polska S.A.

Source: Study of the Institute of Agricultural and Foods Economics, National Research Institution, data of sugar companies, Association of Sugar Industry Technicians, Association of Sugar Producers in Poland.

Deep structural changes in the raw material base of the sugar industry are presented also by a large decrease in the number of planters and growth in the concentration of production in large farms. The number of planters decreased from approx. 259 thousand in 1995 to approx. 36 thousand in 2012. Decrease in the number of farms producing sugar beets was greater than their acreage. In consequence, the area of average plantation increased from 1.5 ha to 5.4 ha. Growing concentration of cultivation is clear and significant from the point of view of production efficiency. High differences in cultivation concentration occur in planta-

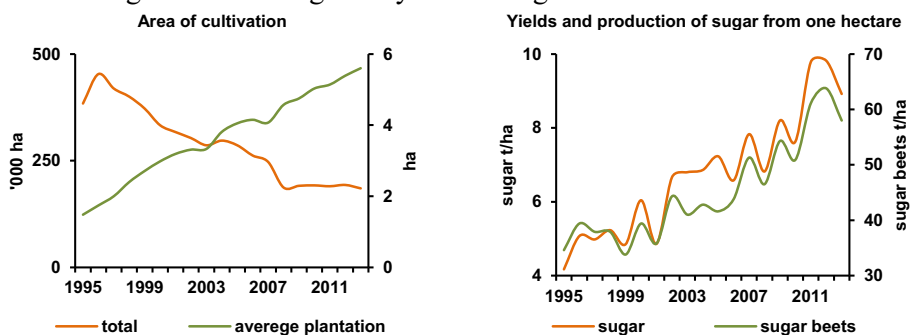
⁵⁰ *Rocznik Statystyczny Rolnictwa 2012*, GUS, Warsaw, p. 190.

⁵¹ Potato cultivation area has been systematically falling: 1995 – 1520 thousand ha, 2000 – 1251 thousand ha and 2011 – 393 thousand ha.

tion areas of particular sugar concerns. In sugar factories belonging to German sugar concerns, the area of average plantation is 5.5-6.5 ha. The most disintegrated structure of suppliers is present in most factories of Krajowa Spółka Cukrowa S.A., in which the acreage of average plantation is 4.7 ha⁵². The entity structure of raw material base remains very disintegrated as compared to the major competitors in the EU-15. In Great Britain, the area of average plantation is 24 ha, in France 14.5 ha, in Germany 11 ha, and in the Netherlands 7 ha⁵³.

The result of concentration of cultivation in regions of favourable ground and climate conditions and in relatively large farms was growth in yields from approx. 40 t/ha to approx. 60 t/ha. In the analysis of linear and exponential trend function it was determined that yields in the years 1995 and 2012 were growing in absolute terms by 1.4 t/ha annually, and in relative terms by 3% annually. The yields of sugar beets demonstrated a clear upward trend, given large volatility in particular years, which was affected, to a significant extent, by weather conditions during the period of vegetation and crops. Increasing yields were accompanied by their improved quality, which is measured by the content of sugar in roots, having effect on the so-called technological sugar yield [Nickel 1983], [Dobrzycki 1973]. In the analyzed period, average technological sugar yield increased from 4.2 t/ha to 9.8 t/ha (Fig. 27). Average annual dynamics of technological sugar yield in absolute terms was 0.28 t/ha, and in relative terms was 4.2%. Technological sugar yield demonstrated greater dynamics than yield of roots, which is confirmed by positive changes in production technology and effectiveness.

Figure 27. Acreage and yields of sugar beets in Poland



Source: Study of IERiGŻ-PIB, data of "Rynek cukru. Stan i perspektywy", no. 35-40, IERiGŻ-PIB, ARR, MRiRW, Warsaw.

⁵² Rynek cukru. Stan i perspektywy, no. 40, IERiGŻ-PIB, ARR, MRiRW, Warsaw 2013, s. 14.

⁵³ CIBE First Harvest Estimates for 2010/2011, Confederation Internationale des Betteraviers Europeens, D.126/23.03.2011

Growing yields compensated partially for reduced area of cultivation and, as a consequence, the decrease in beet crops was relatively small. Due to growing technological sugar yield from one hectare of cultivation, smaller crops did not result in reduction in sugar production. In the years 1995-2000, the acreage was 385-335 thousand ha, and yields did not exceed 40 t/ha. As a result, crops of sugar beets were approx. 13.2 million tons (Tab. 18). After the end of reforms of the market regulation in the EU, the acreage is approx. 190 thousand ha, and yields increased to approx. 63 t/ha. In recent years, crops were approx. 12.3 million tons and were only by approx. 9% smaller than at the beginning of the analyzed period. An exceptional situation occurred in the campaign 2010/2011, when weather conditions in the winter caused decrease in crops to 9.96 million tons.

Table 18. Production of sugar beets in Poland

Specification	J. measures	1995	2000	2010	2012
Cultivation area	thousand ha	385	333	192	193
Share in sown area	%	3.0%	2.7	1.8	1.8
Number of planters	thousand	258.9	111.9	38.2	35.8
Area of average plantation	ha	1.48	2.98	5.03	5.39
Polarization	%	15.82	17.6	16.6	17.4
Yield of roots	t/ha	34.6	39.4	50.9	63.8
Technological sugar yield	t/ha	4.17	6.04	7.6	9.8
Collections	thousand t	13 309	13 134	9 956	12 300
Buying-in prices	PLN/dt	8.08	11.19	11.31	13.72
Share in goods agricultural production	%	5.0	4.0	2.7	3.5

Source: Study of IERiGŻ-PIB, data, Rocznik Statystyczny Rolnictwa GUS, "Rynek cukru. Stan i perspektywy", no. 35-40, IERiGŻ-PIB, ARR, MRiRW, Warsaw.

Profitability of sugar beet cultivation is determined by various factors, but the major role is played by prices paid to planters. In the recent years, buying-in prices have been determined by minimum buying-in price, which, currently in the EU, is 26.29 EUR/t of sugar beets with standard sugar content of 16%. The reform of the market regulation in the EU reduced the minimum buying-in price by 40%, and decrease in the planters' income was partially compensated in the form of sugar payments not related to production. The minimum price and sugar payments are converted into national currency at the Euro exchange rate published by the European Central Bank⁵⁴. In the years 2006-2013, the Euro exchange rate used for conversions was ranging from PLN 3.37 to 4.34. Large exchange rate fluctuation resulted in a great volatility of minimum buying-in price

⁵⁴ Commission Regulation (EC) no. 1913/2006 of 20 December 2006 laying down detailed rules for the application of the agrimonetary system for the euro in agriculture and amending certain regulations. L 356/52, 21 December 2006.

and sugar payments. An important factor decisive for the level of prices is also quality of raw material, which is measured by the content of sugar in roots.

Detailed conditions of contracting raw material and cooperation of the sugar industry with planters were regulated by national trade agreement⁵⁵, terminated by planters in 2008. Development of compromise regulations and signing of a new agreement was extending in time. In this situation, "a trade agreement" was introduced by the Ministry of Agriculture and Rural Development⁵⁶. The terms of this "agreement" were, however, unsatisfactory for the sugar industry. Sugar concerns concluded with planters regional trade agreements that have been binding until today. Trade agreements and valid throughout the whole analyzed period contracting agreements limited to some extent the price risk and strengthened (bargaining) position of farmers in the marketing chain [Porter 2006, p. 24].

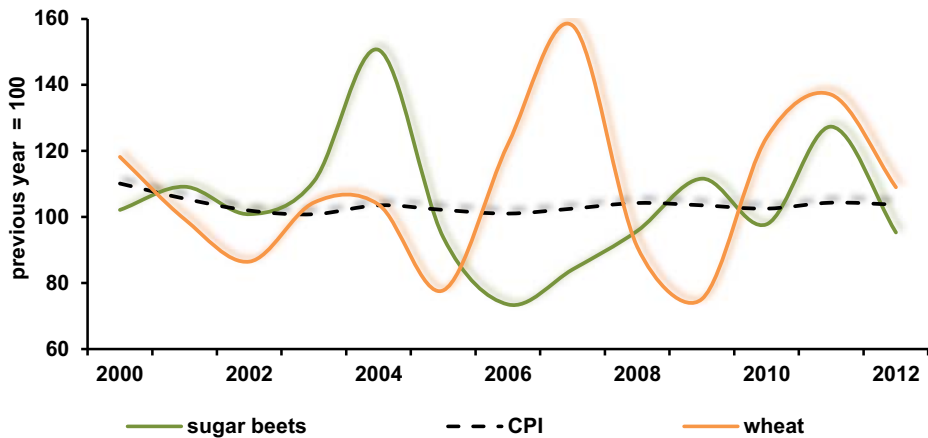
In the years 2000-2003, buying-in prices of sugar beets increased slightly to 124.2 PLN/t. Polish buying-in prices were by 31-33% lower than the minimum buying-in prices in the EU converted into the domestic currency. Low prices of raw material, whose greatest item (approx. 40%) are structures of sugar production costs⁵⁷, determined the price and cost advantages of the national sugar industry. In 2004, the EU market regulations were introduced and the average price paid to planters increased by 50.6% to 187.0 PLN/t and was comparable with the minimum buying-in price in the EU. Integration with the EU coincided in time with the reform of the market regulations and in the next years the minimum buying-in price was reduced. Reduction in the minimum buying-in price resulted in the reduction in prices paid to farmers to 110-115 PLN/t of sugar beets. In the years 2011-2012, the average buying-in prices increased to 137-144 PLN/t, which was affected by provisions in new trade agreements, good financial standing of the sugar industry and high quality of raw material. In the years 2000-2012, the accumulated growth in buying-in prices of sugar beets amounted to 35% and was lower than the cumulated rate of inflation (42%), and much lower than the cumulated increase in wheat buying-in price of 76% (Fig. 28).

⁵⁵ Trade Agreement concluded on 13 May 2004 between the Association of Sugar Producers in Poland and the National Association of Sugar Beet Planters.

⁵⁶ Regulation of the Minister of Agriculture and Rural Development of 10 March 2011 on conditions of purchase and delivery of sugar beets meant for production of sugar under the sugar amount of production aid. Journal of Laws No. 57 of 15 March 2011 item 292.

⁵⁷ P. Szajner: *Ekonomiczne i technologiczne skutki restrukturyzacji polskiego przemysłu cukrowniczego*, paper delivered at the conference entitled "Postęp techniczny w przemyśle cukrowniczym", Sugar Industry Engineers Association, 23-24 April 2012, Zakopane.

Figure 28. Dynamics of buying-in prices of sugar beets, wheat and inflation



Source: Study of IERiGŻ-PIB, data of "Rynek cukru. Stan i perspektywy", no. 35-40, IERiGŻ-PIB, ARR, MRiRW, Warsaw.

Starting from the season 2006/2007, planters have received sugar payments, whose value has been growing gradually to reduce the minimum buying-in price and depended on EUR exchange rate. In the first three seasons, payments amounted to 33-39 PLN/t, and in subsequent seasons it increased to 50-56 PLN/t. Sugar payments did not compensate for decrease in prices, as the average price increased by payments was still nominally lower than in 2004. Due to the growth in buying-in prices in the years 2011-2012 and sugar payments (approx. 55 PLN/t), planters' revenues were comparable with the ones obtained before the reform of the market regulation (Tab. 19). Analyses of profitability and costs of agricultural production conducted by IERiGŻ-PIB (Institute of Agricultural and Food Economics – National Research Institute), proved that in the years 2006-2010 the share of sugar payments in the income obtained from the sugar beet cultivation increased significantly. The results of analyses confirmed also a positive impact of growth in the cultivation scale on its profitability (*scale effects*). Farms cultivating more than 15 ha of sugar beets obtained on average approx. 10% higher income from activities as compared to plantations of total area not exceeding 5 ha⁵⁸.

⁵⁸ A. Skarżyńska, I. Augustyńska: *Produkcja, koszty i dochody z wybranych produktów rolnych*, IERiGŻ-PIB, Warsaw 2004-2012.

Table 19. Buying-in prices of sugar beets and sugar payments

Years	Buying-in price		Sugar pay- ment	Average buying-in price increased by sugar payment
	minimum – the EU	average – Poland		
	PLN/ton			
2000/01	176.60	101.90	-	-
2001/02	187.11	111.20	-	-
2002/03	201.01	112.10	-	-
2003/04	180.26	124.20	-	-
2004/05	182.35	187.00	-	-
2005/06	126.73	175.30	-	-
2006/07	112.84	128.80	33.26	162.06
2007/08	93.92	108.30	37.15	145.45
2008/09	109.32	103.70	39.45	143.15
2009/10	103.97	115.70	53.47	169.17
2010/11	109.32	113.10	50.42	163.52
2011/12	114.04	144.00	56.00	200.00
2012/13	108.70	137.20	52.44	189.64

Source: Study of IERiGŻ-PIB, data of GUS, ARiMR, "Rynek cukru. Stan i perspektywy", no. 35-40, IERiGŻ-PIB, ARR, MRiRW, Warsaw.

3.2. Sugar industry

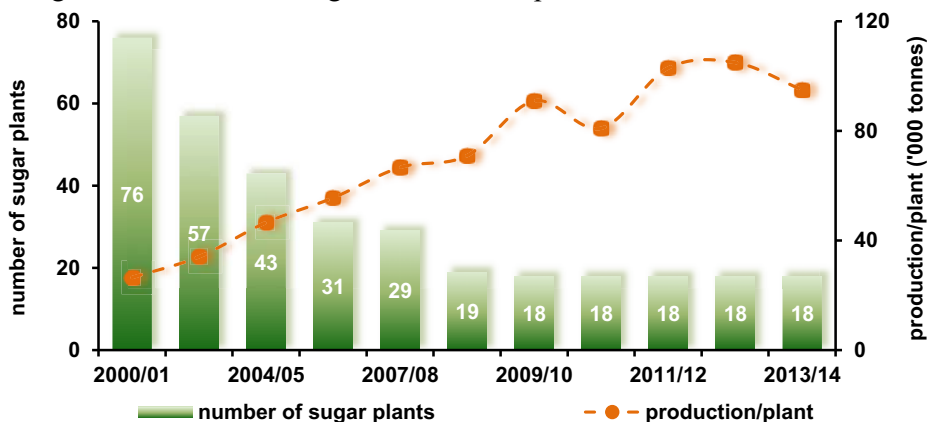
The sugar industry restructuring process proceeded very slowly. In 1995, 76 sugar factories were operating on the market, as two declared bankruptcy. The most numerous group covered 62 state sugar factories, 5 were operating as companies wholly owned by the State, and 9 were privatized. Further ownership transformations were carried out on under statutory regulations and secondary legislation⁵⁹. State sugar factories were transformed into companies wholly owned by the State Treasury and grouped in four Sugar Companies (holdings). In the next years, particular sugar factories and holdings were undergoing privatization. In 2002, Krajowa Spółka Cukrowa "Polski Cukier" S.A. was established, which concentrated 26 plants comprising three Sugar Companies: Lubelsko-Małopolska S.A. Poznańsko-Pomorska S.A. and Mazowiecko-Kujawska S.A. In sugar factories comprising Krajowa Spółka Cukrowa "Polski Cukier" S.A. the State Treasury held majority stake, and further privatization was to be conducted through planters and employees. At the same time, sugar factories were privatized involving foreign sugar concerns (Saint Louis Sucre, British Sugar Overseas, Pfeifer&Langen, Südzucker AG, Nordzucker AG). The

⁵⁹ Regulation of the Council of Ministers of 14 March 1995 on the determination of companies wholly owned by the Treasury and state-owned companies subject to transformation into companies wholly owned by the Treasury whose shares will be contributed to the Sugar Companies. Journal of Laws No. 34 of 14 March 1995 item 165 and item 168.

value of foreign direct investments in the sugar industry amounted to USD 1056.3 million [Chechelski 2005, p. 87].

In subsequent years, the number of operating sugar factories were decreasing systematically and the current ownership structure of the sector was shaped. In the season 2009/2010, the number of sugar factories decreased to 18 that operate in the structures of four sugar concerns. An important factor for acceleration of structural changes was the reform of market regulations in the years 2006-2010. Market shares of the abovementioned concerns calculated on the basis of granted production quotas are as following: KSC Polski Cukier (39.2%), Pfeifer&Langen Polska S.A (26.4%), Südzucker Polska S.A. (25%), and Nordzucker Polska S.A (9.4%). The sugar industry in Poland, like in most EU countries, is a classic oligopoly, and the whole market is controlled by four producers. Four largest sugar concerns in the EU have total 61% share in the production quota, and subsequent five large producers – 28.5%⁶⁰. The decommissioning of subsequent factories was accompanied by increase in the scale of production in operating sugar factories. In the analyzed period, sugar production per 1 sugar factory increased from 20 thousand t to 110 thousand t (Fig. 29). The growth in production concentration was significant, but it is still smaller than in the German sugar industry (210 thousand t)⁶¹.

Figure 29. Number of sugar factories and production concentration



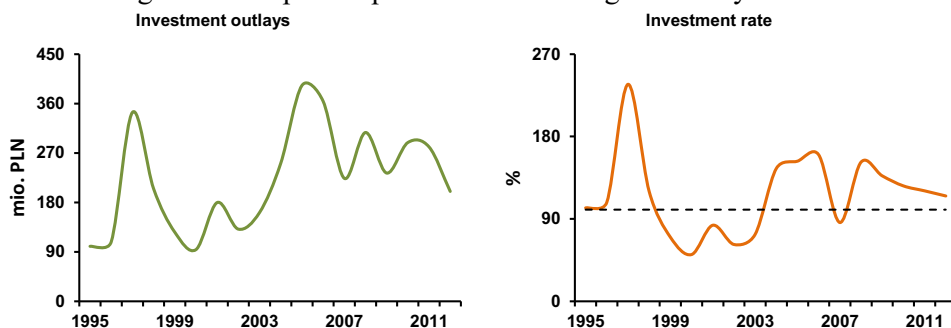
Source: Study of IERiGŻ-PIB, unpublished data of GUS, Association of Sugar Industry Technicians.

⁶⁰ According to the CIBE and KZPBC data, the main producers of sugar in the EU and their share in the production: Südzucker Group (24.2%), Nordzucker Group (15.1%), British Sugar Group (10.8%), Tereos Group (10.6%), Cristal Union (7.9%), Pfeifer&Langen (7.7%), Royal Cosun (6.9%), Krajowa Spółka Cukrowa (4.1%), Italia Zuccheri (2.1%).

⁶¹ Rynek cukru. Stan i perspektywy, no. 40, IERiGŻ-PIB, ARR, MRiRW, Warsaw 2013, p. 17.

The sugar industry underwent a thorough modernization, which required high capital expenditures. In the years 1995-2012, the nominal value of investments amounted to total PLN 3.99 billion, i.e. approx. PLN 220 million annually. Capital expenditures exceeded the value of depreciation, which led to growth in the value of fixed assets. An exceptional situation occurred only in the years 1999-2003, i.e. in the years before accession to the EU and in 2007, when, as a result of the reform of market regulation, sugar concerns were undergoing restructuring (Fig. 30). The structure of capital expenditures was dominated by machines and devices (67%), and smaller share was recorded by buildings and premises (27%) and other investments (3%). Sugar factories were investing, first of all, in technological lines, warehouse economy (nearly all sugar factories store sugar in siloses), energy systems and environmental protection (e.g. wastewater treatment plants)⁶². In the years 2010-2012, new directions appeared in investment activities, aiming at diversification of economic activities. Krajowa Spółka Cukrowa "Polski Cukier" S.A. acquires companies from other food processing sectors (e.g. processing of cereals, production of confectionery), which creates a chance for establishment of a large food concern. The second area of new investments is production of energy from biomass. In two sugar factories, production of biogas from beet pulp was started.

Figure 30. Capital expenditures in the sugar industry



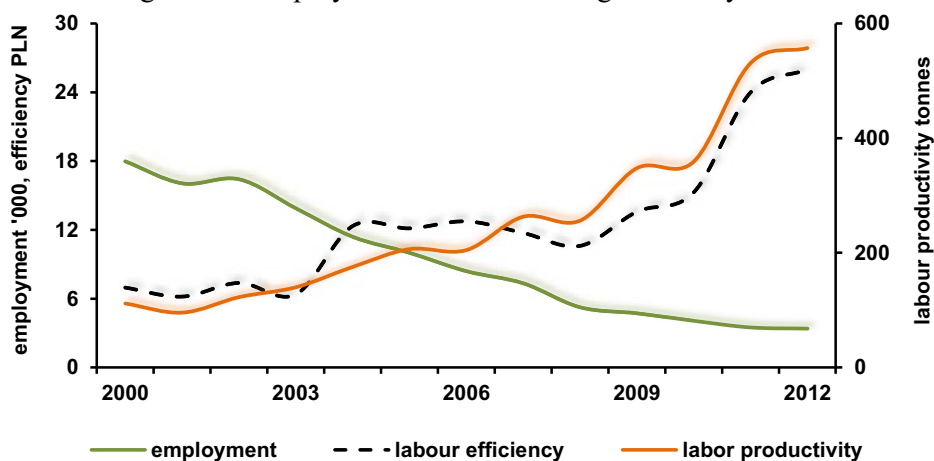
Source: Study of IERiGŻ-PIB, unpublished data of GUS, "Rynek cukru. Stan i perspektywy", no. 35-40, IERiGŻ-PIB, ARR, MRiRW, Warsaw.

Structural transformations and modernization of technological processes made it possible to improve the efficiency of managing resources of production factors. In the years 2000-2012, employment per full jobs decreased from 18 thousand to 3.4 thousand people. Decreasing employment was accompanied by a considerable growth in work efficiency and work effectiveness. Technical work

⁶² P. Szajner: *Economic and technological effects of the industry sugar restructuring*, lecture at the 31st scientific and technical conference entitled "Postęp techniczny w przemyśle cukrowniczym", Sugar Industry Engineers Association, 23-24 April 2012, Zakopane.

efficiency, measured by production of sugar market per one employee, increased five times to 560 t. Work effectiveness was estimated as the ratio of sales revenues to remuneration costs. In 2000, the unit of work payment generated ca. 7 sales revenues, and in 2012 a similar ratio grew to PLN 26 (Fig. 31). Large capital expenditures on fixed assets and simultaneous employment reduction caused increase in capital intensity of production and decrease in its labor consumption. Changes in operation of the sugar industry are illustrated clearly by results of the analysis of the Cobb-Douglas production function. Capital expenditures show greater marginal productivity and elasticity as compared to labor input. The econometric analysis showed that increase in labor inputs in the sugar industry is unjustified economically and manual work will keep on being replaced with tools [Szajner 2012, p. 451].

Figure 31. Employment in the Polish sugar industry



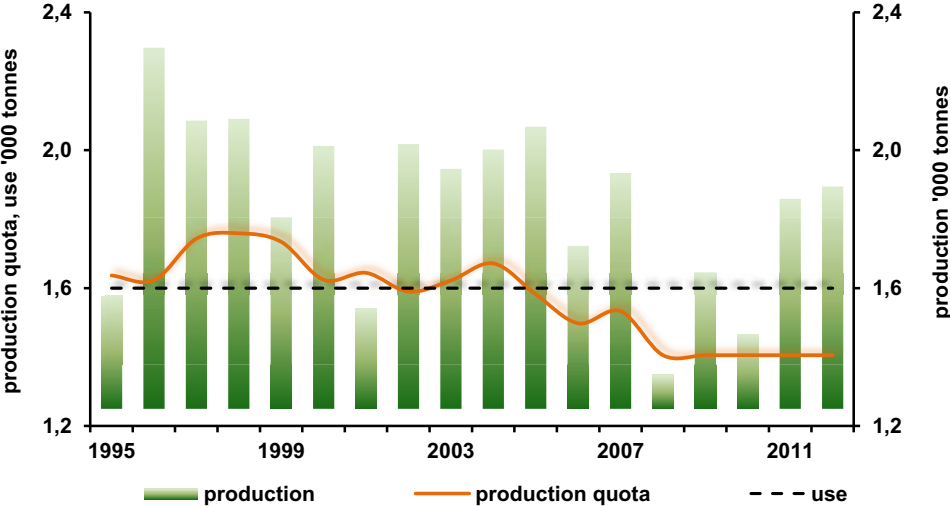
Source: Study of IERiGŻ-PIB, unpublished data of GUS.

The production of sugar in Poland shows great fluctuations, which, to a significant extent, are determined by weather conditions during the vegetation period, crops and processing of sugar beets. In seasons with favorable weather conditions, the production of sugar exceeded 2 million tons. On average, once every five years, due to unfavourable weather situation, supply of raw material was very small and production was smaller than the domestic market demand (1.6 million t). In the years 1995-2012, this situation occurred four times, and production was three times smaller than the production quota (Fig. 32). Production not exceeding the production quota caused some problems with management of out-of-quota sugar. Entities of the sector experienced it particularly severely in the period before the accession, as some manufacturers defaulted on the obligation to export production surpluses. As a consequence, the internal

market showed supply surplus, which affected pressure on prices. After the integration with the EU, management efficiency of out-of-quota sugar improved and the market was balanced.

In the campaigns 2011/2012 and 2012/2013, which were characterized by good weather, production of sugar in 18 sugar factories was 1859 thousand t and 1895 thousand t, respectively. Thus production was a little smaller than total production generated in 76 plants in the second half of the 1990s. Production results show the dimension of growth in production concentration and management efficiency in the sugar sector. Modernization of plants permitted growth in efficiency of sugar from processed raw material and reduction in losses of sugar in the technological process (for instance in molasses) [Nickel 1983, Dobrzycki 1973].

Figure 32. Production quotas and sugar production

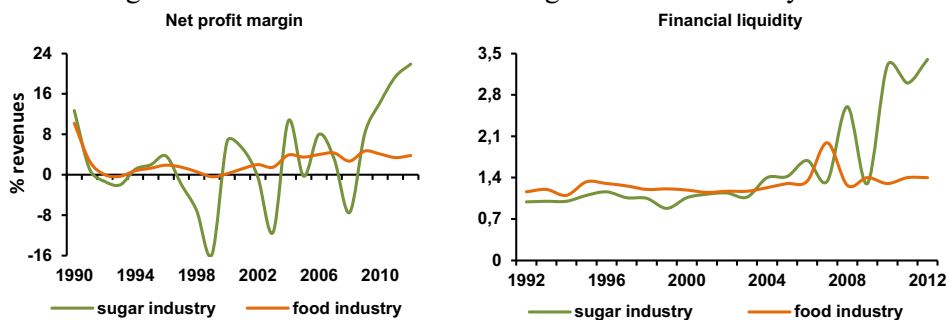


Source: Study of IERiGŻ-PIB, sugar factories' data, ARR, Association of Sugar Producers in Poland.

The sugar industry in Poland is characterized by variable financial situation in comparison to the whole food industry. In particular years, the sugar industry achieved large profits or incurred large losses on business activities. Values of net profitability ratio that are a ratio of net profit to total sales revenues were ranging from -16% to +21.5%. Before integration with the EU, the main reason for large fluctuations on the financial result were low prices of sugar on the domestic and international market and delayed restructuring, which affected adversely management efficiency. Large improvement in financial performance was recorded after the integration with the EU, when sugar factories were sell-

ing sugar at high prices, and sugar was produced from raw material at low 2003 prices. The economic situation deteriorated in 2008, when sugar concerns, in the period of the reform of EU market regulations, paid large fees for the restructuring fund. In subsequent years, paid restructuring aid, improvement in management efficiency (technological progress) and good situation on the internal and external market (growth in world prices) made the sugar industry achieve large profits and exceptionally high profitability (Fig. 33). In the same period, sugar concerns demonstrated a clear financial excessive liquidity and "difficulties" with managing frozen current assets. "The problem of excessive liquidity" was solved partially, for example, by investing in new business activity areas. Good financial situation of the sector is unquestionably a great asset in the perspective of further reforms of the sugar market regulation, since it enables taking up any actions aimed at improvement in the competitive position.

Figure 33. Financial results of the sugar and food industry



Source: Study of IERIGŻ-PIB, unpublished data of GUS, "Rynek cukru. Stan i perspektywy", no. 35-40, IERIGŻ-PIB, ARR, MRiRW, Warsaw.

3.3. Foreign trade in sugar and molasses

Foreign trade played a key role in the stabilization of the domestic sugar market. Market regulations both before the integration and after the accession to the EU were defining precisely the role of foreign trade in this respect, placing on producers the obligation to export out-of-quota sugar (without subventions). The Polish sugar market was characterized by surplus of supply over demand, which is depicted by the ratio of self-sufficiency being a ratio of production to consumption. Gradually changes are introduced in market regulations, including mainly reduction in amounts of production aid and structural transformations contributed substantially to reduction in supply surpluses. The values of self-sufficiency ratios decreased from 140-130% in the second half of the 1990s to 85-125% in the period of EU membership. As a result of the reform of market regulations, since 2008 the production quota has been approx. 15% lower than domestic consumption. Stringent provisions concerning the management of out-

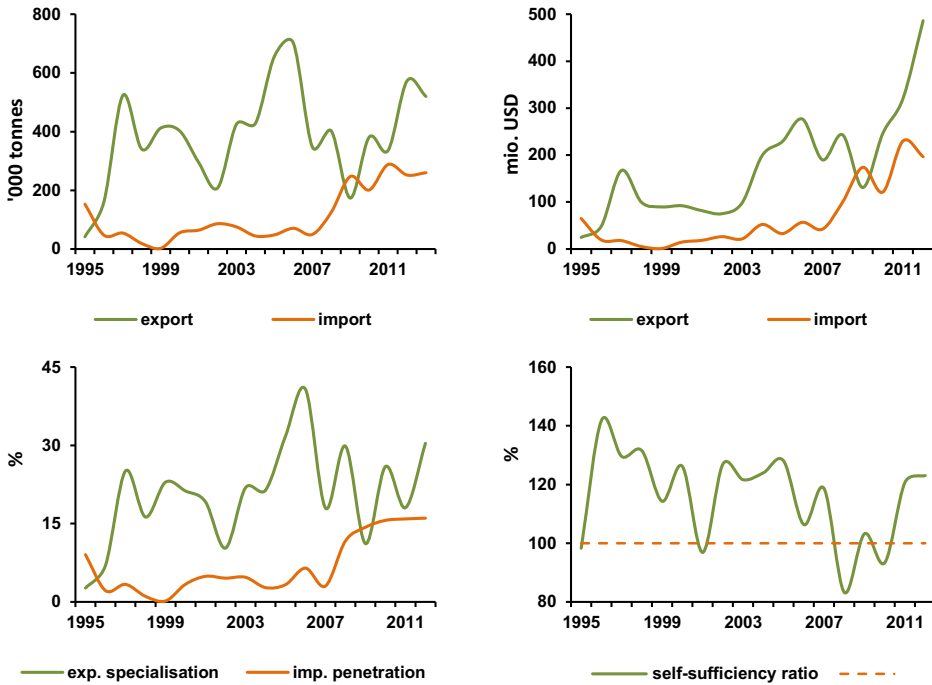
of-quota sugar result in the need for import of 200-250 thousand t of sugar to satisfy internal demand, regardless of the production volume.

Due to significant production potential, the Polish sugar sector is net exporter. In the years 1995-2012, foreign trade showed negative balance only twice, when, as a result of unfavorable weather conditions, crops of sugar beets and sugar production were exceptionally small. Export was characterized by high fluctuations, which was determined by high variability of the production volume and supply surpluses on the internal market (Fig. 34). Export variability ratio expressed in quantity amounted to 0.46. In terms of value, import variability was even greater (0.70), as it was determined additionally by volatility of prices on the international market. In the years 1996-2007, import did not exceed 90 thousand t and had a small share in the supply on the market. The value of import penetration ratio, which is a ratio of import to production less the balance of foreign trade, did not exceed 5%. Growth in import to 200-250 thousand t. annually was recorded during the EU reform of the market regulations, and was one of its goals. As a result, the share of import in the supply on the market increased to approx. 15%. New EU member countries can import cane sugar for refining (raw sugar) only from 2010 and, as a result, the import freight structure changed⁶³. In the years 2010-2012, import of raw sugar increased from 54 thousand t to 120 thousand t. Sugar for refining is imported in the period from March to August, as sugar factories over that period do not process sugar beets. Refining permits better use of production factors and improves management efficiency, but is, at the same time, competition towards sugar beet processing.

An alarming phenomenon is deteriorating international competitiveness of the sugar industry, which is measured by the ratios of revealed comparative advantages as defined by Balassa RCAi and by Lafay LFIi. The LFIi ratio depicts the streams of export and import, particularly the character of the balance. The ratio values greater than zero reflect positive exchange balance, which confirms the sector competitiveness [Szczepaniak 2012, p. 56]. The values of RCAi were smaller than unity, as decrease in the share of products of the sugar sector in the Polish agricultural and food export was greater than in the world export. In consequence, relative share of the domestic sector in the world market remains minute. The values of LFIi were greater than zero, but have been decreasing systematically, which indicates decreasing sector competitiveness [Szajner 2009, p. 197].

⁶³ Commission Regulation (EC) no. 828/2009 of 10 September 2009 laying down detailed rules of application for the marketing years 2009/2010 to 2014/2015 for the import and refining of sugar products of tariff heading 1701 under preferential agreements. Official Journal of the European Union L 240/14, 11 September 2009.

Figure 34. Polish foreign trade in sugar



Note: Export specialization is a ratio of export volume to production volume. The import penetration ratio is a ratio of import to production less foreign trade balance. The self-sufficiency ratio is a ratio of domestic production to domestic consumption (demand).

Source: Study of IERiGŻ-PIB, data of CIHZ, CAAC.

In the years 1995-2012, the geographic directions in foreign trade underwent significant changes. Before integration with the EU, sugar was exported mainly to the former USSR and Arabic countries, with domestic shortages. This export was fostered by export refunds and the obligation to sell production surpluses abroad. The share of the EU-15 and CEFTA countries in export was small, as markets of these countries were also characterized by surplus supply. Additionally, these markets were protected with high customs duties, and export was possible only under preferential quotas.

A clear change in the geographic structure in export took place after the accession to the EU. Incorporation to the common European market and covering by EU regulations caused a strong linkage of the sector with the EU market. Integration with the EU market was facilitated also by foreign direct investments of Western European sugar concerns. The reform of the market regulations made five member states resign from sugar production⁶⁴, and made many other

⁶⁴ Bulgaria, Latvia, Ireland, Portugal and Slovenia.

states become net importers. In 2005, the share of the EU market in sugar export amounted to approx. 40% in 2009, increased to almost 90%, and in 2012, decreased again to approx. 69% (Tab. 20). The result of these changes was marginalization of the other markets, including mainly in CIS countries. However, we should remember that under conditions of large production, out-of-quota sugar was exported beyond borders of the EU. This situation occurred in the period 2005-2006, when large sugar volumes were sold to Asian countries, and in 2011-2012 major markets were the states of the Middle East.

Table 20. Geographical structure of values of foreign trade in sugar

Specification	Export				Import			
	1995	2000	2005	2012	1995	2000	2005	2012
	in % of value							
EU-15	15.9	2.6	25.5	24.3	95.3	79.4	16.5	13.3
EU-10 (12)	-	-	12.4	44.2	-	-	58.7	10.3
CEFTA	1.8	13.7	1.7	-	0.0	19.4	0.4	-
CIS and Central and Eastern Europe	55.9	79.6	40.8	10.3	0.3	0.5	12.5	3.3
EFTA and other developed countries	0.4	0.4	0.3	7.7	0.0	0.2	0.3	0.3
Developing countries	26.0	3.7	19.3	13.5	4.4	0.5	11.6	72.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: CEFTA created in 1993 by the Czech Republic, Poland, Slovakia and Hungary and then accessed by: Slovenia – 1996, Bulgaria – 1998 and Romania – 1999.

Source: Calculations of IERiGŻ-PIB, data of CIHZ, CAAC.

Commercial partners in import were mainly EU sugar concerns. In the period 1995-2000, the EU-15 countries exported to Poland sugar benefiting from export refunds. At the same time, national business entities imported sugar under preferential WTO quota. Major partners in import were also some CEFTA countries, which were granted import quota covered by reduced duty (e.g. Romania). The share of the EU-15 in import was 80-95%. After the accession to the EU, the integration with the EU sugar industry became reinforced, but the EU trade regulations caused increased import from developing countries (ACP, LDC). In subsequent years, the share of developing countries was increasing significantly, as, since 2010, sugar factories have been refining raw sugar. In 2012, the share of developing countries in import was almost 73%, and of the EU countries approx. 24%.

The geographical structure of the foreign trade in sugar is strongly concentrated, but in the recent years trade exchange has been conducted with a growing number of countries. In export, it can be interpreted as expansion to new markets. Import from an increasing number of countries is a result of the introduction of EU trade regulations, in particular preferential quotas granted to

ACP and LDC countries. The integration with the EU enabled, first of all, sector entities to have unrestricted access to the markets of 27 member states. In the period of 1995-2000, the share of five major countries in export was approx. 74% and after the accession it decreased to 47-63%. In the first period, the main recipients were CIS countries (Russia, Uzbekistan and Ukraine), and in subsequent years the main partner became Germany and the EU-12 (Czech Republic, Slovakia, Lithuania). A large share of the German market is a result of large share of German sugar concerns (approx. 60%) in the sugar production in Poland. The confirmation of the export expansion is a large share in the geographical structure of such countries as: Sri Lanka, Israel and Syria.

Similar trends took place in import. In the years 1995-2004, sugar was imported, first of all, from the EU-15 and CEFTA countries. The share of five major trade partners was 87-96%. After integration with the EU, the share of five most significant countries in import decreased to 59-65% (Tab. 21). In the first period, the largest sugar volume was imported from Germany, UK, France and the Netherlands and from CEFTA (Romania, Hungary). After the integration, Germany has been still one of the most important trade partners, but large sugar volumes were imported also from the following countries: Brazil, Jamaica, Cuba, Mozambique, Sudan, Swaziland and Zambia.

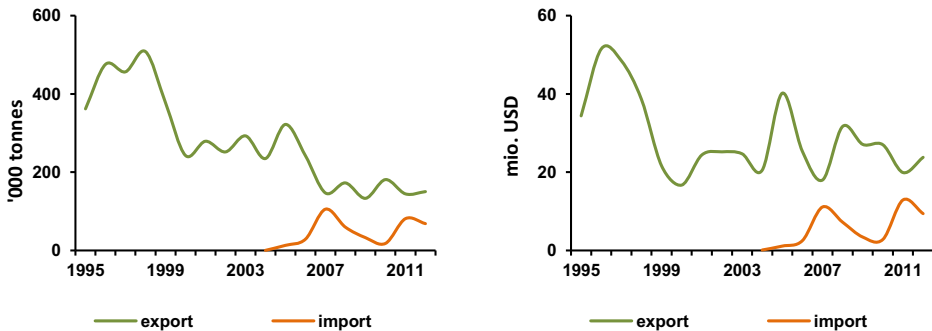
The Polish sugar sector was a large exporter of molasses. In the second half of the 1990s, practically the whole output of molasses, amounting to 380-500 thousand t annually, was exported as on the internal market minute volumes were used. The international market was characterized by large demand for the Polish molasses, which was determined by high content of sugar, being a result of low technological efficiency of the sugar industry. In the years 2000-2006, export decreased to 230-320 thousand t, which was a result of modernization and structural transformations in the sugar industry. In the period of the reform of the market regulations, export decreased to 130-180 thousand t (Fig. 35). Molasses was exported mainly to the EU (UK, Austria, Ireland, Germany) and the United States (25 thousand t annually). Reduction in the processing potential of the sugar industry resulted in a smaller output of molasses, and, at the same time, consumption on the internal market increased (industrial processing, fodder). Increase in internal demand is confirmed also by growing import, which in some years recorded 60-105 thousand t. Molasses is imported from CIS, including mainly Ukraine and Belarus.

Table 21. Concentration of the foreign trade in sugar by countries

1995		2000		2005		2012	
Export in % of value							
5 major	73.5	5 major	73.6	5 major	46.6	5 major	63,2
Russia	27.9	Uzbekistan	30.2	Germany	17.2	Germany	18.3
Belarus	21.1	Russia	14.5	Sri Lanka	7.8	Slovakia	14.7
Kuwait	11.4	Ukraine	14.3	Lithuania	7.5	The Czech Rep.	13.2
Morocco	6.8	Moldova	9.4	Uzbekistan	7.1	Lithuania	9.1
Ukraine	6.3	The Czech Rep.	5.2	Russia	7.0	Israel	7.8
10 major	91.3	10 major	90.9	10 major	67.2	10 major	83,2
20 major	98.4	20 major	98.3	20 major	85.8	20 major	96.4
Import in % of value							
5 major	86.5	5 major	95.7	5 major	64.8	5 major	59,3
Germany	29.6	Germany	68.0	The Czech Rep.	28.7	Cuba	26.3
Great Britain	23.2	Romania	10.9	Latvia	13.4	Jamaica	10.7
Belgium	14.8	Austria	6.2	Germany	12.3	Sudan	9.7
France	11.8	Hungary	3.2	Slovakia	5.9	Zambia	6.3
Spain	7.2	The Netherlands	2.3	Brazil	4.4	Germany	6.2
10 major	100.0	10 major	99.5	10 major	77.2	10 major	82.9
20 major	100.0	20 major	100.0	20 major	79.3	20 major	97.8

Source: Calculations of IERiGŻ-PIB, data of CIHZ, CAAC.

Figure 35. Polish foreign trade in molasses



Source: Study of IERiGŻ-PIB, data of CIHZ, CAAC.

4. Assessment of the impact of world prices on the domestic sugar market

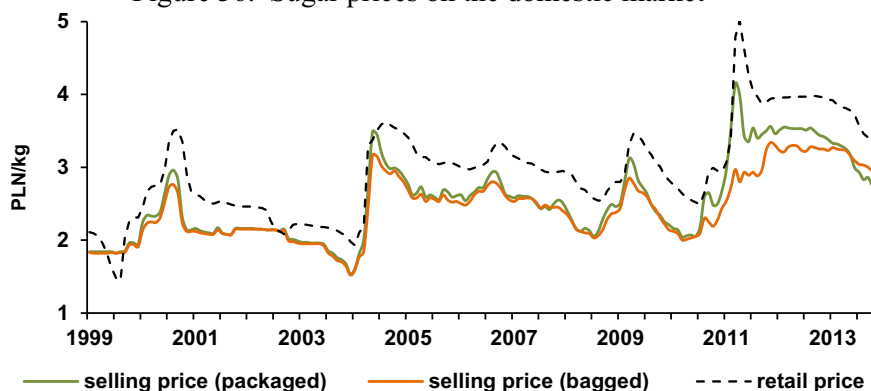
4.1. Sugar prices in Poland

The analysis of domestic prices of sugar applies to selling prices in the sugar industry and prices paid by consumers in retail trade. The sugar industry offers sugar for two groups of recipients: bagged sugar (e.g. processing industry, export) and packaged sugar (e.g. households, gastronomic establishments). Owing to availability of statistical data in terms of monthly selling prices and high inflation in the first period of system transformations, the analysis was restricted to the period 1999-2013.

In the analyzed period, selling prices and retail prices of sugar were characterized by substantial volatility. Selling prices were ranging from 1.52 to 4.15 PLN/kg and retail prices from 1.44 to 5.01 PLN/kg. Selling prices of packaged sugar were on average higher by 0.11 PLN/kg (4.5%) than prices of bagged sugar. The difference reflects, first of all, costs of preparation. In the second half of the year 2013, an exceptional situation occurred, as prices of bagged sugar, as a result of smaller pace in decrease, were higher than prices of packaged sugar. The reason for that was large demand on the part of the food industry, which is created largely by growing export of processed food products. The second reason could be conclusion, a few months before, of supply agreements at relatively high prices. Drop in prices of packaged sugar was caused by a great supply from the campaign 2012/2013 and a stable demand on the part of households. As a consequence, the market recorded surplus of supply over demand. Retail prices were on average higher by 0.41 PLN/kg (15%) than selling prices of packaged sugar, and the approximate difference depicts gross margin. In some periods (e.g. May-August 1999, May-June 2004 and January-February 2011), prices in retail trade were comparable and even lower than selling prices (Fig. 36).

In the years 2000-2012, the accumulated retail sugar price growth index amounted to 133.3% and was lower than consumer price indexes (inflation, 141.7%) and food price indexes (147%). The accumulated growth in selling prices of packaged sugar and bagged sugar amounted to 138.2% and 142%, respectively. Selling prices demonstrated greater dynamics of prices than buying-in prices of sugar beets (134.8%), which was one of the reasons for good financial situation of the sugar industry (Tab. 22).

Figure 36. Sugar prices on the domestic market



Source: Unpublished data of the Central Statistical Office (GUS).

Table 22. Dynamics of sugar prices in Poland

Year	Price change indexes		Sugar beets buying-in prices	Sugar prices		
	total	food		selling prices		retail
				bagged	packaged	
previous year = 100						
2000	110.1	110.5	102.1	127.4	131.8	151.9
2001	105.5	105.2	109.1	89.5	86.3	84.9
2002	101.9	99.4	100.8	99.6	99.3	90.5
2003	100.8	99.0	110.8	86.7	87.3	94.0
2004	103.5	106.7	150.6	144.1	149.8	146.4
2005	102.1	102.2	93.7	98.2	95.6	99.7
2006	101.0	100.6	73.5	102.5	102.9	99.6
2007	102.5	105.0	84.1	94.8	93.1	96.5
2008	104.2	106.2	95.8	87.7	89.2	90.0
2009	103.5	104.1	111.6	115.0	115.9	115.2
2010	102.5	102.8	97.8	85.4	88.0	87.3
2011	104.3	105.6	127.3	137.3	153.5	149.2
2012	103.7	102.7	95.3	110.0	99.1	97.4
Accumulated price indexes, 2000 = 100						
	141.7	147.0	134.8	138.2	142.0	133.3

Source: Calculations of IERiGŻ-PIB, GUS data "Sugar market. Stan i perspektywy", no. 35-40, IERiGŻ-PIB, ARR, MRiRW, Warsaw.

Sugar prices were characterized by a clear volatility around the upward trend. Positive values of the arithmetic mean and of the median result from the presence of trend in time series. The value of bagged sugar selling price variability index amounted to 0.19, and the variability indexes of packaged sugar prices and retail prices were close to 0.22. The values of kurtosis and skewness were different from zero, and thus time series did not have a normal distribution. The values of kurtosis were smaller than zero and the value of the analyzed variables were less concentrated than in the normal distribution. The skewness was higher than zero and in time series right-side asymmetry was present. Results of the

Jarque-Bera test confirmed that the distributions of domestic sugar prices were not close to a normal distribution (Tab. 23).

Table 23. Descriptive statistics of domestic sugar prices

Specification	Levels of monthly prices (PLN/kg)			First differences in price logarithms		
	selling prices		retail prices	selling prices		retail prices
	bagged	packaged		bagged	packaged	
Number of observations	178	178	178	177	177	177
Average	2.44	2.55	2.96	0.003	0.002	0.003
Median	2.44	2.50	2.95	-0.003	-0.004	-0.006
Minimum	1.52	1.53	1.44	-0.169	-0.203	-0.144
Maximum	3.34	4.15	5.01	0.290	0.308	0.145
Gap	1.82	2.62	3.57			
Standard deviation	0.46	0.55	0.65	0.045	0.056	0.060
Volatility coefficient	0.186	0.215	0.221	16.837	24.868	22.991
Skewness	0.307	0.560	0.322	2.452	1.685	3.943
Kurtosis	-0.868	-0.469	-0.088	14.325	7.956	22.534
Jarque-Bera test	<i>JB=8.38</i> <i>p=0.015</i>	<i>JB=10.93</i> <i>p=0.004</i>	<i>JB=3.14</i> <i>p=0.078</i>	<i>JB=1690.61</i> <i>p=0.000</i>	<i>JB=550.53</i> <i>p=2.85e-120</i>	<i>JB=4203.69</i> <i>p=0.000</i>

Source: Calculations of IERiGŻ-PIB, unpublished data of GUS.

The analysis of variability of sugar selling prices in Poland are similarly like in the case of the world prices conducted using the time series analysis. The selling prices of packaged and bagged sugar demonstrated very small differences and similar development trends. As a result, the decomposition of time series was restricted to selling prices of sugar in packages. Decomposition of time series of selling prices was conducted using a multiplicative model and 12-monthly moving average.

The selling prices demonstrated seasonal fluctuations S_t , which were a result of changes in supply and reflected the campaign character of production. Seasonal fluctuations of domestic prices had a very similar distribution during the year like the seasonality of world white sugar prices. The highest seasonally prices were recorded in March-September and were by approx. 2 p.p. higher than the long-term trend. The lowest prices were recorded during the sugar campaign, i.e. in the period of October-February, which were lower by 1-3 p.p. than long term trend.

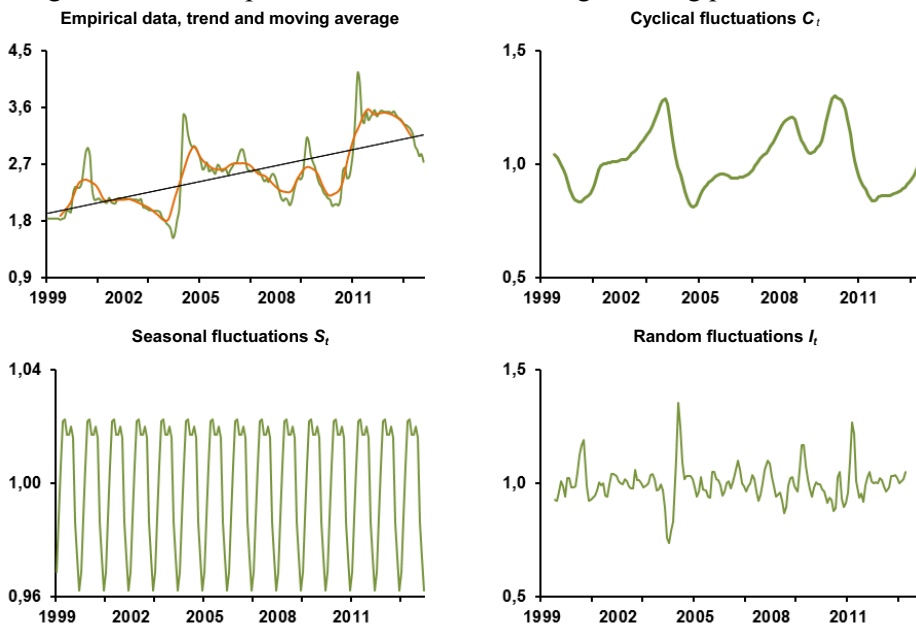
The analysis of cyclical fluctuations was started from estimating the trend function using the simple linear regression $T_t = 7.039t + 1918.7$. The trend function chart is characterized by a relatively good match with the empirical data ($R^2 = 0.438$). The ratios of cyclical fluctuations C_t show the dimensions of price changes which, in some periods, were approx. 30 p.p. as compared to the periodical trend. Cyclical fluctuations were significantly smaller than price fluctuations on the international market. Business cycles in the national sugar industry included, like on the world market, periods of 5-6 years. The periodicity of prices

is, above all, the result of production volatility, which, on average every 5-6 years, shows a very large decrease.

The last stage of the time series decomposition was separation of random fluctuations I_t and assessment of their impact on the level of selling prices. The values of random fluctuations were ranging from -25 p.p. to 30 p.p. and indicate clearly periods when random determinants had a strong impact on prices (Fig. 37).

When summing up the results of decomposition of the time series of domestic selling sugar prices, it should be stated that the greatest impact, like in the case of the world prices, was exerted by the cyclical fluctuations C_t and the random factors I_t . The seasonal fluctuations exerted an expressly smaller impact on volatility and the process of price determination.

Figure 37. Decomposition of time series of sugar selling prices in Poland



Source: Calculations of IERiGŻ-PIB, unpublished data of GUS.

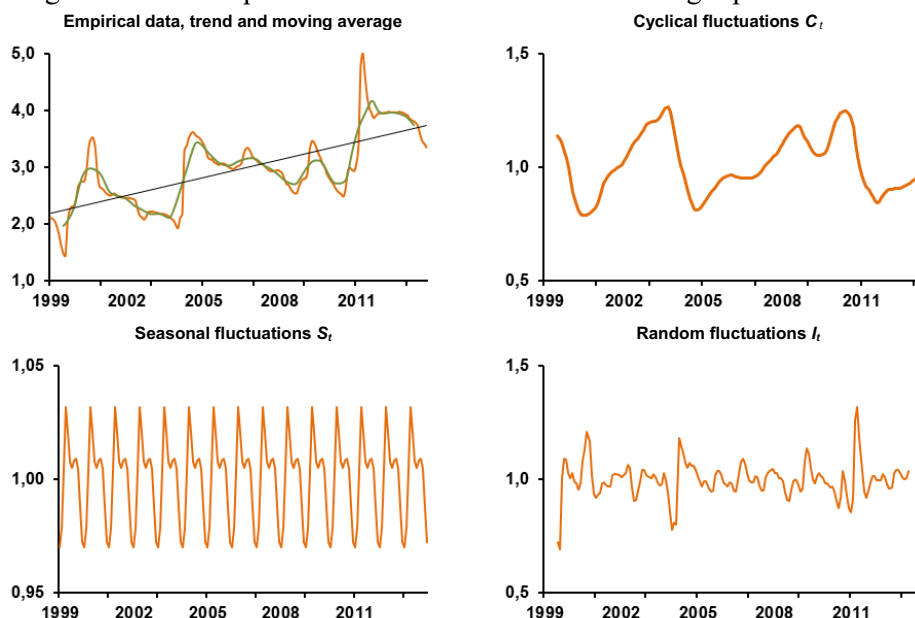
In the assessment of volatility of sugar prices, the similar analytical method was used as in the case of world prices and selling prices, which was based on the stochastic process of decomposition. Particular elements of the time series were separated, using a multiplicative model and 12-month moving average.

Retail prices demonstrated also minute seasonal fluctuations S_t which were a result of changes in supply and reflect the character of production. The depiction of seasonal fluctuations shows, however, their slightly different progress as compared to the selling prices. Seasonal drop in prices is present also in

the period of the sugar campaign, but it lasts four, rather than five months (November-February). The price drop scale is the same and is 1-3 p.p. The highest seasonal prices are recorded in April, when they are by 3 p.p. higher than the long-term trend, and in other months the difference is 1-2 p.p.

The analysis of cyclical fluctuations was started from estimating the trend function using the simple linear regression $T_t = 0.009t + 2.1757$. The trend function chart shows relatively good match with the empirical data ($R^2 = 0.48$). The ratios of cyclical fluctuations C_t reach values from -15 p.p. to 25 p.p. and were smaller than selling prices, but the length of the economic cycle was the same: 5-6 years. The random fluctuations in retail prices I_t were characterized by a very similar course as random fluctuations in selling prices, but the range of volatility was greater and was from -30 p.p. to 32 p.p. (Fig. 38). The results of the decomposition of the time series of retail sugar prices showed that, like in the case of drop in world prices and selling prices, the greatest impact on the level of prices was exerted by the cyclical fluctuations C_t and the random factors I_t . The seasonal fluctuations exerted an expressly smaller impact on volatility and the process of price determination.

Figure 38. Decomposition of the time series of retail sugar prices in Poland



Source: Calculations of IERiGŻ-PIB, unpublished data of GUS.

From the charts of selling prices and retail prices, a long-term upward trend can be read, as demonstrated also by the decomposition of the time series.

The long-term trend suggests that time series are non-stationary. The statistical evaluation of stationarity was conducted using the Dickey--Fuller unit root test (*ADF*). The test results confirmed clearly that the time series of domestic sugar prices cannot be considered as stationary. The condition for evaluation of volatility is transformation of the time series to stationarity. For this purpose, natural logarithms of prices and their first differences were used, and their stationarity was tested by using the Dickey-Fuller unit root test (*ADF*). The values of *DF* statistics were much lower than the critical value and low values *p* are the basis for rejection of the hypothesis H_0 about non-stationarity and it can be presumed that the time series were integrated in the first degree $Y_t \sim I(1)$ (Tab. 24).

Table 24. The results of ADF of domestic sugar prices

Time series	Test type	Critical value $\alpha - I = \delta$	Dickey-Fuller test statistics	Value <i>p</i>	Decision
Selling prices of packaged sugar					
Levels of prices	without intercept	-0.0005	-0.1287	0.6395	
	with intercept	-0.0382	-1.7499	0.4060	
	with intercept and trend	-0.0714	-2.9210	0.1556	
First differences in logarithms	without intercept	-0.5779	-6.5958	1.77e-010	<i>I(1)</i>
	with intercept	-0.5798	-6.5865	4.11e-008	<i>I(1)</i>
	with intercept and trend	-0.5812	-6.5823	3.68e-008	<i>I(1)</i>
Selling prices of bagged sugar					
Levels of prices	without intercept	0.0003	0.1124	0.7182	
	with intercept	-0.0320	-1.4839	0.5420	
	with intercept and trend	-0.0691	-3.1135	0.1030	
First differences in logarithms	without intercept	-0.5491	-6.0378	3.79e-009	<i>I(1)</i>
	with intercept	-0.5529	-6.0432	9.42e-007	<i>I(1)</i>
	with intercept and trend	-0.5531	-6.0281	9.91e-007	<i>I(1)</i>
Retail prices of sugar					
Levels of prices	without intercept	-5.9685e-005	-0.0145	0.6780	
	with intercept	-0.0444	-1.7533	0.4043	
	with intercept and trend	-0.0919	-3.2528	0.0743	
First differences in logarithms	without intercept	-0.6557	-7.6548	3.77e-013	<i>I(1)</i>
	with intercept	-0.6578	-7.6490	5.19e-012	<i>I(1)</i>
	with intercept and trend	-0.6586	-7.6360	2.94e-011	<i>I(1)</i>

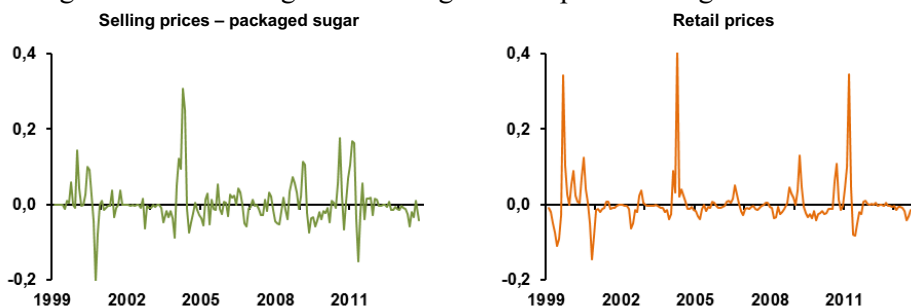
Source: Calculations of IERiGŽ-PIB, unpublished data of GUS.

First differences of natural price logarithms may be used also in the price volatility analysis. Differences in price logarithms correspond to growth logarithms of these price that are defined as logarithmic rates of return. An advantage of this approach is that logarithm growths multiplied by 100 reflect percentage changes. Logarithmic rate of returns on selling prices demonstrated smaller volatility than retail prices. Maximum changes of selling prices reached 30 p.p., and retail prices 40 p.p., but the range of fluctuations between the highest and the lowest values was 50 p.p. and 54 p.p., respectively (Fig. 39).

Large price volatility hinders assessment of risk that is important for all sugar market participants. In the conditions of high volatility, price risk assessment may be overestimated and, on this basis, business entities can make inap-

appropriate decisions (e.g. investment decisions). Price volatility is the main factor of high variability of financial performance of the national sugar industry. The risk assessment is hindered by the fact that price change are to a significant extent triggered by business cycles and random fluctuations. Seasonal fluctuations that are characterized by certain regularity and, consequently, greater predictability, have a small impact on price volatility.

Figure 39. The first growths in logarithmic prices of sugar in Poland



Source: Calculations of IERIGŻ-PIB, unpublished data of GUS.

Sugar prices at different stages of the marketing chain show strong connections, as at the successive stages of distribution they are increased by processing or gross margins. A great statistical dependence of prices at the level of production and retail trade is depicted by high value of Pearson's linear correlation coefficient ($R = 0.95$). A long-term analysis of the relation between selling prices and retail prices was conducted by using the classic least square methods and using the concept of co-integration in the sense of Engle-Granger. Statistical tests were conducted for the first differences of price logarithms. Results of regression analyses and tests of co-integration were similar, as the linear regression equation and co-integration equation had a similar form. Growth in selling prices by 1 p.p. resulted in growth in retail prices by 0.65 p.p., but independent variable described to a small degree the dependent variable ($R^2 = 0.35$). The co-integration means that selling and retail prices can show short-term disruptions, however, in the long term balance is maintained between them (Tab. 25).

Table 25. Results of test of co-integration of domestic selling and retail sugar prices

Test	Critical value $\alpha-1=\delta$	Dickey-Fuller test statistics	Value p	Decision
Unit root:				
sugar price indexes Y_t	-1.0145	-4,8153	4,80e-005	$I(1)$
energy price indexes X_t	-0.8438	-4,2639	0.0005	$I(1)$
DF residues	-1.2902	-4,0373	0,0063	$I(1)$
Co-integration equation:	$Y_t = 0,635 \cdot X_t + 0,0012$			
Variable X_t				
standard error	0.0654			
<i>t - Student</i>	9.6970			
value p	4.58e-018			
Intercept				
standard error	0.0037			
<i>t - Student</i>	0.3241			
value p	0.7462			
Determination coefficient R^2	0.3495			
Durbin-Watson statistics	1.7834			

Source: Own calculations, unpublished data of the Central Statistical Office (GUS).

4.2. Impact of world prices on domestic prices

Assessment of the impact of the international market on the domestic market was conducted using comparative analysis of the levels of world prices of white sugar and Polish selling prices. The impact of world prices on domestic prices was examined using the regression analysis and Engle-Granger co-integration test. Prior to commencing of the statistical analysis, the domestic selling bagged sugar prices were expressed in US dollars as to ensure their comparability with prices quoted on international exchanges. The analysis was conducted using monthly quotations of prices in the period of 1999-2013.

In the discussed period, the domestic selling sugar prices were on average two times higher than the world sugar prices. In some years, the difference was still greater (3.5 times), but very short periods were recorded where selling prices were comparable with world prices. A significant impact on the difference in compared prices was exerted by currency exchange rate at which on domestic prices were converted into American dollars. Under the conditions of depreciation of the exchange rate of zloty, prices expressed in dollars were falling and price competitiveness of the Polish sugar on the domestic market was improving. An opposite situation was present in the case of appreciation of the exchange rate of national currency. High differences in domestic and world prices have economic consequences. Prices on the world stock exchanges are much lower than prices in all industrialized countries and countries producing sugar from sugar beets. The reason for this are lower costs of production from sugar

cane in economically developing countries. Price and cost competitiveness of cane sugar makes internal markets of industrialized states protected by high customs duties. Otherwise, large import would cause a deep reduction in cultivation and processing of sugar beets. In Poland, after introducing determinations of RU GATT/WTO, basic rates of duty in import of white sugar amounted to 430 EUR/t, and in preferential quotas they amounted to 170 EUR/t. Currently in the EU, the basic rate of duty on white sugar was fixed at 419 EUR/t, and in case of raw sugar at 319 EUR/t⁶⁵. Duties are high enough to protect effectively the internal market against too cheap import. In countries with lowest costs of production, prices are 200 EUR/t. If these costs are increased by a small profit of the producer (10%, 20 EUR/t), costs of freight (130 EUR/t) and refining (150 EUR/t) and duties (319 EUR/t), the final price on the EU market will be approx. 820 EUR/t and will be higher than prices of sugar produced in the EU.

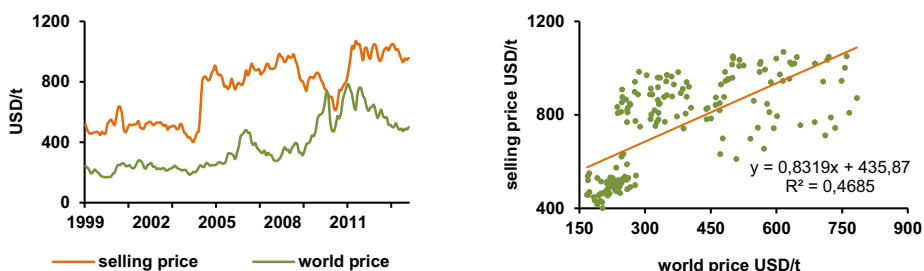
The domestic sugar market is strongly integrated with the EU market and, as a consequence, also with the world market. A similar situation happened also before integration with the EU, as on the internal market surplus of supply was present, which was exported. Export specialization of the sugar sector was reinforcing the impact of world prices on domestic prices. The world prices were determining the prices obtained by exporters and profitability of export transactions, and in this way they were transmitted to selling prices. Low world prices resulted in difficulties in export and large supply was maintained on the internal market, which affected pressure on selling prices. The correlation analysis demonstrated relatively strong association of domestic prices with world prices. The value of the Pearson's linear correlation coefficient amounted to $R = 0.685$. The regression analysis with the least square method and Engle-Granger co-integration tests confirmed dependence of domestic prices on the economic situation on the international market. The concept of co-integration is based on the assumption that between prices of two compared markets short-term disturbance can occur, but in the long run relative balance is maintained. The simple linear regression showed that growth in world prices by unit may lead to growth in domestic prices by 0.83. Price changes quoted on international exchanges explained in approx. 47% changes in domestic selling prices (Fig. 40).

Testing of co-integration of time series of world and domestic price indexes was preceded by assessment of their stationarity. The results of Dickey-Fuller tests did not enable rejecting the hypothesis H_0 about series non-

⁶⁵ Commission Regulation (EU) no. 1006/2011 of 27 September 2011 amending Appendix I to Council Regulation (EEC) no. 2658/87 on the tariff and statistical nomenclature and on the Common Customs Tariff. (Journal of Laws 28.10.2011).

stationarity. The first differences in logarithms of price indexes created time series that were stationary and integrated in the first degree $Y_t \sim I(1)$. The co-integration of price indexes was conducted using the Engel-Granger test. Indexes of domestic selling prices of bagged sugar were adopted as the variable dependent Y_t , and the world white sugar prices were the explaining variable X_t . Results of test indicated a long-term relation between the analyzed sugar prices, but the independent variable was describing, to a very small extent, the dependent variable ($R^2 = 0.10$). Growth in sugar prices on the world market by 1 p.p. resulted in growth of sugar prices by 0.07 p.p. (Tab. 26).

Figure 40. World and domestic white sugar prices



Source: Calculations of IERiGŻ-PIB, unpublished data of GUS, NBP, ERS USDA, F.O. Licht's "Sugar&Sweetener Report".

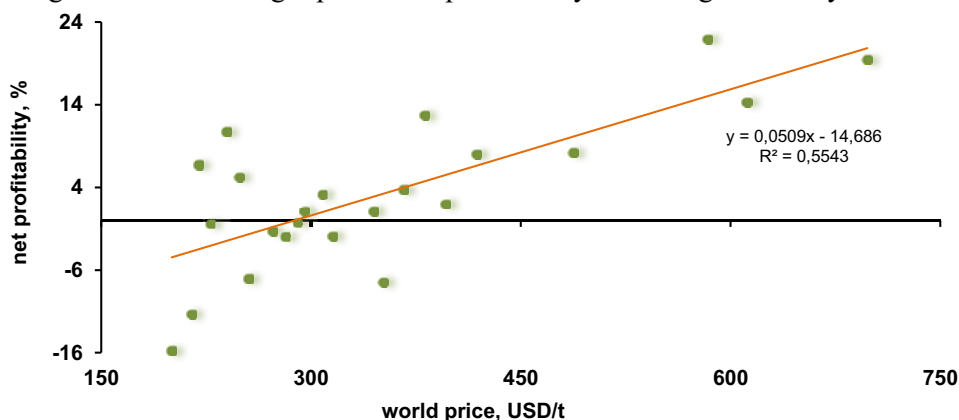
Table 26. Results of tests of co-integration of world and domestic sugar prices

Test	Critical value $a-I=\delta$	Dickey-Fuller test statistics	Value p	Decision
Unit root:				
ind. selling prices Y_t	-1.033	-4,518	0,0001	$I(1)$
ind. world prices X_t	-0.967	-3,790	0.0003	$I(1)$
DF residues	-0.999	-4,395	0,0021	$I(1)$
Co-integration equation: $Y_t = 0,0737 \cdot X_t + 0,0032$				
Variable X_t				
standard error		0.058		
t - Student		1.260		
value p		0.209		
Intercept				
standard error		0.003		
t - Student		0.818		
value p		0.415		
Determination coefficient		0.008		
R^2				
Durbin-Watson statistics		1.278		

Source: Calculations of IERiGŻ-PIB, unpublished data of GUS, F.O. Licht.

A characteristic feature of the Polish sugar industry is a great volatility of financial performance. The statistical analysis showed that financial performance of the sugar industry in the long term are clearly correlated with the economic situation on the world sugar market. The depiction of financial performance of the sugar industry and world sugar prices indicates that increase in the value of net profitability ratio is present in the years of good economic situation. The assessment of strength and direction of impact of changes in world prices on profitability was conducted using the least square method. The dependent variable was net profitability ratio, and the variable explaining white sugar prices at the exchange in London. On the basis of the estimated linear regression equation, growth in prices by unit resulted in growth in profitability ratio by 0.05 p.p. (Fig. 41). The linear regression equation was characterized by good matching, as the variable independent was describing well the dependent variable ($R^2 = 0.554$). The value of Durbin-Watson statistics amounted to $DW = 1.99$, which means a positive auto-correlation between residual components of the analyzed model.

Figure 41. World sugar prices and profitability of the sugar industry



Source: Study of IERiGŻ-PIB, unpublished data of GUS, "Rynek cukru. Stan i perspektywy", no. 35-40, IERiGŻ-PIB, ARR, MRiRW, Warsaw.

The financial situation of the sugar industry, which, as proved, is largely dependent on the economic situation on the world market, has a direct impact on profitability of sugar beet cultivation. Under the conditions of high profitability of processing, sugar concerns could contract raw material at prices higher than the minimum buying-in price (26.29 EUR/t). In most member states, the minimum price does not ensure, however, profitability of cultivation [Kirner 2007]. In the period 2006-2013, direct payments and sugar payments had a large share in income of national planters [Skarżyńska 2011]. In 2014, farmers submit for

the last time applications for sugar payments and in the subsequent seasons lack of support will mean a significant decrease in profitability of sugar beet cultivation. In the new budget perspective of the EU, however, there is a possibility to support sugar beet cultivation with payments related to production. The member states that so far have applied SAPS (e.g. Poland) may allocate for this purpose 15% (13%+2% for leguminous plants) of the national envelope of direct payments⁶⁶. However, we should remember that these payments may be directed to most directions of agricultural production and it is not decided that sugar beet planters will be able to benefit from them. Decrease in profitability will probably make farmers withdraw from sugar beet cultivation and the sugar industry will have no raw material for processing. Good economic situation on the foreign markets and high prices of sugar on the internal market will determine more than before cultivation and processing of sugar beets. At low prices, beet sugar production in Europe may be maintained only in the most effective regions of Western Europe that, as compared to the Polish plantation areas, have competitive advantages determined by soil and climate conditions and structure of farms. So far, domestic planters have leveled the listed competitive advantages with lower direct costs (e.g. wage), but in the future this may prove insufficient. The implementation of future changes in market regulations in the EU sugar industry and possible liberalization of the world trade in agricultural and food products under WTO will be a tremendous political challenge for administration of the EU and economic challenge for the sector entities that will be forced to sharpened competition with cane sugar.

⁶⁶ EU Regulation no. 1310/2013 of the European Parliament and of the Council of 17 December 2013 laying down certain transitional provisions on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and amending the Regulation (EU) No. 1305/2013 of the European Parliament and of the Council as regards resources and their distribution in respect of the year 2014 and amending Council Regulation (EC) no. 73/2009 and Regulations (EU) No. 1307/2013, (EU) No. 1306/2013 and (EU) No. 1308/2013 of the European Parliament and of the Council as regards their application in the year 2014 (Official Journal of the European Union L 347/865 of 20 December 2013). Countries can allocate for this type of support up to 10% of national direct payment envelope (8 + 2% for leguminous plants), and some countries (among others, those that applied SAPS, including Poland) up to 15% of the envelope (13 + 2% for leguminous plants). Payments can be used in the following sectors: cereals, oil seeds, high protein plants, leguminous plants, flax, hemp, rice, nuts, starch potatoes, milk and dairy products, mutton and goat meat, beef and veal, olive oil, silkworms, dried feed, hop, sugar beet, sugarcane and chicory, fruit and vegetables, and groves with short rotation. Payment should not result in production growth, but only in its maintenance.

Conclusions

Sugar is included in the group of products which have played an important role in the economic development of the world. Sugar cane is listed in the group of six plants that have changed the face of agriculture in the world. Development of the sugar industry caused changes in agriculture, food industry, foreign trade in agricultural and food products and, first of all, in the structure of demand for food. Popularization of sugar cane cultivation was one of the main factors of economic development of countries located in the intertropical climate zone. Sugar cane and by-products of its processing will be applied also in other sectors of the economy (e.g. production of bioethanol). In the European agriculture, sugar beets are plants with the largest productivity from unit of surface. According to the agrotechnical assumptions, sugar beets are cultivated with the use of organic fertilizers, and thus they begin crop rotation on good soils and leave very good position for cultivation of spring crops. The sugar industry is a counting sector of the food industry, and sugar remains the main sweetener in the secondary food processing, households and in other sectors of economy (e.g. chemical and pharmaceutical industry). Sugar, being a component of many food articles, plays an important role in diet, as provides 10-20% of calories. The sugar sector and sugar are criticized also for adverse socio-economic effects. Excessive sugar consumption is one of the important reasons for intensity of lifestyle diseases in economically developed countries. Ecological environment draws also attention to the fact that sugar cane cultivation area increases mainly at the expense of restricting the rain forest area. Sugar cane is cultivated in monoculture, which involves many negative environmental impacts, including, among others, reduced biodiversity and is one of the reasons for increasing frequency of extreme phenomena.

The sugar industry has a long history, as sweetening substances from sugar cane were generated in antiquity. Production of sugar from sugar beets started in Europe in the 19th century, which, since the very beginning, has been strongly supported. The protectionist policy towards the European sugar industry caused that, in the second half of the 19th century, the world production of beet sugar was greater than of cane sugar. The beet sugar production without support does not withstand, however, competition with cane sugar. As a result, European and American sugar industry used in the 20th century higher support (measured by *PSE* index) than the whole agricultural and food sector. As a result of reforms of the EU market regulation a high reduction in support was recorded (e.g. export refunds). In recent years, in the United States the value of *PSE* also decreased, but is still higher than the average level in the agricultural and food

sector. In Brazil, which is the largest producer of sugar in the world, the sugar industry was not supported. In China, characterized by a huge demand potential, *PSE* demonstrated high fluctuations, and it means big changes in the policy towards the sector in particular years.

The raw materials for production of sugar are sugar cane and sugar beets. Sugar cane is cultivated on long-term plantations in the tropical and subtropical climate. In the 1950s, the world cultivation area was growing annually on average by 2.1 and is currently 25.8 million ha. The share of sugar cane in the world area of arable land increased within 50 years from 0.7% to 1.8%. The genetic and agrotechnical progress led to improved cultivation effectiveness which manifested itself in growth in yields by 40%, to 70 t/ha. In consequence, crops of sugar cane increased, at that time, 3.5 times to 1.7 billion t. Different trends were recorded in sugar beets cultivation. The world cultivation area decreased from 8.8 million ha at the turn of the 1980s and 1990s to ca. 4.9 million ha in 2012. Sugar beets are cultivated, first of all, in Europe and North America. Decrease in the cultivation area was compensated partially by twofold increase in yields to 55 t/ha. As a result, crops of sugar beets in the world decreased from 294 million tons to 270 million tons.

The world production of sugar showed an upward trend by 2.2 million tons annually and in 2011 it amounted to 171 million tons per raw sugar. In the season 2013/2014, according to the estimates of F.O. Licht, it grew to 182 million tons. Changes in supply of raw materials determined the sugar production structure. The cane sugar production was growing to 147 million tons and is presently approx. 80% of the world production. In the same period, the beet sugar production fell to 40 million tons and is 20% of the world production. The largest sugar producers are Brazil (22%), India (15.5%), EU (10%), China (7.5%), Thailand (5.6%), as well as the United States (4.5%).

The demand for sugar is determined directly by consumption in households and consumption in the secondary food processing and other sectors of the economy. The world demand for sugar shows upward trend, and is determined by demographic changes and improvement in the income situation and changes in the consumption model in economically developing countries. According to F.O. Licht, the world consumption in the years 1989-2013 increased to 175 million tons and was smaller than production growth. The ratio of closing stock to consumption in the world sugar balance ranging from 33% to 46%. In the 1950s, the sugar consumption per capita increased from 16 kg to 21 kg. In the industrialized countries consumption fell to 40 kg/per capita. In economically developing countries of Asia and Africa, the consumption is growing but it is still small

(10-14.5 kg/per capita). In many regions of the world, a high potential of demand growth is recorded.

The foreign trade in sugar belongs to those areas of international exchange with the most developed protectionism and interventionism. Industrialized countries using tariff and non-tariff instruments of the trade policy to protect internal markets and increase competitiveness of own sugar industry. The geographic diversity of production and demand areas makes the foreign trade (approx. 65 million tons per raw sugar) play an important role in the world balance (36% of production). The object of the foreign trade is, first of all, raw sugar (for refining), as the sugar industry of many ACP and LDC does not have technical possibilities for white sugar production. In the structure of goods of the world foreign trade in agricultural and food products, the share of sugar fell from 5-6% in the years 1961-1990 to 2.3-2.8% in the years 2000-2012. It shows that the trade exchange with other agricultural and food products was characterized by a greater growth dynamics. The main exporters are Brazil, Thailand, Australia, France and Guatemala. Large importers are Indonesia, USA, Malaysia and Russia.

On international commodity exchanges prices of raw and white sugar are quoted, which are closely correlated and show similar volatility. Commercial transactions in sugar have the greatest share (approx. 35%) in the overall number of futures contracts concluded for agricultural and food products. Prices of white sugar are higher than of raw sugar, as they include costs of refining (refining bonus). In the long term, prices of white sugar were ranging from 130 to 932 USD/t and of raw sugar were ranging from 60 to 905 USD/t. Horizontally, differences in these prices were ranging from 14 to 220 USD/t. The decomposition of the time series demonstrated that high price volatility was determined by above all cyclical and random fluctuations. The businesses cycles on the world sugar market include periods of 5-6 years and result mostly from the periodicity of sugar cane production. Seasonal fluctuations in world prices are relatively small and their cause is the campaign character of production. A consequence of high price volatility may be difficult price risk assessment. On the basis of the overstated assessment, the sector entities can make inappropriate business decisions. Investors with great market experience are able to identify the character of changes in prices and distinguish deterministic changes from seasonal fluctuations. High price differences occur between economically developing countries (300-400 USD/t) and industrialized countries (800-900 USD/t), and the cause is protectionist trade policy in many regions of the world.

In recent years, the world food prices demonstrated a clear upward trend, and sugar prices were characterized by the greatest dynamics among all agricultural and food products (*FAO Food Price Index*). High prices of food were the result of the accumulated impact of many demographic, economic, natural and sociological factors. The main reason for changes in food prices are demand and supply relations. Increasing world populations and improving income in economically developing countries stimulate demand. The demand for agricultural products is created also by the industry producing biofuels and the convergence of food prices (including sugar) with energy prices are stronger and stronger. Due to progress in IT and telecommunication technologies, capital became the most mobile production factor. High prices of food were an opportunity for resources of free capital to join the game at international commodity exchanges.

In the years 2006-2010, the system of regulation of the EU sugar market underwent a deep reform. Previous market regulations which had been binding since 1968 were criticized for maintenance of high prices on the internal market and small price competitiveness of the sector on the international market. The subsidized export from the EU was increasing supply on the world market and prices at world exchanges were low, affected negatively economic situation of developing countries. The European Commission, taking into consideration the position of WTO on subsidized export, the need to improve effectiveness and competitiveness of the sector and interests of the food market participants, suggested changes in market regulations. The result of reforms was a deep industry restructuring. Cultivation and processing of sugar beets was limited to the regions characterized by the most favorable conditions. Production of sugar (amounts of production aid) was reduced and the consequence was growth in import in the market supply. Improving pricing competitiveness was aimed at providing reduction in the minimum sugar beet buying-in price (by 40%) and reference sugar price (by 36%). All assumed goals of the reform have not been executed. Adverse effects covered decrease in profitability of sugar beet cultivation, high costs of restructuring and greater dependence of the market on import. The price competitiveness did not improve, because in the period of the world reform, the prices increased to the record level of 800-900 USD/t and the decrease occurred no sooner than in 2013. A positive effect of change in the policy towards the sector was, first of all, growth in technical effectiveness of sugar beet cultivation and processing.

The Polish sugar sector underwent deep structural changes, both in agriculture and in the sugar industry, which accelerated after integration with EU and, first of all, as a result of the market regulation reform. The area of sugar

beet cultivation fell by half to approx. 190 thousand ha. Plantation regions are located in the neighborhood of sugar factories in the regions with the most favorable soil and climatic conditions. Decrease in the cultivation area was compensated by growth in yields which, in the last campaigns, amounted to approx. 60 t/ha. The number of planters fell with a simultaneous growth in area of average plantation. The sugar industry underwent big ownership, structural and modernization changes. The industry restructuring resulted in the oligopoly structure, similar to the structure in the EU. Sugar is produced in 18 factories belonging to four sugar concerns. Large investment expenditures and modernization of the technological line made production per plant increase five times, to approx. 110 thousand t. Large growth in management effectiveness, in particular growth in work and capital productivity, was recorded. Good economic situation on the internal and international market and positive effects of restructuring contributed to large improvement in financial performance of the sugar industry.

Accession to the EU, and direct foreign investments in the sugar industry made the industry more and more linked to external markets. The sugar production exceeded demand on the internal market and export played an important role in managing surpluses. After the reform of market regulations in the EU, the situation changed. The national amount of production aid (1405 thousand t) is smaller than the internal market demand (1600 thousand t), but restrictive regulations on out-of-quota sugar are still binding. As a result production surpluses are exported and, at the same time, it is necessary to import 200-250 thousand t to cover internal demand. As a result of the reform the share of import in the market supply increased to approx. 15%. A new phenomenon are importing sugar for refining, which is implemented in the inter-campaign period. Refining enables sugar factories to use resources better, but may, at the same time, compete with the production of sugar from sugar beets.

The sugar industry is a food economy sector where the impact of the world market on local markets is clearly noticeable. The co-integration of the domestic market with the international market is depicted by a strong dependence of domestic selling prices and prices at international commodity exchanges. Due to large difference in the level of these prices, the domestic (EU) market is protected by high duties. Volatility of prices on the world market determines profitability of export transactions and the share of export in the domestic production is 15-35%. Transmission of world prices on domestic selling prices is shown mainly in financial performance of the sugar industry. Statistical analysis showed that the sugar industry was reaching the best financial results under conditions of good economic situation on external markets. Good economic and fi-

nancial situation has a direct impact on cultivation of sugar beets. Planters of sugar beets will be offered lower buying-in prices, and as a result farms will be searching for more profitable directions of production (e.g. cereals, rapeseed). Due to decrease in beet sugar production profitability, demand and contracting of raw material are likely to decrease. Sugar factories located in northern regions of the country can increase the raw sugar refining process, as their advantage may be lower transport of raw sugar from ports.

Since the beginning of the 19th century the world market has been characterized by a very strong competition between beet sugar and cane sugar. The beet sugar production in industrialized countries was withstanding to rivalry only as a result of protectionist market policy. Lower costs of cane sugar production and possible liberalization of the world trade under WTO may be a serious threat to the European sugar industry. The announced further reform of regulations of the EU market in 2017 will be very a large challenge, because in the most unfavorable scenario the sugar beet cultivation and processing will be maintained only in the most effective and competitive EU regions. It can be assumed that the share of import in the supply on the market will increase, and large dependence on import reduces food safety. Resignation from sugar beet cultivation and reduction in their share in the structure of sowings will have also negative consequences in the context of balanced agriculture development. The market liberalization and import of cheaper raw sugar do not have to imply drop in its price on the internal market. Increased import demand of countries producing sugar beet may result in the growth in prices on the international market, which, like it has been so far, will be reflected in domestic prices.

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