

Article

Sustainable Concentration in the Polish Food Industry in the Context of the EU-MERCOSUR Trade Agreement

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Abstract: Concentration within the food industry is a desirable process in the context of improving economic efficiency, which is the basis for building sustainable competitive advantages in internationalisation and globalisation. Excessive concentration of market structures can generate negative externalities that threaten sustainability in the long term. Maintaining a balance between the freedom of economic activities and the protection of consumers and environmental interests is fundamental to the stability of the entire economy and its position in the international market, which is a priority of the EU-MERCOSUR trade agreement. The aim of this article was to assess the process of concentration of the Polish food industry and its impact on factor efficiency in the context of changing external conditions. In order to do so, the Cobb–Douglas production function was used. The research results showed that there is a progressive concentration in the food industry. Changes in the entity structure are taking place in an evolutionary way, as illustrated by the still high fragmentation of companies. Large companies make good use of economies of scale, which is mirrored in their high efficiency. The structure of the Polish food industry makes it possible to realise the objectives of agricultural policy, including in terms of sustainable development and improvement of competitiveness on the global market. Taking into account the current entity structure of the Polish food industry, it will be crucial for the long-term sustainability to take into account contemporary economic, environmental and social issues in the EU-MERCOSUR trade agreement.

Keywords: food industry; economies of scale; sustainability; MERCOSUR; trade; production function



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1. Introduction

The agri-food sector in Poland is one of the important sectors of the economy, with the food industry as a key player, since this is the main marketing channel for the processing of domestic and imported agricultural raw materials and for the distribution of food products [1]. The great economic and social importance of the food industry is confirmed by its share in the value of production and employment of the total industry, which amounts to 15.1% and 13.4%, respectively [2]. The food industry also determines the systematic growth of the positive balance of foreign trade in agri-food products, as the balance of foreign trade in agricultural raw materials is negative [3]. The food industry in Poland comprises about 5.0 thousand enterprises, of which only about 6.0% are large entities. Food industry enterprises are mostly found in smaller towns and, therefore, have a positive impact on the development of rural areas. This is significantly influenced by the implementation of

innovative technologies and management, as well as support for the modernisation of the raw material base in agriculture and demand for services (e.g., transport, logistics, etc.).

The Polish food industry shows a long-term trend of production concentration, which results from the drive to reduce costs and improve competitiveness on international markets [4,5]. These processes have their good and bad sides. On the one hand, they increase the ability of companies to expand the market by increasing the scale of production, positive economies of scale and innovation, thus contributing to the economic growth of the country and strengthening the market position of companies [4,6]. On the other hand, there are risks associated with the existence of monopolistic practices. Jurczyk and Porter point out that the consequences of high concentration in industry can be lower production and monopolistic prices as well as progressive asymmetry of information and bargaining position of market participants [7,8]. Consequently, many countries are introducing anti-monopoly regulations [9–11]. The move towards full freedom of movement of capital and products significantly weakens the role of many countries in creating their own socio-economic policies. The consequences of these actions may result in negative externalities, most notably environmental degradation and the imbalance of economic systems, creating challenges for sustainable development [12].

Given the key role of industry concentration in the implementation of international trade agreements, the need for a robust organisational and legal framework to mitigate the risks associated with international trade is highlighted [13]. International trade agreements are important for economic development, but they also pose risks of changing competitive conditions for both producers and consumers, as well as for the environment. The agreement between the EU and MERCOSUR, which includes Brazil, Argentina, Paraguay and Uruguay, poses such risks. The COVID-19 pandemic, the war in Ukraine and the strategies for transforming the EU economy towards sustainability have already created major challenges for companies, which are engaged in permanent adjustment processes to maintain their competitive position in the domestic and international markets. The liberalisation of foreign trade with the MERCOSUR countries will be another challenge; hence, an important task for the EU will be to maintain its competitiveness in relation to its new market partners. The agreement should take into account the protection of the interests of all Member States, as well as the mitigation of trade-related risks.

This raises the question of whether the Polish food industry is prepared for the liberalisation of trade with MERCOSUR countries. It seems that one of the processes that can minimise these concerns is the concentration of the entity structure, which enables the improvement of competitiveness on international markets. In the context of the Polish food industry, research work focuses on evaluating the process of increasing the market share of large companies [14]. In 2002, large companies accounted for 4.2% of the number of all enterprises, and their share in employment and revenue was 39.8% and 43.0%, respectively. In 2023, the share of large companies in the number of companies, employment and revenue increased to 5.7, 52.9 and 61.3%, respectively.

There is ample evidence in the literature on the positive impact of concentration on the competitiveness of enterprises or the acceleration of trade liberalisation processes. The evaluation of production concentration in food industry enterprises has been studied in many countries [15,16]. The results of these studies have confirmed the positive impact of positive production scale effects on the economic efficiency and market power of enterprises [17–19]. In Poland, studies also dealt with structural changes, financial performance and international competitiveness of the food industry, including by industry, which confirmed the progressive process of concentration and specialisation of production in large enterprises [5,20]. The present research fills the research gap in this area by using the Cobb–Douglas production function as a tool for assessing concentration processes and

economies of scale in the Polish food industry. The aim of the article is to evaluate the process of concentration of the entity structure in the Polish food industry and its impact on factor efficiency in the context of changing external conditions. Bearing the above in mind, the following research hypothesis was stated: concentration of the Polish food industry structure results in a rise in factor productivity, which is of key importance with respect to the sustainable development of enterprises and their competitiveness in the global market.

2. Literature Review

Globalisation and trade liberalisation are creating an increase in market concentration in many industries, including the food industry. Concentration processes contribute to the strengthening of companies in the EU and global market and increase their capacity for market expansion [19]. However, international trade agreements with countries with different production structures and standards pose major challenges in terms of the sustainability of economies and maintaining competitive positions in markets. Uncontrolled concentration does not always lead to a dominant position in the market, but may strengthen the position of the trader in a way that significantly restricts competition. Maintaining a balance between the freedom of action of companies and the protection of market interests is fundamental to the stability of the economy and its strength in international markets. When assessing concentration processes in a changing external environment, it is important to present the issue from a theoretical and practical point of view.

2.1. Concentration Versus Economic Efficiency of Food Industry

Concentration is defined as the process of increasing the economic power of companies through mergers and acquisitions of other companies. It can, therefore, be conceptualised as the increasing quantitative advantage of a specific group in the total population of units that make up the collective [5]. The key to consolidating market advantage in an environment of intensifying competition is efficiency [21]. In the literature, we encounter two analytical approaches to the phenomenon of concentration, i.e., those relating to the market and those relating to production. However, regardless of the perspective adopted, they are related to the pursuit of market advantage. What distinguishes the two approaches is the manner in which it is achieved. Market concentration focuses on increasing the share of a company's products or a group of products in the total market [22]. Production concentration focuses on economies of scale by increasing production and efficient use of factors or acquiring other actors in the production process [6]. Regardless of the perspective taken, business concentration has many causes and different effects on both firms and the economy as a whole, as explained by many economic theories. Currently, the idea of concentration is viewed in two ways. The first approach (Harvard school) considers concentration as a cause of efficiency gains, while the second (Chicago school) puts it the other way around—concentration is perceived as an effect of efficiency gains [23,24].

The analysis of the market structure's efficiency is a key area of interest in market organisation and competition. The relationship between concentration and efficiency is not so clear-cut. An increase in concentration does not always imply an increase in efficiency. Stigler believed that large firms resulting from mergers do not always manifest greater efficiency, implying that scale is not the only source of advantage [25]. Entrepreneurial action, the use of a more efficient combination of factors of production, leads to maximised output and improved efficiency. In turn, more efficient firms (with lower marginal costs) have much greater market power and, therefore, earn higher profits [23,26]. Profit maximisation can occur by maintaining prices and scale of the firm or by reducing prices and thereby increasing market share, which leads to increased concentration. This means that efficiency gains do not necessarily result from concentration. Efficiency improvements are also influ-

enced by market shocks, the economic situation and the structure of international trade, which should be taken into account when negotiating international trade agreements. It is also worth noting that higher market concentration enables firms to exercise their market power and increases the propensity to collude on prices [26,27]. However, this power is not necessarily enforced, as noted by Kufel and Hamulczuk, pointing to cases where the sole producers of a given product do not achieve monopoly margins for various reasons [19]. Market concentration can lead to a lack of competition, but this is not always the rule. The increase in concentration depends on a number of factors, such as regulation, innovation and market power. A company can implement innovations that reduce costs or improve the utility of products that are difficult to imitate, allowing profits to increase [24,28]. It is important to strike a balance between economies of scale and protecting competition. Such approaches to concentration maintain the balance between the freedom of action of firms and the protection of market interests and are fundamental to the stability of the economy and its strength in international markets.

The food industry in Poland is continuing the processes of ownership, structural and modernisation transformations, which were initiated in the period of social and economic transformation in 1989. In the first period, enterprises were adjusting to the conditions of the market economy, and the privatisation process played a key role in this respect [6,29,30]. Foreign direct investment played an important role in the privatisation of enterprises [31,32]. Global food corporations implemented modern and efficient management methods, including technology and production organisation and management [33]. The extent of foreign direct investment in individual food industries varied widely [34,35]. The largest share of transnational food corporations is found in the production of beer, confectionery, spirits, soft drinks, vegetable oils and sugar, and the smallest is found in milk and meat processing [36]. The ownership transformation coincided with the liberalisation of world trade under the GATT/WTO and the signing of the Association Agreement with the EU [37,38]. In the changing macroeconomic and market conditions, the domestic food industry was forced to adapt to the conditions of increasing competition in the internal and international markets. Confirmation of the difficult competitive conditions and low international competitiveness of the Polish food industry in that period was both the high volatility of financial results and the negative balance of foreign trade [39]. However, enterprises carried out intensive investment activities aimed at modernising plants, including increasing the scale of production and achieving food health safety standards required in the EU [40]. Financial resources from EU pre-accession aid programmes (e.g., SAPARD) and national preferential loans played an important role in investments [41,42]. During the period of EU membership, the food industry carried out processes of adaptation to the conditions of competition in the common market and changing conditions, including in particular market conditions determined by successive reforms of the CAP [43]. Accession to the EU resulted in the dynamic development of the Polish economy, including the agri-food sector. The food industry effectively used EU and national investment support programmes and free access to the common market, which is characterised by a large number of consumers with high purchasing power [44]. This was confirmed by an increase in the concentration of the entity structure, including a reduction in the number of enterprises and employment [45]. There were clear consolidation trends in the Polish food industry, as the number of enterprises decreased by approximately 20%. The largest decreases are in the number concerned, mainly small and medium-sized companies in the highly fragmented segments of food processing, i.e., meat production, dairy and production of bakery and flour products. The share of large companies in the revenue of the food industry is about 65%, but is smaller compared to Western European countries. Consolidation trends will continue and will mainly include the meat, bakery and flour production, fruit processing and, to a lesser

extent, the dairy industry [4]. As a result, the economic power of enterprises increased, and they benefited economically from increasing production scale effects and innovative technological solutions [46]. Increases in labour and capital productivity underpinned improved financial performance as well as international competitiveness [47]. This was reflected in the expansion into new markets and a growing foreign trade balance [48–50].

2.2. Economies of Scale

Economies of scale in production is a category in microeconomics that is often referred to in the literature as economies of scale, which explains the response of average production costs relative to the size of production [51–53]. Accordingly, scale effects are associated with processes of production concentration in medium and large enterprises [54]. In theoretical terms, increasing economies of scale occur when an increase in production from Q_1 to Q_2 results in a decrease in average costs from AC_1 to AC_2 , which also cover the costs of labour and capital and are a source of comparative advantages. Which can be a source of competitive advantage. Increasing economies of scale can also be interpreted as an improvement in economic efficiency based on higher labour and capital productivity, increased specialisation of production and better management and organisation of labour [55,56]. However, processes of production concentration have limits, as there are diminishing economies of scale once a certain optimum is reached, when an increase in production from Q_2 to Q_3 results in an increase in average costs from AC_2 to AC_3 (Figure 1). In this case, further increases in the scale of production will be economically unjustified and lead to inefficient use of factors and deterioration in financial performance and competitiveness [57,58]. This situation is the result of risks associated with loss of control in areas such as technology, management, logistics and communication.

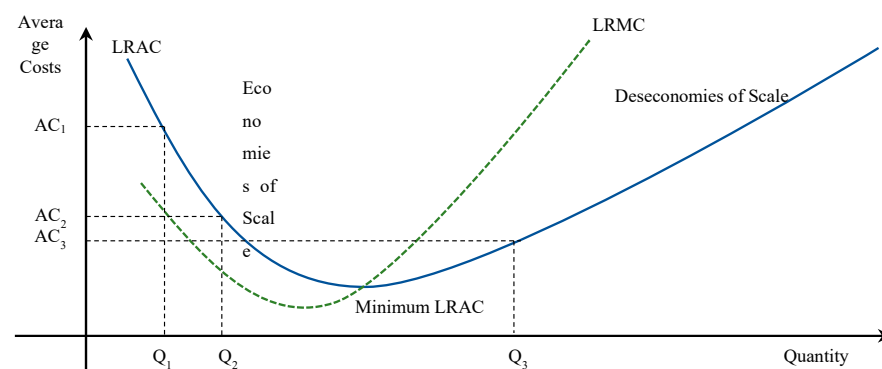


Figure 1. Effects of scale.

Increasing economies of scale in production, which have the effect of strengthening the economic power of companies, enable them to achieve the following:

- Improving the bargaining position vis-à-vis domestic and foreign counterparties;
- Better access to operational funding (e.g., loans, subsidies);
- Increase the possibility of investment and implementation of modern production technologies;
- Implementing specialist management techniques;
- Economic cooperation and co-operation with other companies on the basis of the creation of oligopolistic structures that create high barriers to entry for competitors;
- Intensive product promotion;
- The employment of skilled labour that corresponds to a particular field of production [59,60].

Economies of scale generally result in doing business in larger markets, and it is one of the most important benefits of globalisation and regional integration processes [61]. The ef-

fects of economies of scale depend heavily on the industry, and greater benefits are obtained by companies in industries that have a large share of transnational corporations [62].

2.3. Concentration in the View of Sustainable Development of Enterprises and UE-MERCOSUR Agreement

Between 2004 and 2023, food companies were well prepared to operate in the midst of global socio-economic crises, including the 2008 economic crisis [63,64], the COVID-19 pandemic [65] and the war in Ukraine [66], which resulted in increased production and trade risks. The war in Ukraine resulted in a food and energy security crisis in many regions of the world [67]. The global economic crisis, and especially the war in Ukraine, limited consolidation processes in the Polish food industry. Only five company takeovers were announced in 2022 compared to 22 in 2021, resulting in an increase in risk in the context of increased operating costs and a worsening macroeconomic outlook (rising inflation and interest rates) [4]. Over the concerned period, growing concentration within the food industry led to the development of exports of Polish food onto the global market, which was confirmed by rising surplus of foreign trade [48]. The export achievements of large companies reflected investments focused on modernisation, which allowed for the production of food matching high food safety standards. Most of the companies implemented quality standards (HACCP, ISO, IFS, BRC GS, GLOBALG.A.P) demanded by importers [49,50]. Taking into account international economic conditions and adverse climate change, the EU is implementing the sustainable economic development strategies European Green Deal, From Farm to Fork and Fit for 55. The objectives of the planned economic transformation are energy and food security and climate protection. This will be realised through the implementation of a closed-loop economy model, including the reduction of consumption of fossil raw materials, water, waste and GHG emissions, and sustainable food production and consumption [68–70]. The Polish food industry is implementing innovative solutions in the area of energy, water and waste management, the main aim of which is to reduce costs and improve competitiveness [71,72]. The F2F strategy assumes a significant reduction in the use of antibiotics, mineral fertilisers and pesticides in the production of agricultural raw materials, as well as an increasing share of organic products. Polish farms, as compared with main competitors on the global market, are characterised by a fragmented agrarian structure and low-intensity production technologies. Therefore, the Polish food industry processes high-quality raw materials, reflecting that Polish food strongly competes on the global market in terms of taste, as well as quality and sanitary standards. The energy transformation of Polish enterprises, which widely takes advantage of renewable energy and ecological packaging, also plays an important role in this area. Such a situation clearly differentiates Polish products in terms of customers' attitudes. In addition, certified organic and/or sustainable food products are on an upward path, which raises the attractiveness of Polish food products in the whole world [73].

This is influenced by major changes in international economic conditions, not only economic crises and armed conflicts in many regions of the world, but also the liberalisation of trade within the framework of bilateral agreements. In addition to its intensive impact on economic growth and development, particularly on business productivity, liberalisation can indirectly have a negative impact on the natural environment [74,75]. This includes overexploitation of natural resources, deforestation, desertification of areas, overfishing, waste dumping and GHG emissions. Studies indicate that the EU-MERCOSUR agreement could increase deforestation by 5–25% per year [76].

In 2024, after 20 years of preparatory work and negotiations, the Free Trade Agreement between the EU and the MERCOSUR group of countries was finalised. The agreement is comprehensive and includes commitments in a number of areas: elimination of tariffs on 91% of products, liberalisation of foreign trade in services and access to the public procure-

ment market. In the agri-food sector, regulations also cover the protection of geographical indications for food products, phytosanitary and veterinary standards, environmental protection and labour rights. The final version of the agreement has not yet been presented to EU member states for approval, but it is provoking critical assessments and protests from the agri-food sector community, which fears strong competition for products imported from MERCOSUR. The main source of MERCOSUR's competitive advantages is lower production costs, determined by favourable agro-climatic conditions (e.g., harvesting crops twice a year) and production on large farms and industrial plants processing agricultural raw materials, which benefit from positive economies of scale. The production of agricultural raw materials and food takes place under less stringent veterinary and phytosanitary standards, including liberal regulations on the use of GMO products and pesticides [77]. These activities can have a negative impact on the environment, and trade agreements can exacerbate this problem. These concerns are not unfounded, as foreign trade generates demand for environmental functions, including through demand for natural resources, concentration of production or overuse of the assimilative capacity of the environment [12]. According to Asako [78] and McGuire [79], benefits from trade do not always result in welfare gains if production for export pollutes the environment. It is also worth noting that, due to less stringent production standards for health safety and climate protection, there are significant differences in MERCOSUR countries compared to the EU. There are justified concerns that, as a result of trade liberalisation, risks to consumer health and safety may arise, which will require appropriate regulation. Gozlan and Marette point out that trade liberalisation reinforces the need for product quality regulation [80].

The agri-food sector in the EU is implementing sustainable production technology, which has a positive impact on the environment but generates high costs, which negatively affect competitiveness. The assessment of the impact of the MERCOSUR FTA on the EU agri-food sector has been the subject of scientific analysis for many years, the results of which do not always share the concerns of the agricultural community [81]. The reciprocal opening of agri-food markets will take place within the framework of detailed schedules of tariff reductions or abolition. Such actions appear to be legitimate, as numerous examples confirm that customs policies can be legitimate, provided that their long-term goal is liberal trade [82,83]. It is worth emphasising that trade liberalisation should take into account national circumstances. List believes that weaker and less competitive economies should be protected in order to compete with other countries at a later stage [84]. Protectionist policies on import restrictions can support production provided that domestic firms increase production and also gain economies of scale [85]. For sensitive products, liberalisation under the MERCOSUR agreement provides for the introduction of tariff quotas (TQRs) at zero or reduced tariffs, which will be progressively increased. The EU import tariff quota for poultry meat will eventually be 180,000 t, beef 99,000 t, cheese 30,000 t and milk powder 10,000 t. On the sugar market, liberalisation will only apply to cane sugar for refining and will consist of an additional quota of 10,000 t for Paraguay and the elimination of tariffs for around 180,000 t of Brazil's WTO-allocated quota. The agreement provides additional quotas for imports of honey, ethanol and rice [86]. These import quotas are relatively small, as they represent 1–2% of the EU's consumption of the products in question [87]. Consequently, the impact of preferential imports on the supply–demand situation in the EU will be small due to their small share in market balances [88]. For products such as soybean meal, which is the primary source of feed protein in the EU and has no alternative substitutes, large imports have been made on preferential terms for many years. In this case, regulation will play an important role in ensuring that imported products do not come from plantations created by deforestation. This is supported by the Copeland and

Taylor model, which shows that environmental agreements with a developing country reduce environmental damage [89].

A free trade agreement may represent an opportunity for the EU to increase its trade flows, mainly in industrial products and services. The conclusion of such an agreement should also aim to systematically raise the economic level of individual countries by intensifying concentration processes, reducing the degree of economic differentiation and seeking to even out development disparities between countries. Furthermore, this economic integration facilitates foreign direct investment into the EU economy and access to natural resources (e.g., rare earths), which are essential for the energy transition and digitalisation of the economy. The agri-food sector in the EU, including the food industry in Poland, needs to accelerate structural transformation and modernisation in order to prepare for competition with MERCOSUR during the transition period. Adaptation processes will be carried out in two interrelated areas. The first area is the concentration of the entity structure of the food industry, aimed at increasing the economic strength of enterprises. The second area is modernisation investments aimed at implementing innovative technology and the organisation of production and management. Concentration of production in efficient enterprises increases the benefits of economies of scale and also facilitates the implementation of large investment projects, which are a condition for improving technical and economic efficiency as a basis for long-term competitiveness.

The above analysis indicates that the concentration of production contributes to the rising productivity of enterprises, which is mirrored in their financial performance. The production concentration and the sustainability and efficiency of the Polish food industry are strongly linked with each other. Large enterprises have attained a greater capacity to take advantage of resources and technologies in order to increase efficiency and, at the same time, to reduce negative impact on the environment. Sustainable practices, such as the effective use of energy and other resources and the reduction of externalities, can contribute to growing efficiency and competitiveness. The research conducted by Zgrzywak-Ziemak [90] indicates a relationship between the sustainability of an enterprise and its performance in terms of the growing value of sustainability factors and an improvement in performance. The EU-MERCOSUR agreement will enforce an acceleration of concentration processes, which would still result in an improvement in efficiency and a gradual implementation of sustainable practices.

3. Materials and Methods

The evaluation of structural changes in the Polish food industry was carried out using the methods of comparative statistics, analysis of structural changes and average annual dynamics with the use of the compound percentage formula and the trend function [91]. The relations between production and factor inputs were analysed using the Cobb–Douglas production function, whose independent variables are labour and capital [92–94]. The parameters of the function were determined using non-linear model estimation and the least squares method, which was preceded by a logarithmic transformation of the exponential function to a linear function form (1).

$$O_t = aK_t^\alpha L_t^\beta \Rightarrow \ln O_t = \ln a + \alpha \ln K_t + \beta \ln L_t \quad (1)$$

where:

- O_t —production value;
- K_t —total capital value;
- L_t —labour costs;
- a —constant.

The estimation of the parameters of the production function makes it possible to assess factor productivity and elasticity. The average productivity of capital AQK and labour AQL illustrates the value of output obtained from capital and labour inputs. The inverse of factor productivity illustrates the capital intensity (AQK-1) and labour intensity (AQL-1) of production (2). The marginal factor productivity, MQK and MQL, is the increase in output resulting from a unit increase in the factor input, holding the other factor constant. The capital-labour input ratio allows for an assessment of the of technical utility of labour (ut).

$$\begin{aligned} AQ_K &= \frac{Q_t}{K_t} = aK^{\alpha-1}L^\beta & AQ_L &= \frac{Q_t}{L_t} = aL^{\beta-1}K^\alpha \\ MQ_K &= \frac{\partial Q_t}{\partial K_t} = a\alpha K^{\alpha-1}L^\beta & MQ_L &= \frac{\partial Q_t}{\partial L_t} = a\beta L^{\beta-1}K^\alpha \end{aligned} \quad (2)$$

The elasticity of production illustrates the percentage change in output caused by a one per cent change in the inputs of one factor of production, assuming that the inputs of the other factor do not change. In mathematical terms, the elasticity of a function is the relationship of the limit of the quotient of the relative increase in the value of the function to the relative increase in a given variable (3). The marginal rate of substance tells how much capital inputs can be reduced when labour inputs increase by a unit ($\partial K_t / (\partial L_t)$), or how much labour inputs can be reduced when capital inputs increase by a unit ($\partial L_t / (\partial K_t)$), so that output remains constant. The marginal rates of substitution of inputs correspond to the respective marginal productivity relations ($\partial K_t / (\partial L_t = -MQ_K / MQ_L)$) and ($\partial L_t / (\partial K_t = -MQ_L / MQ_K)$).

$$e_K = \frac{\frac{\partial Q_t}{Q_t}}{\frac{\partial K_t}{K_t}} = \frac{\frac{\partial Q_t}{\partial K_t}}{\frac{Q_t}{K_t}} = \frac{MQ_t}{AQ_t} = \alpha \quad e_L = \frac{\frac{\partial Q_t}{Q_t}}{\frac{\partial L_t}{L_t}} = \frac{\frac{\partial Q_t}{\partial L_t}}{\frac{Q_t}{L_t}} = \frac{MQ_t}{AQ_t} = \beta \quad (3)$$

The statistical material for this study consisted of CSO data on production, labour and capital expenditures expressed in million PLN in the Polish food industry, which cover Division 10 of the NACE Classification in the EU [95]. In addition, GUS statistical data included the number of enterprises, employment and production value divided into three groups of enterprises according to the scale of economic activity:

Small: with up to 49 employees;

Medium: with 50–249 employees;

Large: employing 250 or more employees.

The time span of this study was 2002–2023. In order to eliminate the impact of price changes on the results of this study, empirical data were expressed in 2002 prices and the deflator was the cumulative price index of sold industrial production. Statistical calculations were performed using the STATISTICA 5.1.0 programme [96].

4. Research Results and Discussion

The results of the analysis of structural changes in the Polish food industry confirmed the progressing concentration of production, which is also confirmed by numerous studies conducted in this area [4,6,14]. Conducted research proved that, between 2002 and 2023, the number of total enterprises decreased by from 30% to 4923, and this was determined by both the consolidation of smaller business entities into large enterprises and bankruptcy processes, which resulted in the cessation of production activities. This is confirmed by the varying dynamics of the decline in the number of enterprises in each group. The number of small enterprises decreased to the greatest extent (by 32.5%), and the number of large enterprises decreased to the smallest extent (by 7.5%). As a result, the share of small entities in the structure of Polish food industry enterprises decreased from 77 to 74%, and the share of large companies increased from 4 to 6%. The share of medium-sized enterprises

also increased slightly to around 20%. The food industry shows a fragmented enterprise structure, which is a characteristic of the entire Polish agri-food sector. Agriculture also shows a highly fragmented farm structure. According to the Central Statistical Office (CSO), in 2020, there were about 1.3 million farms, but only about 70% sold products on the market, including to the food industry [97]. Consequently, the raw material base of the food industry consists of a large number of small family farms, which adversely affects the logistics and transaction costs of purchasing agricultural raw materials, as well as the economies of scale of production activities [98,99]. Large disparities in this respect exist not only in comparisons with the main competitors from Western and Central Europe, but above all with North and South American countries, including MEROCOSUR, where agricultural raw materials are produced on large-scale farms [100].

The process of production concentration in the Polish food industry is much better illustrated by changes in the structure of production value and employment. In 2002–2023, the production value of the food industry in real terms almost doubled to ca. PLN 200 billion, and this was mainly determined by the production growth in the group of large enterprises. This is confirmed by changes in the production value structure, in which the share of large enterprises increased from 48 to 61%. The share of small enterprises decreased from 18 to 11%, and that of medium-sized enterprises from 34 to 27% (Figure 2).

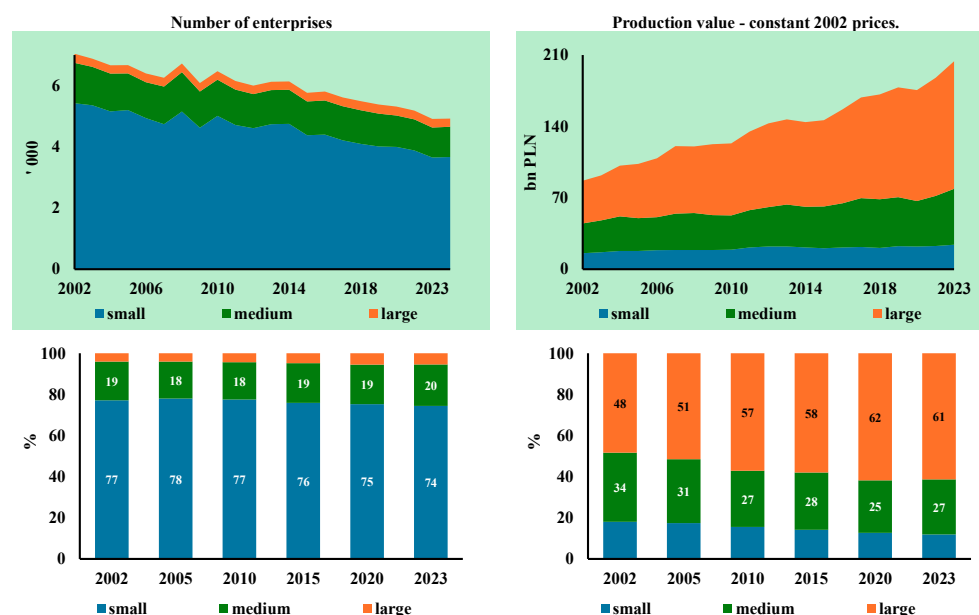


Figure 2. Number of enterprises and value of production in the Polish food industry. *Source: own calculations. Legend: small up to 49 employees, medium—50–249 employees, large—more than 250 employees.*

As compared with the majority of the EU countries, the concentration level of the Polish food industry, measured as the share of large enterprises in the value of production, is relatively high. Only a few member countries have a degree of concentration higher than Poland; those are as follows: France, Netherlands, Ireland, Germany and Sweden [4].

Analogous trends applied to employment, which in the period in question decreased by from 5.5% to 370,000. The 26.3% increase in employment in the group of the largest enterprises only partially compensated for the decrease in the number of employees in small and medium-sized enterprises, which was 29.7% and 23.4%, respectively. Consequently, the employment structure in the food industry confirms the concentration of production in large enterprises, whose share in the employment structure increased from 40 to 62%. The share of small companies in the employment structure decreased from 25 to 19%, and that of medium-sized enterprises from 35 to 29%. Since the vast majority of plants are located

in rural areas or small towns, the changes in the level and structure of employment in the food industry are in line with the objectives of social policies. As a consequence of that, the food processors are one of the most important employers and thus strongly contribute to the development of local societies [101].

An assessment of concentration processes and changes in the scale of production is also possible by analysing average employment and production value per enterprise. Between 2002 and 2023, average employment per enterprise increased by from 36.4% to 75 persons. In large companies, average employment increased by from 31.9% to 696 persons, while, in small and medium-sized enterprises, the employment dynamics were lower, at 5.1 and 1.2%, respectively. The average value of production expressed in real prices per enterprise more than tripled to PLN 41.5 million. The dynamics of the average value of production varied between groups of companies. In the group of the largest companies, average production tripled to PLN 466.3 million. In small and medium-sized companies, the dynamics of the average production value were lower (Table 1).

Table 1. Number of enterprises, employment and production value (PLN million) in the Polish food industry.

Specification	2002	2023	
		2002 = 100	
Number of enterprises	7036	4914	69.8
small	5426	3646	67.2
medium	1318	988	75.0
large	292	280	95.9
Employment per company	55	75	136.4
small	18	19	105.1
medium	104	105	101.2
large	528	696	131.9
Production per company	12.3	41.5	336.3
small	2.9	6.6	229.3
medium	22.1	55.4	250.2
large	143.6	446.3	310.8

Source: own calculations.

The evaluation of economies of scale in the Polish food industry was carried out using a two-factor Cobb–Douglas production function. Estimation of function parameters was performed using both the non-linear model and the least squares method, which was preceded by a logarithmic transformation of the exponential function to a linear function form. Both analytical procedures showed similar function parameters α and β , which illustrate the elasticity of production with respect to capital and labour, and their sum allows for the evaluation of scale effects. The estimation of the parameter α was statistically significant, and it was related to the variable banding capital inputs and the free expression. The estimation of the parameter β of the variable responsible for labour inputs was statistically insignificant. However, this does not change the fact that the fit of the production function model to the empirical data was statistically significant. This is confirmed by the values of the coefficient of determination $R^2 = 0.873$ and the Durbin–Watson statistic $DW = 1.31$, which indicates positive autocorrelation.

The research showed that the production elasticity of the Polish food industry with respect to capital is $\alpha = 0.88$ and is much higher than with respect to labour $\beta = 0.1$ (Table 2).

The main reason for this is the high capital intensity of production (about 0.6), which is represented by total capital expenditure per unit of production value. Between 2002 and 2023, the value of capital expenditures increased by 83.0% in real terms to PLN 104.9 billion, and this was determined by large investments, the real value of which amounted to PLN 132.5 billion. The labour intensity of production remained at a much lower level (around 0.1), and this was determined by a decrease in employment by from 5.5% to 302,000, which was compensated by a real increase in wages by from 68.2% to PLN 16.2 billion. The higher dynamics of capital than labour input resulted in an increase in technical equipment of labour utilisation (ut) from 6.0 to 7.5. The marginal productivity of labour and capital was characterised by variability in individual years, and this was determined by fluctuations in the value of production, which were a consequence of changes in the economic situation. This is also indicated in the research conducted by Kraciuk, who notes that this is a phenomenon characteristic of the food industry, whose performance is determined by the characteristics of agricultural raw materials processed [6]. Estimation of the production function also showed that the marginal productivity of capital is significantly higher than the marginal productivity of labour (Figure 3). The consequence of this is the progressive substitution of labour by capital, and this was determined by the implementation of modern technology based on efficient machinery and automation of production lines (Figure 4). Companies were implementing innovative Industry 4.0 solutions based on digital technologies aimed at improving efficiency and building sustainable competitive advantages [102–105]. Innovative solutions and technologies are also applied to energy and waste management, logistics and warehouse management, as well as management. Of particular importance in this respect was the energy transition, which aimed to replace solid fuels with gaseous fuels and electricity, resulting in the reduction of employment in coal and coke-fired boiler plants. The processes of concentration and modernisation within the Polish food industry have not yet been completed, and are coherent with the objectives of environmental policies. The obligation for reporting within the EU CSRD Directive creates a space for improvement of comparative advantages with respect to a positive impact on the environment. It is assessed that ca 10% of the operators within the food industry in Poland will be obliged to conduct such reporting [106].

Table 2. Production function of the food industry in Poland.

$Q_t = aK_t^\alpha L_t^\beta$			$\ln Q_t = \ln a + \alpha \ln K_t + \beta \ln L_t$		
Model Parameters	Standard Error	<i>p</i>	Model Parameters	<i>p</i>	Standard Error
const $a = 2.2013$	1.199233	0.08212 **	const $\ln a = 0.8367$	0.04784 **	0.393178
$\alpha = 0.8757$	0.243788	0.00194 ***	$\alpha = 0.8841$	0.00015 ***	0.195421
$\beta = 0.1063$	0.236886	0.65869	$\beta = 0.0742$	0.70820	0.187832

“****” the test result is statistically significant at the level of $p < 0.001$; “***” the result is significant at the level of $p < 0.01$. Source: own calculations.

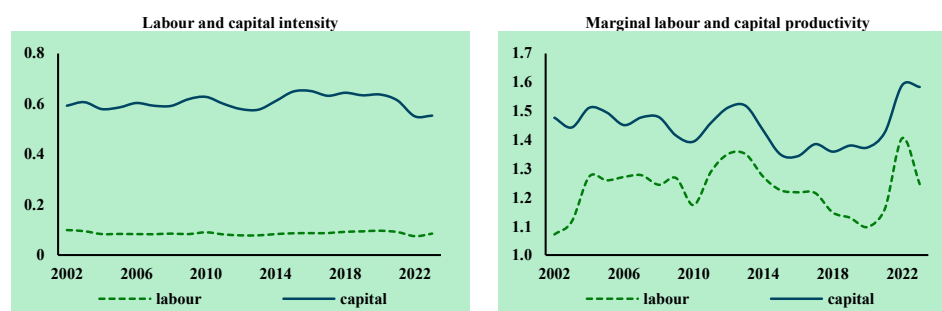


Figure 3. Intensity and marginal productivity of labour and capital in Polish food industry. Source: own calculations.

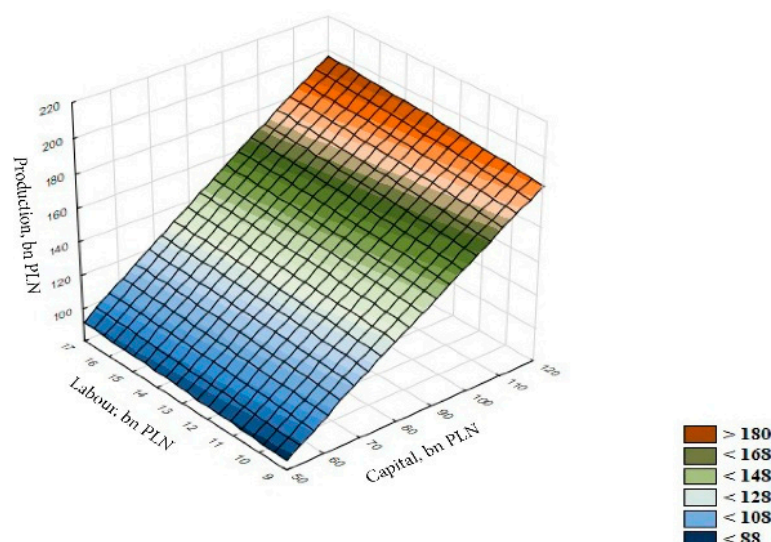


Figure 4. Production function of the food industry in Poland. *Source: own calculations.*

The substitution of labour by capital is also illustrated by the increasing share of third-party services in the total cost structure, as many companies use transport, logistics, procurement and cleaning and security services for facilities. This is confirmed by the Grześ study, which shows a statistically significant relationship between outsourcing and the size of employment [107]. Malak-Rawlikowska shows that the size of enterprises influences the reduction of transport costs and contributes to a better bargaining position in negotiations and to faster modernisation through easier access to support programmes [108].

The parameters of the production function indicate that the Polish food industry operates under constant scale effects, as the sum of the parameters α and β is close to unity. Fixed scale effects confirm that the restructuring and modernisation transformations of enterprises have been highly economically successful. The concentration of production in large and medium-sized enterprises and the implementation of capital-intensive technology resulted in improved economic efficiency. The industry has reached an optimum in this respect, as changes in production do not affect average costs. Confirmation of the efficiency of the food industry is provided by positive financial results and a growing foreign trade balance. This is also pointed out by Pawłowska, who notes that the positive financial results of companies with high market shares are due to size and greater efficiency [109]. Between 2002 and 2023, the net profit of the food industry expressed in real terms increased fivefold to PLN 9.7 billion, and individual years accounted for 2–5% of net revenues. Although the profitability of the food industry is lower compared to other sectors of the economy, it shows relatively small changes. The main reasons for that are CAP intervention instruments, low price elasticity of demand for food and adjustment of production potential of plants to the possibilities of production of raw materials in Polish agriculture and demand for imported agricultural raw materials from other climate zones. However, it should be stressed that individual branches of the Polish food industry are characterised by very different levels of economic efficiency and profits. The main reason for this is differences in the concentration of the entity structure and production specialisation of enterprises. Low profitability and fragmented structure of enterprises are present in industries processing animal products (meat, milk) and in the primary processing of cereals, fruits and vegetables. High efficiency and profitability are characterised, inter alia, by industries with an oligopolistic structure and a large share of transnational food corporations that produce sugar, vegetable oils and processed food products with a high share of added value (confectionery, beer, soft drinks). These results are supported by the efficient market structure hypothesis, according to which concentrated markets are those markets in which highly efficient companies operate [6].

The positive effects of structural and modernisation transformations in the Polish food industry have made it possible to achieve good economic results and a strong competitive position on the international market, mainly in the EU. Concentration and modernisation processes have not yet been completed, and enterprises are pursuing adaptation processes to changing conditions; this is determined by the need to implement sustainable production in the context of the EU climate policy and the liberalisation of foreign trade with MERCOSUR countries [110]. Preferential imports from MERCOSUR countries, regardless of the fact that they are limited to relatively small quotas, will result in changes in the conditions of competition in the EU market for agricultural and food products [111]. In addition, the EU is negotiating bilaterally with other trading partners to liberalise trade in agri-food products. Therefore, the Polish agriculture and food industry should prepare for future changes in market conditions, including, in particular, increased competition from imported products. In the food industry, the discussed processes will take place in two interrelated areas. The first area will be the continuation of structural changes, and the concentration of production in large and medium-sized enterprises will result in an increase in their economic power and bargaining position in relations with contractors. This does not, of course, exclude the possibility of a large group of small enterprises that will produce for local markets within short supply chains. Small enterprises are an important element of regional development, but they do not affect the international competitiveness of the Polish food industry. The market position of small enterprises in the food industry will weaken due to high barriers to entry and participation in the international market. However, small companies will be a permanent component of its entity structure due to strong links with agriculture, diversification of activities in line with contemporary nutrition trends and favourable for the development niches: fruit and vegetable processing, ready meals, spices, confectionery, etc. [4,112]. Such structural conditions will contribute to the balance of progressive concentration processes and the implementation of sustainable rural development strategies. In the supply of the internal market and in foreign trade, a key role is played by large companies, which will be forced to compete with products from MERCOSUR countries in the first instance. A second area for building competitive advantages will be the implementation of innovative and sustainable Industry 4.0 solutions, which will result in improved efficiency and economies of scale. Innovative technologies using digital solutions require very large investments, which only economically strong companies will be able to realise. This is confirmed by technological innovations in large fruit and vegetable producer organisations, which have reached the level of innovation activity of large food industry enterprises. Less involvement in this area, comparable to the activity of medium-sized companies, is observed in smaller agricultural producer groups [113]. Sustainable production technology and high food health safety standards generate high costs, but, at the same time, can be a source of qualitative competitive advantages.

Further research using the Cobb–Douglas production function will enable a comparative analysis of economies of scale in individual branches of the Polish food industry. Analogous studies at the level of individual food industries should also address changes in the entity and ownership structure.

5. Conclusions

1. The food industry in Poland is an important sector of the economy, which reflects strong demand for domestic and imported agricultural raw materials, a significant share in the value of production and employment in the entire industry sector, and a large positive balance of foreign trade. Enterprises have undergone a process of profound ownership, structural and modernisation changes in order to adapt to the changing environment: liberalisation of foreign trade under GATT/WTO, accession

to the EU and reforms of the CAP, as well as growing production and trade risks, which have been generated by global economic crises, the COVID-19 pandemic, the war in Ukraine and progressive climate change. In the coming years, a major challenge for the food industry will be the liberalisation of foreign trade under bilateral agreements (e.g., with MERCOSUR countries). As a consequence, major changes in the competitive conditions on the international market are expected so that only economically strong and efficient companies will be able to retain their competitive position, which would require significant investments.

2. The research results showed a growing concentration of the Polish food industry. The changes in its structure have been undergoing with an evolutionary pattern, which is confirmed by a still high degree of fragmentation within the branch. Large enterprises effectively take advantage of economies of scale, which is mirrored in their high level of efficiency.
3. Over the period of 2002–2023, the Polish food industry continued the processes of structural transformation. This was confirmed by a decrease in the number of enterprises and a significant share of large companies in the production structure. Small and medium-sized enterprises decreased their share in production, but the structure of the sector is still characterised by high fragmentation. The research showed that the average value of output per enterprise more than tripled in real terms. The decrease in the number of enterprises was accompanied by a reduction in employment, with the average employment per company increasing by 36.4%. The results of the research undoubtedly confirmed the continuation of concentration processes in large enterprises, with their increased economic power resulting in a strengthened bargaining position versus both domestic and foreign competitors, which confirms the stated research hypothesis. Small enterprises, which produce for local markets within short supply chains, are an important element of regional development; however, they do not affect the international competitiveness of the Polish food industry. The market position of small enterprises will be eroded due to high entry barriers. Nevertheless, small companies would still remain in the structure of the food industry due to strong linkages with agriculture and diversification of activities in line with modern food trends. Consequently, the structure of the food industry assures the achievement of sustainable development objectives under conditions of foreign trade liberalisation.
4. The concentration of the food industry structure was accompanied by large investments, with the total value reaching PLN 132.5 billion in real terms. At the same time, the value of total capital and labour increased in real terms by 83.0% and 68.2%, respectively. Reflecting that, technical utilisation of labour increased, and the production of the food industry became more capital-intensive than labour-intensive. Estimation of the Cobb–Douglas production function showed that its elasticity with respect to capital was many times higher than its elasticity with respect to labour. As a result, there was a substitution of labour by capital. The research showed that food industry enterprises operate on fixed economies of scale, as the sum of the elasticity coefficients of labour and capital is close to 1. The economies of scale indicate that the structural transformation and modernisation of enterprises were highly successful, and this was confirmed by increasing profits and competitiveness in the international market, indicating that enterprises are well prepared for the implementation of the trade agreement with MERCOSUR countries.
5. Due to the economic transformation in the EU, the food industry has been implementing the innovative solutions of Industry 4.0, a sustainable resource management in a closed model. The aim of these changes is to improve economic efficiency (e.g., cost

reduction) and maintain competitiveness. Structural change and modernisation in the food industry are not yet complete and will continue in the future, and will be determined by EU climate policy and the liberalisation of foreign trade with MERCOSUR countries. Preferential import quotas will result in increased competition, as the production of agricultural raw materials in MERCOSUR countries takes place under favourable climatic conditions, liberal regulations on GMOs and pesticides, and in very large farms and industries that benefit from economies of scale and have a strong bargaining position versus contractors. This situation may mean that the benefits of this liberalisation will accrue primarily in the large food corporations, while smaller-scale enterprises will be confronted with new competitive conditions.

6. The results of the research contribute to a more comprehensive approach to the problem of concentration impact on the factor efficiency of food industry enterprises, as well as on the possibilities of sustainable development of the food industry. So far, studies of structural, ownership and modernisation changes, as well as those focused on financial performance, have shown great variation across food industries. Therefore, further research on concentration and economies of scale, including the use of production functions, should be continued in a broader and conducted for particular branches of the food industry. The results of these studies will make it possible to assess factor inputs and their marginal productivity, elasticity, substitution and technical armament of labour. On such a basis, it will be possible to assess economies of scale in particular industries and to identify further directions for investment in order to improve the structure, modernisation level and sustainability. The development of the research should also include the identification of possible sources and areas of concentration inefficiencies. The cognitive and application value of this research can be a complementary element of economic analyses of concentration processes.

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