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REGIONAL DIFFERENTIATION OF CHANGES IN PIG LIVESTOCK PROCUREMENT IN POLAND IN 1999–2022 IN THE CONTEXT OF ECONOMIC AND ENVIRONMENTAL CONDITIONS

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ABSTRACT: The aim of the study was to identify and analyse regional differentiation in the changes in pig livestock procurement in Poland between 1999 and 2022, as well as to indicate the main economic and environmental factors determining these changes. The research was based on data from the Statistics Poland (GUS), the National Research Institute of Agricultural and Food Economics (IERiGŻ- PIB), the Ministry of Climate and Environment (MKiŚ), and the Chief Veterinary Inspectorate (GIW). Descriptive and comparative statistics, along with the method of standard deviations from the mean value for a given year, were applied to assess the procurement intensity in relation to agricultural land area. During the analysed period, production became increasingly concentrated in selected voivodeships- namely Wielkopolskie, Pomorskie, Łódzkie, and Mazowieckie- accompanied by a decline in the importance of western and southern regions. The observed changes were driven by economic factors, including the decrease in the number of small and medium-sized farms and the growing import of piglets, as well as by environmental pressures and the spread of African swine fever (ASF). The findings highlight the need to implement pig farming technologies that mitigate environmental impacts, to strengthen strategies for combating ASF, and to promote the principles of sustainable development.

KEYWORDS: pig production, regionalisation, intensification, ASF, Poland

Introduction

For decades, the pork market has been the dominant segment of the meat sector in Poland. The traditionally high consumption of pork among Polish consumers, as well as its deep- rooted position in national culinary culture, long served as grounds for optimism regarding the market's prospects in the context of Poland's accession to the European Union. However, only a few years after accession, it became apparent that pork production- unlike the markets for other types of meat- was facing increasing difficulties. This phenomenon resulted from the interplay of multiple and diverse factors operating within both the immediate and broader economic and institutional environment.

Between 1999 and 2022, significant structural and spatial changes were observed in pig livestock production in Poland, both at the national and regional levels. These tendencies reveal a decline in the number of farms engaged in pig breeding, accompanied by the concentration and intensification of production in selected regions (Mirkowska & Ziętara, 2019; Ziętara, 2019). In light of these transformations, regional- scale studies gain particular relevance, as they reflect the spatial differentiation of agricultural production and provide insight into local determinants shaping these processes. Pig farming, as an activity exerting a considerable impact on the environment, must take into account the ecological consequences of livestock rearing, such as water contamination, greenhouse gas emissions, and soil degradation. Moreover, the spread of African swine fever (ASF) represents a serious threat to market stability and production continuity.

An analysis of regional changes in pig livestock procurement in Poland is therefore of particular importance given the dynamic transformations occurring within this sector. Pig production continues to play a vital role in Polish agriculture and is crucial for the country's food security. Understanding the processes driving changes in production and its spatial distribution may contribute to the development of more effective agricultural policies and sustainable development strategies.

Literature Review

The largest pig-producing countries in the world are China, the United States, and the member states of the European Union. In these countries, large-scale farms typically play a dominant role (Olipra, 2023). Nevertheless, national markets remain vulnerable to adverse phenomena such as epidemics and changes in trade policy, which may disrupt supply chains and affect price stability (Szymańska, 2019).

Poland is a significant producer and consumer of pork within the EU. Over the past two decades, pig production in Poland has undergone major structural transformations, shifting from a state of self- sufficiency and net exports to a growing dependence on imports, particularly of piglets (Hryszko & Szajner, 2018). Despite the ongoing concentration of production and the decline in the number of pig farms, small and medium- sized producers continue to prevail. According to data from the Agency for Restructuring and Modernisation of Agriculture, as cited by Polpig (2022), the average herd size in 2022 was approximately 159 pigs per farm- still a relatively low level of concentration compared with other EU member states. For instance, the average Danish farm maintained more than 2,000 pigs. Nevertheless, the average herd size in Poland has been increasing steadily (Hansen, 2022; Mirkowska & Ziętara, 2019; Ziętara, 2019). Alongside the ongoing concentration of production and the declining number of fattening farms, other important trends have emerged within the sector. These include changes in production organisation, with an increasing reliance on open- cycle systems based on the procurement of piglets for fattening. At the same time, new forms of cooperation with slaughterhouses and processing plants have developed, including various forms of vertical integration such as contract production, subcontracted rearing, and fattening operations run directly by processing enterprises. Growing specialisation within particular stages of the pig production chain has contributed to improvements in efficiency and scale.

In Poland, as in many other countries, animal production is also undergoing a clear process of regionalisation. Olszańska (2012) demonstrated that such spatial differentiation processes have been observed for decades. They are shaped by multiple factors, including economic, environmental, social, and institutional conditions. The regionalisation of animal production in Poland is currently

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influenced to a large extent by the EU's Common Agricultural Policy and the availability of financial support instruments. Kołodziejczak (2020) emphasised the pivotal role of direct payments in driving regional specialisation. These policies have promoted production intensification in western and central Poland but have simultaneously deepened regional imbalances. Areas dominated by small farms- such as the Małopolskie and the Podkarpackie voivodeships- have lost competitiveness, resulting in declining pig production and the abandonment of traditional farming systems (Wicki, 2019). Subsidy mechanisms and agricultural support policies also play an important role in these processes. Marks-Bielska (2016) demonstrated that subsidies have been directed primarily toward larger producers, thereby enhancing production efficiency but also intensifying environmental pressures such as greenhouse gas emissions and groundwater pollution. Pro-environmental programmes have been insufficiently promoted among smallholders, further reinforcing the dualism of the agricultural structure. One outcome of these dynamics has been the intensification and concentration of production, particularly in regions such as Wielkopolskie, which faces significant water resource deficits. Roguet et al. (2015) also emphasise the role of other factors in their research, such as the importance of economies of scale and agglomeration effects, especially in areas with well-developed infrastructure. These factors have proven to be important in the development of pig farming in selected areas of Poland.

Bioclimatic conditions have also been recognised as important determinants of production profitability (Roguet et al., 2015; Yashina & Solntseva, 2021). Although environmental regulations such as the Nitrates Directive are designed to limit production concentration, their effects are often overshadowed by economic incentives. Over time, however, their importance is expected to increase.

Local communities and other elements of the microenvironment also play a crucial role in shaping regional production structures. The presence of successful producers, livestock procurement centres, and appropriate infrastructure creates local conditions conducive to similar economic activities among neighbouring farms. Conversely, Puškaric et al. (2013) and Marks-Bielska (2016) note that these processes have significant social consequences. The declining profitability of small farms and rising competition from industrial- scale producers have accelerated the disappearance of traditional farming forms- a trend intensified following Poland's EU accession. This structural shift has led to income losses among smallholders and the erosion of traditional livestock-rearing practices vital to rural communities. Moreover, migration from rural to urban areas and the influx of non- agricultural populations into rural regions have transformed the social and occupational composition of these communities. The rise of large- scale fattening farms has gradually altered the nature of agricultural employment – from family -based to wage labour. According to Kołodziejczak (2020), large farms increasingly rely on seasonal or external workers, reducing local engagement in production. While such enterprises often provide employment opportunities in regions with high unemployment, they simultaneously diminish the role of the family farm and contribute to the fragmentation of social ties, increasing the dependence of local residents on external employers. Although the scale of this transformation in Poland remains moderate, the growing prominence of industrial pig farms is clearly visible in the country's overall livestock production structure.

Scholars have consistently underscored the significant environmental consequences of intensive pig farming. Livestock production adversely affects global temperature, biodiversity, and the quality of natural resources such as air, water, and soil (Sakadevan & Nguyen, 2017). These effects arise from disruptions in the biogeochemical cycles of carbon, nitrogen, and phosphorus (Bartley et al., 2006; Leip et al., 2015). Documented impacts include soil degradation (Bell et al., 2011; Whitmore, 2001), climate change (Caro et al., 2014; Moumen et al., 2016; Sejian et al., 2015), air pollution (Casey et al., 2006; Fablet et al., 2018), water contamination (Sakadevan & Nguyen, 2017), and ecosystem instability (Randolph et al., 2007). These outcomes are linked to high livestock densities, large volumes of waste generation, intensive use of natural resources, and pollutant emissions.

A key environmental issue is the emission of greenhouse gases and odorous compounds- mainly methane and nitrous oxide (Augustyńska- Prejsnar et al., 2018; Hermann & Harasimowicz-Hermann, 2006). Gerber et al. (2013) estimated that pig production accounts for approximately 9% of total agricultural greenhouse gas emissions. Intensive farming also generates volatile organic compounds and ammonia, which cause odour nuisance and degrade air quality. Hayes et al. (2006), Olszańska et al. (2024), Samanta et al. (2022), and Williams (2024) highlight the impacts of ammonia emissions on human health and the quality of life of nearby residents. The large quantities of manure produced

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are a major source of nitrates and phosphates, which can leach into soil and surface waters, leading to eutrophication and aquatic biodiversity loss (Brito et al., 2022; Galloway et al., 2008). O'Connor et al. (2017) and Simões et al. (2022) document associations between intensive pig farming and elevated health risks among populations living in proximity to large- scale operations. Concentrated animal production also facilitates the spread of infectious diseases, including zoonoses. Livestock farming is additionally associated with substantial water and energy consumption. The water footprint of pork production- encompassing drinking water for animals, feed production, and facility maintenance- averages 6,000 litres per kilogram of meat (Mekonnen & Hoekstra, 2012). Intensive production requires significant energy inputs for heating, ventilation, transport, and waste processing. Excessive manure fertilisation contributes to soil salinisation and reduced fertility. Long- term application of such practices alters soil structure and leads to the accumulation of heavy metals such as copper and zinc, commonly present in pig feed. Nicholson et al. (2003) found elevated concentrations of heavy metals in soils surrounding pig farms, which constrain crop production potential. Furthermore, feed production demands vast land areas, driving deforestation and the conversion of natural habitats to cropland. Foley et al. (2011) estimated that approximately 30% of global agricultural land is devoted to producing livestock feed, including for pigs.

In summary, the regionalisation of animal production in Poland results from a complex interplay of economic, environmental, and social factors. The key challenge is to balance economic interests with environmental protection while supporting both large- scale farms in western Poland and smaller holdings in the south, which are vital for preserving rural cultural and social heritage.

Previous studies on pig production in Poland- particularly its regional aspects- have been fragmented, typically covering short time horizons or focusing on specific components of the production system. A comprehensive, long-term regional analysis integrating economic and environmental dimensions, as well as structural transformations in pig production over a 24- year period, has been lacking.

This article addresses this research gap by:

- Analysing regional differentiation in pig production in Poland between 1999 and 2022, enabling the identification of changes in pig livestock procurement and cross-regional comparisons through the use of the standard deviation method relative to agricultural land area;
- Integrating economic and environmental factors- including EU agricultural policy, globalisation, piglet imports, ASF, and historical determinants- to provide a holistic understanding of the processes shaping production regionalisation.

Through this approach, the paper offers a comprehensive examination of long-term changes in pig production in Poland from both economic and ecological perspectives.

Based on the identified research gap, the objective of this study is to identify and analyse regional differentiation in the changes in pig livestock procurement in Poland between 1999 and 2022, and to determine the key economic and environmental factors shaping these changes. These objectives are formulated in the form of the following research questions:

RQ1: What regional changes occurred in pig livestock procurement in Poland between 1999 and 2022?

RQ2: Which economic and environmental factors had the greatest influence on these changes?

RQ3: What are the potential consequences of these changes for the natural environment and the stability of the pork market in Poland?

Research Methods

To address the objective outlined above, we compiled secondary data covering the procurement of pig livestock over the entire study horizon, the register of installations holding integrated permits, and the emergence and spatial progression of new ASF outbreaks in Poland. The principal data sources were Statistics Poland (GUS), the Institute of Agricultural and Food Economics – National Research Institute (IERiGŻ– PIB), the Ministry of Climate and Environment (MKiŚ), and the Chief Veterinary Inspectorate (GIW). The core analyses span 24 years, from 1999 to 2022 (for selected components, shorter sub-periods were used where dictated by data availability). The geographical

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scope comprises the whole of Poland, disaggregated by voivodeship and by broader regions constructed through grouping voivodeships with similar characteristics.

The article employs methods of descriptive statistics. In the investigations of regionalisation in pig livestock procurement- and to allow intertemporal comparisons under a changing overall level of the phenomenon- we adopted, as a measure of inter-voivodeship dispersion, the standard deviation (S(x)) relative to the mean (x) for a given year.

Based on the annual distributions, voivodeships were classified into groups that differ by the magnitude of the analysed characteristic:

- values above the Polish mean in a given year:
  - Group 1 – <x, x+1*S(x)),
  - Group 2 – <x+1*S(x), x+2*S(x)),
  - Group 3 – <x+2*S(x), x+3*S(x)) and higher, analogously;
- values below the Polish mean in a given year:
  - Group -1 – (x, x-1*S(x)>,
  - Group -2 – (x-1*S(x), x-2*S(x)> and lower, analogously.

The number of groups identified in a given year depends on the variability of the phenomenon in that period. Additional comparability over time and space was ensured by analysing procurement volumes per 100 hectares of agricultural land (UAA), which facilitates intensity- based comparisons among voivodeships of different sizes. A key advantage of this procedure is the possibility of conducting consistent long- run comparisons (Olszańska, 2012).

Classification based on standard deviations from the annual mean offers several advantages that make it a useful tool in statistical and regional analyses, such as those of pig livestock procurement. It enables precise grouping using clearly defined statistical criteria that account for both central tendency and dispersion, yielding more granular insights than partitions based solely on the mean. The method helps identify regions that deviate markedly from average values, potentially signalling material trends or anomalies in the population under study. It is well-suited to constructing multi-year thematic diagrams and maps that visualise spatial differences across regions, thereby simplifying presentation and interpretation. It also allows regions to be compared by their standardised distance from the mean, which makes the approach broadly applicable in socio- economic and environmental research. An additional benefit is its robustness to shifts in the overall level of the analysed variable across years, since the grouping scale adjusts flexibly to the data. However, it is worth remembering that the presence of provinces whose values differ significantly from the others can strongly influence the average. As a result, this may distort the division into groups, which is a certain limitation of this method. Therefore, the results obtained should be analysed in the context of the total volume of production and procurement in a given province. This approach provides a more complete picture of the changes taking place (Olszańska, 2015).

The authors also considered alternative classification and regional analysis techniques- including quantiles, Jenks natural breaks, z- score standardisation, cluster analysis, principal component analysis (PCA), shares- based partitions, and the location quotient (LQ). Each of these has merits depending on data structure and research purpose. However, given the study's aim- straightforward temporal comparability and sensitivity to evolving patterns- the standard- deviation- from- mean method described above was assessed as the most operationally suitable.

To identify factors underpinning the observed changes, we adopted an analytical, synthetic and deductive approach. This choice reflects the complex, multifaceted nature of the processes shaping the regionalisation of pig production- namely, EU agricultural policy, globalisation, ASF occurrence, piglet imports, and historical determinants. Many such drivers are qualitative in character or are difficult to measure with precision at the regional level over a 24- year horizon, which further justifies a mixed inferential strategy.

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Results

Poland is a significant producer of live pigs in the EU (ranked 4th–6th), but for many years, pork imports have exceeded exports, and the level of self-sufficiency is estimated at 85–95%. It is also worth noting that pork remains the dominant type of meat in the Polish diet: in 2022, per capita pork consumption reached 46.3 kg per year, accounting for 58.8% of total meat consumption (78.7 kg per person) (IERiGŻ- PIB, 2023). Over the analysed period, pig farming in Poland underwent profound structural changes, primarily resulting from efforts to optimise production costs in response to persistently declining profitability of agricultural holdings. Consequently, the number of farms engaged in pig production has declined sharply.

According to data from the Agency for Restructuring and Modernisation of Agriculture (ARiMR), as cited by the agricultural portal farmer.pl (2022), the number of registered pig herds in Poland as of 10 October 2022 stood at 59.2 thousand. More than 2,300 herds were lost in the third quarter of 2022 alone, and within the preceding three years, their number nearly halved. By April 2024, only 49.9 thousand herds remained, compared with 53.8 thousand in 2023. The main reasons identified for this decline are low profitability and the impact of African swine fever (ASF). These data point to a deep and ongoing crisis in pig production, characterised by a continuous and substantial decrease in herd numbers and total livestock population. In the near future, Poland risks becoming not only a net importer of piglets but also of pork meat to meet domestic demand. For comparison, according to data from the Central Statistical Office's agricultural censuses, at the beginning of the 1990s, over 1.5 million farms were involved in pig farming in Poland. By 2010, their number had decreased significantly, but was still very high at 397,100.

Despite long- term support for producer organisations, producer groups still play a limited role in the pig market. Greater efficiency in vertical integration is achieved by slaughterhouses and processing plants through contract farming and subcontracted production systems. In 2021, between 20% and 22% of pig livestock procurements in Poland were conducted under fattening contracts, compared with 12- 15% in 2016, depending on whether the share was measured by number, mass, or value of procurement livestock (Kurek, 2024).

Pig farming mainly involves fattening piglets (usually procurement) to a specific weight currently accepted by slaughterhouses, which usually takes between 3.5 and 5 months. Since 2013, large farms have increasingly depended on imported piglets- a trend that has intensified in recent years, reaching around 50% of total annual slaughters. Data on live animal imports (under 50 kg) confirm this growing dependence (IERiGŻ- PIB, 2005, 2010, 2015, 2022). The high demand for young animals reflects producers' pursuit of high- quality genetic material that ensures superior carcass leanness and growth performance. On the other hand, however, dependence on piglet imports is cited as the main problem facing the Polish pork market. The following example illustrates the scale of this phenomenon in recent years.

According to ARiMR data, in 2021, there were 18,184 large pig farms in Poland that reported no piglet births in the preceding year, while collectively selling 11.22 million fatteners. More than half of these- 6.26 million pigs- originated from Danish piglets, with an additional 0.5 million imported from the Netherlands and Germany. Thus, approximately 4.5 million pigs fattened in open production cycles were based on domestic piglet production (Janusz-Twardowska, 2021). These figures also illustrate the significant role of large- scale fattening farms in total livestock supply.

Table 1 presents data on changes in the number of large pig- fattening farms and large sow farms (data available since 2016). In Poland, the legal basis for the operation of large industrial farms requiring integrated permits is Directive 96/61/EC of 24 September 1996 (Directive, 1996)

In 2016, there were 158 agricultural installations with integrated permits for pig farming in Poland, including 96 dedicated to pig fattening and 62 to piglet production. By 2024 (provisional data), this number had increased by approximately 25%; compared to 2016, the 2023 figure represented a 39% rise. The distribution of industrial pig farms- and consequently their environmental impact- varies substantially across voivodeships. The highest concentrations are observed in two regions: the Wielkopolskie and Zachodniopomorskie, followed by a group of five voivodeships (Warmińsko-Mazurskie, Pomorskie, Lubuskie, Kujawsko-Pomorskie, and Łódzkie) that also exhibit relatively high densities of such facilities. Over time, the structure of these installations has evolved,

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with a slight downward trend in the number of large sow farms, while fattening farms have increased in number. The Wielkopolskie consistently maintained the highest share of such installations across all analysed years.

A further critical challenge is the persistent spread of African swine fever (ASF), a viral disease affecting both wild boars and domestic pigs. ASF inflicts severe economic losses due to sanitary restrictions, culling measures, and export bans on live pigs and pork products. To contain the disease, the Chief Veterinary Inspectorate (GIW) introduced a system of risk- based control zones, with corresponding biosecurity regulations and movement restrictions. These measures are justified given the disease's high contagion; however, they exert a considerable negative impact on local pig production by necessitating mass culling and triggering substantial declines in pork prices. At present, no effective treatment or vaccine for ASF exists. Disease control thus relies primarily on preventing its spread through disinfection protocols and biosecurity enforcement. Unfortunately, these measures have proven insufficient, largely due to the continuing prevalence of the virus in wild boar populations, which act as a natural reservoir of infection. Consequently, ASF continues to expand geographically, posing a persistent threat to the stability of Poland's pig sector (Arias et al., 2019; WETGIW, 2024).

Table 1. Number of agricultural installations with integrated permits in Poland, 2016- 2024 (by voivodeship)

Specification	31.12.2016			31.12.2017			31.12.2019			31.12.2021			31.12.2023			30.09.2024		
	Total	2,000 places for pigs weighing over 30 kg	750 places for sows	Total	2,000 places for pigs weighing over 30 kg	750 places for sows	Total	2,000 places for pigs weighing over 30 kg	750 places for sows	Total	2,000 places for pigs weighing over 30 kg	750 places for sows	Total	2,000 places for pigs weighing over 30 kg	750 places for sows	Total	2,000 places for pigs weighing over 30 kg	750 places for sows
Poland, including Voivodeship:	158	96	62	163	110	53	179	118	61	191	123	68	220	143	77	197	130	67
Dolnośląskie	12	7	5	8	5	3	9	5	4	10	7	3	10	7	3	10	7	3
Kujawsko- Pomorskie	0	0	0	13	10	3	13	9	4	13	9	4	16	12	4	16	12	4
Lubelskie	7	7	0	8	8	0	10	9	1	10	9	1	12	10	2	12	10	2
Lubuskie	16	8	8	11	6	5	13	7	6	18	10	8	21	12	9	18	10	8
Łódzkie	9	7	2	12	10	2	13	11	2	12	10	2	13	11	2	13	11	2
Małopolskie	3	2	1	3	2	1	3	2	1	3	2	1	3	2	1	3	2	1
Mazowieckie	6	1	5	5	2	3	7	3	4	7	3	4	8	4	4	8	3	5
Opolskie	6	4	2	4	2	2	4	2	2	9	5	4	9	5	4	7	4	3
Podkarpackie	2	0	2	0	0	0	1	1	0	4	2	2	4	2	2	4	2	2
Podlaskie	2	1	1	2	1	1	2	1	1	2	1	1	2	1	1	2	1	1
Pomorskie	17	11	6	21	14	7	22	15	7	18	12	6	22	13	9	18	12	6
Śląskie	4	3	1	4	3	1	3	3	0	4	3	1	4	3	1	4	3	1
Świętokrzyskie	4	2	2	1	0	1	3	0	3	2	0	2	2	0	2	2	0	2
Warmińsko- Mazurskie	14	5	9	16	8	8	17	8	9	18	8	10	21	9	12	17	8	9
Wielkopolskie	29	23	6	34	23	11	36	26	10	33	23	10	39	29	10	37	28	9
Zachodniopomorskie	27	15	12	21	16	5	23	16	7	28	19	9	34	23	11	26	17	9

Source: authors' work based on (Augustyńska-Prejsnar et al., 2018; MKiŚ, 2024).

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African swine fever (ASF) was first detected in Poland in 2014, initially in the eastern part of the country, where pig production is relatively limited. At present, the disease is also found in the central regions of Poland, affecting the Warmińsko- Mazurskie, Podlaskie, Mazowieckie, and Lubelskie Voivodeships. ASF outbreaks have additionally been reported in the Łódzkie, Świętokrzyskie, Podkarpackie, Lubuskie, and Wielkopolskie Voivodeships, posing serious challenges to the stability of pig production in these areas (Olszańska, 2020; WETGIW, 2024). In 2022, only 14 ASF outbreaks among domestic pigs were recorded in Poland- a substantial decrease compared with the 2016- 2021 period (124 outbreaks in 2021). However, half of the 2022 outbreaks occurred in the Wielkopolskie Voivodeship, and two more in the Zachodniopomorskie Voivodeship; most of these cases affected large- scale commercial herds (WETGIW, 2024). Despite this reduction, the number of confirmed infections among wild boars remains high, which significantly limits the prospects for eradication in the short term.

Data from the Chief Veterinary Inspectorate (GIW) illustrate the changing scale of the epidemic over time. Yet, beyond the epidemiological dimension, ASF has also imposed severe economic costs. According to Portal Spożywczy (2025), by 2025 ASF had been detected in 576 farms, resulting in the culling of approximately 210,000 pigs with an estimated direct value of over PLN 106 million. Additional preventive culling in "contact herds" eliminated a further 300,000- 400,000 animals, leading to additional losses estimated at PLN 160- 213 million. The average cost of a single outbreak ranged from PLN 530,000 to 630,000, but indirect losses- such as falling procurement prices, trade disruptions, and loss of export markets- were equally significant, though more difficult to quantify.

Figure 1 presents the total volume of pig livestock procurement in Poland between 1999 and 2022. The data indicate a substantial increase in procurement over the analysed period. Compared with 1999, the 2022 level was 55% higher, with an average annual growth rate exceeding 35,500 tonnes, and a relatively good fit of the trend line. However, cyclical fluctuations characteristic of the pig market were evident: lower procurement levels occurred in 2001, 2009, 2012, and 2019, whereas higher- than- trend increases were recorded in 2003, 2007, and 2021.

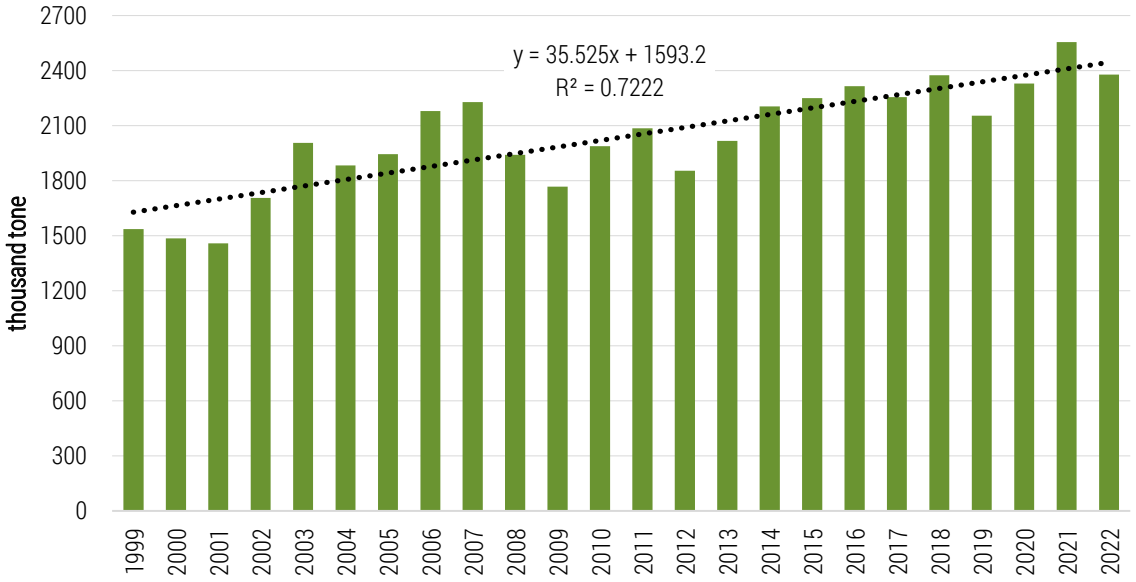

Figure 1. Live pig procurements in Poland in 1999- 2022 [thousand tonnes]

Source: authors' work based on data (Statistical Yearbook of Agriculture and Rural Areas 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Statistical Yearbook of Agriculture 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022).

Recent data suggest that market cyclicality has gradually weakened- a favourable trend contributing to market stability and predictability. Regional variation in the intensity of agricultural production is a natural and frequently observed phenomenon; it generally attracts attention only when its negative consequences become apparent. This diversity stems from the different conditions relevant to a given type of agricultural production.

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In these processes, several factors play a crucial role, including historical conditions, the evolution of farm structure, and the traditions and accumulated experience associated with specific types of agricultural production. The surrounding environment- particularly the microenvironment- also exerts a significant influence. This encompasses, among others, dynamically operating slaughterhouses and meat-processing plants, as well as their strategic efforts to secure reliable sources of raw material. Studies on the regional differentiation of animal production in Poland have been conducted, among others, by Okularczyk (1999, pp. 8- 12) and Witczak (2002, pp. 189- 196). However, a review of the literature indicates that research in this field remains limited.

Table 2 presents the regional differentiation of pig livestock procurement in Poland, enabling an examination of changes in procurement volume per 100 hectares of agricultural land relative to the national average in a given year. The results clearly indicate that pig production was markedly diversified across the country, with only a small group of voivodeships recording procurement levels above the national mean.

Throughout the analysed period, only five to six voivodeships were identified each year in which the volume of pig livestock procurement per 100 hectares of agricultural land exceeded the national average. Voivodeships with high production intensity were primarily located in western and central Poland. In eleven voivodeships, procurement generally fell within the range between the national average and one standard deviation below the mean for the respective year. The Dolnośląskie Voivodeship was the area that consistently stood out due to its low procurement levels; since 2001 (with the exception of 2004), it has been the only region classified in the -2 interval. Particularly noteworthy are the changes observed among high- intensity production regions. Over the 24-year period, the Wielkopolskie clearly dominated in terms of procurement intensity per unit of agricultural land. Until 2011, it was the only region classified at the +3 level, indicating the highest concentration of production. However, in subsequent years, its position weakened: for seven out of the next nine years, it was placed in the +2 group. This notable shift occurred in 2012, coinciding with a significant nationwide decline in pig procurement, and the situation in this voivodeship did not improve substantially thereafter. This trend suggests that some producers in the region either temporarily reduced their production or withdrew from it entirely. Alternatively, the relative decline may also reflect rapid growth in other voivodeships- both factors likely contributed, as indicated by the data presented in Figure 2. The Kujawsko-Pomorskie remained in the +2 group for most years until 2018. In the last four years of the analysed period, the procurement price in this province per unit of agricultural area was only above the average in the first group.

A notable increase in procurement intensity per unit of area was recorded in two voivodeships: Łódzkie and Pomorskie, with the latter becoming the leader in this classification. During the first eight years of the study period, the Pomorskie Voivodeship was in the -1 group. Between 2007 and 2010, it moved above the national average (+1), and during the following eleven years, it was consistently classified in the +2 group. In 2017–2019 and 2022, it was the only voivodeship reaching the +3 level. Considering the significant decline in the number of pig farms, this pattern indicates the development of large-scale fattening operations in the region. Another voivodeship that stood out was the Łódzkie, which entered the +2 group in 2012 and maintained this position thereafter. Overall, among the voivodeships where procurement intensity per unit of agricultural land exceeded the national average, there has been a decline in internal differentiation over time. In recent years, the Pomorskie Voivodeship joined this group, becoming one of the fastest-developing regions in terms of production.

Returning to the original, unstandardised data, several important observations can be made when comparing 2022 to 1999 (see Figure 2). On average, pig procurement in Poland per unit of agricultural area almost doubled (a 1.91 – fold increase). The Pomorskie Voivodeship stood out with a 6.3 – fold increase, followed by the Mazowieckie Voivodeship (3.41- fold increase), which moved from the -1 group to the +1 group during the last four years of the study. The Łódzkie Voivodeship also advanced to the +2 group, with a 2.8 – fold increase. Other voivodeships showing above – average growth included the Opolskie and Świętokrzyskie, although in most years they remained in the -1 group, reaching +1 only occasionally. By contrast, the Wielkopolskie Voivodeship recorded a growth rate below the national average (1.32 – fold increase), explaining its relative decline compared to other regions.

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Table 2. Changes in regional pig procurements in Poland per 100 agricultural holdings in 1999- 2022 [standard deviations from the average value in a given year]

Voivodeship	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Pomorskie	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	2	2	2	2	2	2	3	3	3	2	2	3
Łódzkie	1	1	2	2	1	1	1	2	2	2	1	1	1	2	2	2	2	2	2	2	2	2	2	2
Wielkopolskie	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3	2	2	2	2	2	2	2
Kujawsko-Pomorskie	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	1	2	1	1	1	1
Mazowieckie	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1
Lubelskie	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Lubuskie	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Małopolskie	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Opolskie	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	1	-1	-1	1	1	-1	-1	1	-1
Podkarpackie	-1	-1	-1	-1	-1	-1	-1	2	-1	-1	-1	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Podlaskie	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Śląskie	-1	-1	-1	-1	-1	1	1	-1	1	1	1	-1	1	1	-1	1	1	-1	-1	-1	-1	-1	-1	-1
Świętokrzyskie	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1	-1	-1	-1
Warmińsko-Mazurskie	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Zachodniopomorskie	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Dolnośląskie	-1	-1	-2	-2	-2	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

Source: authors' work based on (Statistical Yearbook of Agriculture and Rural Areas 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Statistical Yearbook of Agriculture 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022).

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Alongside these upward trends, a distinct group of voivodeships experienced a marked decrease in procurement intensity over the 24-year period. This was most pronounced in the Dolnośląskie Voivodeship, where procurement per unit of agricultural area in 2022 amounted to only 35.2% of its 1999 level. Declines were also observed, though to a lesser extent, in the Zachodniopomorskie, Małopolskie, Lubuskie, and Podkarpackie Voivodeships, i.e. regions located in southern and western Poland.

The analysis of pig livestock procurement per 100 hectares of agricultural land can be further extended by examining the temporal variability of this phenomenon over the years (Figure 3). The values of this coefficient can be considered relatively high, although their annual variability differed across the study period. Between 1999 and 2022, the coefficient ranged from 52.65% to 71.28%. During the last ten years of the analysed period, these values increased gradually, while between 2001 and 2009 they remained relatively stable. The lowest regional differentiation in procurement levels among voivodeships was recorded in 2010, whereas the highest was observed in 2021- 2022. The differences in this indicator reflect both the growing concentration processes in pig production and the increasing divergence among individual voivodeships.

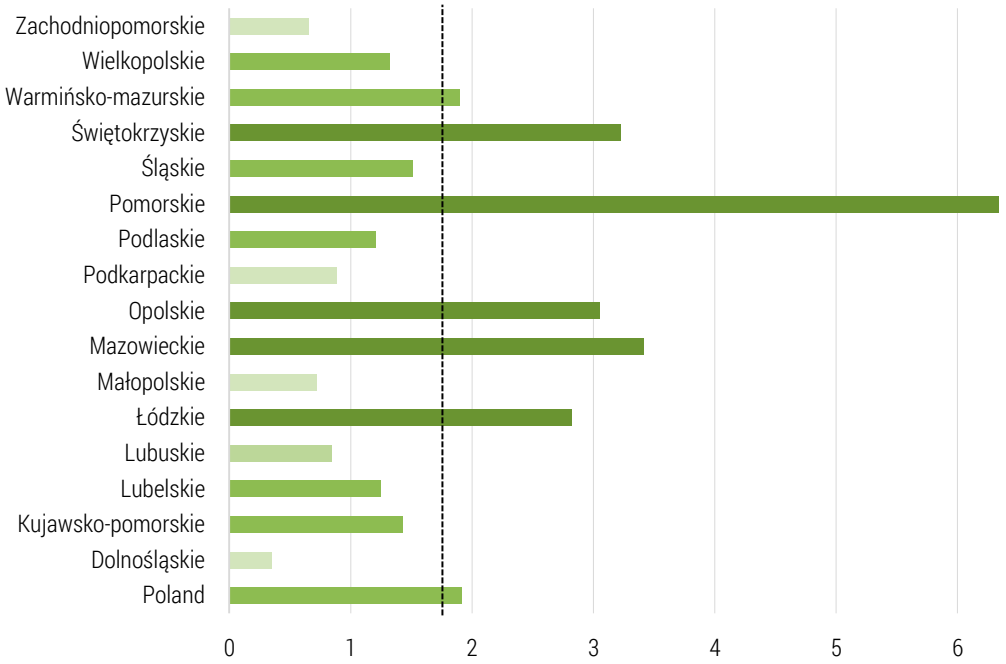

Figure 2. The relation between the level of pig livestock procurement in 2022 per 100 hectares of agricultural land and the corresponding data from 1999

Source: authors' work based on data (Statistical Yearbook of Agriculture and Rural Areas 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Statistical Yearbook of Agriculture 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022).

To deepen the analysis of regional differentiation in pig farming in Poland, the shares of individual voivodeships in national pig livestock procurement were also examined for the first and last years of the analysed period (Figure 4).

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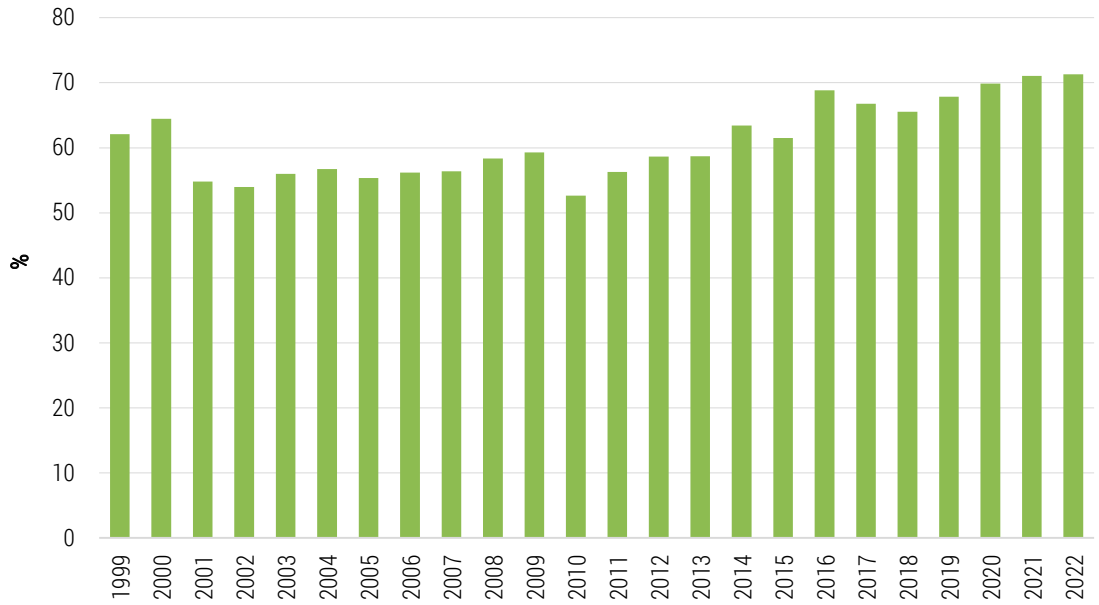

Figure 3. Variation in the level of pig procurement between provinces in subsequent years in relative terms (coefficient of variation) in Poland in 1999–2022 [%]

Source: authors' work based on data (Statistical Yearbook of Agriculture and Rural Areas 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Statistical Yearbook of Agriculture 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022).

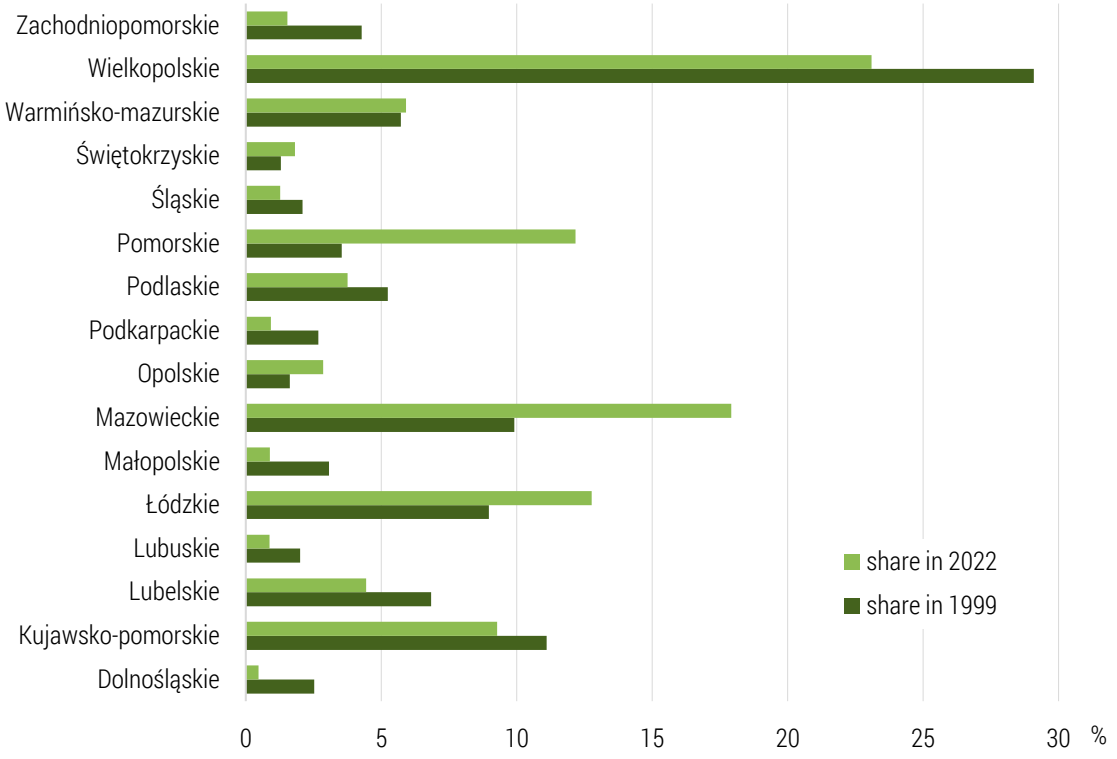

Figure 4. Shares of individual provinces in the procurement of live pigs in 1999 and 2022 [%]

Source: authors' work based on data (Statistical Yearbook of Agriculture and Rural Areas 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Statistical Yearbook of Agriculture 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022).

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Despite the decline in the relative position of the Wielkopolskie Voivodeship in terms of pig livestock procurement per unit of agricultural land, this region continues to hold a dominant share in Poland's overall pork production. However, its share has changed considerably over the analysed period – from 29.1% in 1999 to 23.1% in 2022. Thus, the region remains the undisputed leader in pig production, despite experiencing numerous ASF outbreaks in recent years (in 2024 – 23 outbreaks out of 44 confirmed nationwide; in 2023 – 10 out of 30; in 2022- 7 out of 14; in 2021 – 8 out of 124; and in 2020 – 5 out of 103) (WETGIW, 2024). The disease has clearly spread westward from eastern Poland into the Wielkopolskie and neighbouring voivodeships, causing extensive damage. For instance, the Leszno County, long known for its intensive pig production, has been seriously affected. Unfortunately, given the persistent presence of ASF in wild boar populations, it is likely that additional areas will have to be temporarily excluded from production. The implications for the stability of the entire red meat sector are therefore severe and may further deteriorate. Conversely, there has been a notable increase in procurement in the Łódzkie and Pomorskie Voivodeships, which until recently had been only marginally affected by ASF. Meanwhile, in 2024, a substantial part of the Mazowieckie Voivodeship was marked in blue on the ASF risk map, indicating proximity to active outbreaks (within approximately 7 km of infected zones), although in recent years, only a few sporadic outbreaks have been confirmed there. In addition to these regions, several other voivodeships- the Opolskie, Świętokrzyskie, and Warmińsko- Mazurskie- also recorded an increase in their share of national pork procurement in 2022 compared with 1999. However, their overall contribution to Poland's total pig supply remains relatively modest. The remaining voivodeships, particularly the Dolnośląskie, Lubuskie, Małopolskie, Podkarpackie, Śląskie, and Zachodniopomorskie, experienced a decline in share, in some cases to marginal levels.

Discussion

Despite the ongoing concentration of pig production, the significant dependence on piglet imports raises concerns about the long-term sustainability of the sector. Increasing international competition and market volatility may further undermine the profitability of Polish farms. This issue is compounded by the African swine fever (ASF) epidemic, which has had a particularly severe impact on regions affected by outbreaks, hampering the development of small and medium-sized farms. Although larger farms have adopted biosecurity measures, the protection of smaller producers remains a persistent challenge.

Regions with the highest production concentration, which together accounted for 66% of national pig procurement in 2022, are either already affected by ASF or at high risk of future outbreaks. While modern farms equipped with biosecurity systems can reduce the risk of disease transmission, outbreaks in neighbouring holdings can still lead to severe economic losses. Reduced risk does not imply complete elimination, as demonstrated by 2024 data, when several outbreaks occurred in medium and large farms, including one involving more than 11,000 animals. ASF will therefore remain a major challenge for the industry for years to come, causing regional shifts in production. These observations relate to recent years.

Data also reveal that, due to production concentration and the ASF epidemic, the number of small and medium farms engaged in traditional pig farming has declined sharply. Pig fattening is now largely dominated by large- scale operations, which either raise their own animals or import piglets and contract their rearing to individual farmers (Wesołowska, 2021). Furthermore, new large- scale fattening facilities compliant with sustainability and environmental protection standards are being established in Poland. The emergence of specialised piglet production farms (Gobarto, 2024) confirms this trend. However, data on the number of integrated permits for pig production show that such farms still represent a small fraction of the total number of pig producers.

The intensification and concentration of agriculture also present significant environmental challenges. Investments in sustainable technologies can partially solve these problems. Banhazi et al. (2018) emphasise that investments in technologies such as precision waste management systems can reduce ammonia emissions by up to 40%, representing a substantial environmental benefit. At the same time, production concentration contributes to regional imbalances. In voivodeships such as the Dolnośląskie and Podkarpackie, pig production has declined, highlighting the need for targeted support

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for less competitive regions. This stems from the fact that large slaughterhouses tend to locate in high- production areas to optimise raw material supply, while meat plants in low-production regions usually rely on imported carcasses or semi-processed meat.

In recent years, the Common Agricultural Policy (CAP) has played a pivotal role in shaping Poland's pig sector, though its effects have been mixed. While it has improved efficiency and specialization, it has also deepened regional inequalities and generated new environmental pressures In the future, this policy should focus on supporting smaller farms through dedicated subsidies and educational programmes, implementing more effective mechanisms to support the development of local producer groups and the concept of short supply chains (the possibility of increasing the competitiveness of smaller farms), as well as promoting sustainable agricultural technologies that reduce negative environmental impacts. Implementing such initiatives would help balance economic, environmental, and social objectives in the Polish agricultural sector.

The development and implementation of precision agriculture technologies – including animal health monitoring sensors, feed optimisation systems, and waste management innovations- can reduce greenhouse gas emissions, improve production efficiency, and mitigate environmental impacts.

Furthermore, regenerative agriculture, which integrates livestock and crop production, leverages natural biogeochemical cycles to reduce dependence on synthetic fertilisers, enhance soil quality, and support biodiversity. Similarly, organic pig production, adhering to the principles of ecological farming, minimises the use of chemicals and promotes animal welfare. The demand for organic meat products continues to grow across the EU, and the premium prices of such products may improve the profitability of small family farms. Studies by Foley et al. (2011) indicate that organic agriculture can be more profitable in the long term, particularly for family- owned holdings seeking to avoid direct competition with large industrial farms.

It is also crucial to intensify educational efforts to promote modern technologies and organisational innovations, such as precision farming, organic and open-system agriculture (supporting animal welfare and sustainability), and the integration of pig and crop production within closed- loop systems. These practices could reduce dependence on piglet imports and lower the sector's environmental footprint. Valuable insights can be drawn from EU countries, such as the Netherlands, where regenerative agriculture models are already being successfully developed (Gerber et al., 2013; Sakadevan & Nguyen, 2017).

Conclusions

Poland's accession to the European Union has had a profound impact on the evolution of the pig sector, introducing new legal regulations and transforming market structures. The Polish pork market urgently requires strategic stimuli to support the rebuilding of livestock numbers, the broader adoption of closed- cycle fattening systems, and the development of modern piglet production facilities delivering high- quality genetic material. Equally important is the creation of production units compliant with environmental protection standards and aimed at improving animal welfare. All these measures have a significant impact on the stability of the sector, especially in the context of ongoing changes such as the Mercosur agreement and the potential opening of the Ukrainian market.

Domestic demand for pork remains stable and is likely to persist at this level, even as poultry consumption continues to rise. Although international trade in meat and meat products has not yet had a decisive impact on the domestic supply of pork, this situation may change if the number of pig-fattening farms continues to decline at the current rate. Pig production has become a high- risk branch of agriculture, mainly due to ASF outbreaks, price volatility, and fluctuating profitability. The substantial import of piglets highlights the sector's dependence on international market conditions. At the same time, this phenomenon has positive aspects, as it contributes to improving the quality of Polish livestock and encourages production specialisation.

The Wielkopolskie Voivodeship has maintained its dominant role in pig procurement both at the beginning and end of the study period. Although its share in total procurement has declined, the region remains the leading centre of pig production in Poland, reflecting a high level of specialisation and production concentration. In recent years, the Mazowieckie and Łódzkie Voivodeships have

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gained increasing importance, with a significant rise in their national procurement shares. This reflects growing production intensity in central Poland, possibly linked to better access to processing infrastructure and markets, as well as lower ASF exposure (at least to date). By contrast, a decline in the role of western and southern voivodeships (Dolnośląskie, Zachodniopomorskie, Lubuskie, Małopolskie, and Podkarpackie) has been observed. This may result from a decrease in livestock numbers on small farms and the discontinuation of pig farming, associated with a shift toward alternative, less risky agricultural activities. Among northern regions, the Pomorskie Voivodeship has significantly increased its share in national procurement, indicating the expansion of large-scale commercial operations, while the Warmińsko- Mazurskie Voivodeship maintained a moderate but growing share. Overall, the data confirm an increasing concentration of pig production in a few key voivodeships, implying that a small number of regions now account for most national output, which in turn increases systemic risks (e.g., ASF outbreaks, drought, or local price shocks).

The analyses and considerations presented in this article allow us to answer the research questions formulated at the outset:

RQ1: The analysis of regional changes in pig procurement in Poland between 1999 and 2022 reveals a concentration of production in only a few voivodeships: Wielkopolskie, Łódzkie, Pomorskie, and Mazowieckie. At the same time, many regions have shown a clear decline in pig farming. From an economic perspective, these transformations are understandable, yet their social and structural implications are less favourable. The number of pig farms has declined continuously and significantly, while the supply of raw material is increasingly dominated by large- scale, industrial producers. The globalisation of the meat trade and the import of piglets have enhanced production specialisation but also increased dependence on international market conditions, particularly in Denmark and Germany. Consequently, the market structure has shifted, with greater regional differentiation in procurement levels- indicating that disparities in production intensity among voivodeships are now larger than they were at the beginning of the study period.

RQ2: Among the economic and environmental factors influencing regional changes in pig procurement, the most significant are the EU's agricultural policy, meat market globalisation, and the spread of ASF. The continuous pressure to optimise production costs, driven by rising input prices, has forced small farms to withdraw from pig production and led to the expansion of large- scale operations. Regions with intensive production have begun to face environmental challenges, such as water pollution and greenhouse gas emissions, necessitating stricter environmental regulations. EU subsidy systems and legislative frameworks (e.g., the Nitrates Directive) can mitigate these environmental impacts but also reshape the sector's structure, as compliance requires substantial and ongoing investments. The ASF epidemic has profoundly affected the structure of pig farming in Poland, restricting development in affected regions and raising biosecurity costs.

RQ3: The environmental and market consequences of regional concentration in pig production in Poland include:

- increased production intensity in selected regions, leading to greater groundwater contamination, higher greenhouse gas emissions, and local ecosystem overload;
- growing dependence on imported piglets, making the Polish piglet market more vulnerable to price fluctuations and policy decisions in exporting countries;
- ASF remains a major concern- new outbreaks undermine market stability, force herd culling, and raise production costs.

To mitigate the negative effects of regional concentration in pig production, the following measures are essential:

- continuous modernisation of farms- promoting, supporting, and subsidising the adoption of technologies that reduce environmental impacts, such as ammonia emission reduction systems;
- Implementation of a more effective ASF control strategy- enhancing animal movement control and wild boar population monitoring. As long as infection levels among wild boars remain high, ASF will continue to threaten domestic herds. Poland has struggled with this issue for 12 years, and its consequences for the sector remain severe.
- implementing the principles of sustainable development in the sector- encouraging production diversification to reduce import dependence and strengthen food security;

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- supporting less competitive regions– regional policies should include compensatory mechanisms and the promotion of alternative agricultural activities in areas negatively affected by the decline of pig farming.

Among the key implications is the recommendation to implement systemic support measures for modern farms and advanced technologies that can enhance the sector's competitiveness. Strengthening local producer groups is also essential, although their effectiveness has so far been limited, largely due to low farmer participation and engagement.

Limitations and Future Research

The authors acknowledge that an analysis based solely on secondary statistical data may not fully capture the local variability in livestock production conditions. This limitation arises in part because the procurement of pig livestock does not always directly correspond to the actual production volume within a given region. Another challenge concerns the uneven geographical distribution of procurement across voivodeships, leading to data asymmetry. As a result, this method may not fully reflect true regional disparities, especially in cases where a few voivodeships dominate in terms of procurement volume. A further methodological issue is the presence of outliers, i.e., regions with exceptionally high or low procurement levels, which may significantly affect both the mean and standard deviation, thereby distorting the classification results. Additionally, the applied approach does not account for local structural factors, such as the organisation of agriculture, the number of livestock farms, or the degree of urbanisation, which may result in the misclassification of regions with otherwise similar production conditions. For these reasons, it would be advisable to complement the present analysis with alternative quantitative methods to better assess the level and dynamics of procurement across voivodeships.

In Poland, there is still a lack of comprehensive, continuous research that systematically monitors the state of the natural environment in relation to the impact of agricultural activity, particularly animal production. This research gap hampers a full understanding of the magnitude of environmental pressures generated by intensive livestock farming on natural resources and local ecosystems.

One of the most pressing environmental issues is the increasing scarcity of water resources, particularly in the Wielkopolskie Voivodeship, which has one of the lowest water availability levels in the country. Meanwhile, a significant part of the country's pig production is concentrated in this region. This requires large amounts of water both for animal husbandry and technological processes. The imbalance between limited water resources and the scale of production may be one of the reasons for the slowdown in pig production growth in Wielkopolskie. It is worth noting that this province is also a leading producer of cattle and poultry, which further increases pressure on the local environment.

As highlighted by Gerber et al. (2013), the integration of livestock and crop production systems can reduce greenhouse gas emissions by 20- 30% compared with intensive farming systems. This provides a strong argument for limiting the concentration of livestock production. The authors emphasise that long- term research into the environmental and socio-economic impacts of production concentration and intensification is essential for improving agricultural policy design. Understanding these relationships can facilitate the creation of more sustainable rural development strategies that balance economic objectives with the protection of natural resources and the enhancement of rural quality of life.

The contribution of the authors

Conceptualisation, A.O. and A.S.K.; literature review, A.S.K., K.P. and J.S.; methodology, A.O.; formal analysis, A.O. and A.S.K.; writing, A.O., A.S.K. and K.P.; conclusions and discussion, A.O., K.P. and J.S.

The authors have read and agreed to the published version of the manuscript.

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REGIONALNE ZRÓŻNICOWANIE ZMIAN W SKUPIE ŻYWCA WIEPRZOWEGO W POLSCE W LATACH 1999–2022 W KONTEKŚCIE UWARUNKOWAŃ EKONOMICZNYCH I ŚRODOWISKOWYCH

STRESZCZENIE: Celem artykułu była identyfikacja i analiza regionalnego zróżnicowania zmian w skupie żywca wieprzowego w Polsce w latach 1999–2022 oraz wskazanie głównych czynników ekonomicznych i środowiskowych determinujących te zmiany. Badanie oparto na danych GUS, IERiGŻ–PIB, MKiŚ oraz GIW, wykorzystując statystykę opisową i porównawczą oraz metodę odchyleń standardowych od wartości średniej dla danego roku do oceny intensywności skupu w odniesieniu do powierzchni użytków rolnych. W badanym okresie wystąpiła koncentracja produkcji w wybranych województwach: wielkopolskim, pomorskim, łódzkim i mazowieckim, przy jednoczesnym spadku znaczenia województw zachodnich i południowych. Na zmiany wpływały czynniki ekonomiczne, w tym spadek liczby małych i średnich gospodarstw oraz import prosiąt, a także presja środowiskowa i ASF. Wnioski podkreślają potrzebę stosowania technologii chowu ograniczających wpływ na środowisko, skuteczniejszej strategii walki z ASF oraz stosowania zasad zrównoważonego rozwoju.

SŁOWA KLUCZOWE: produkcja trzody chlewnej, regionalizacja, intensyfikacja, ASF, Polska

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