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FACTORS AFFECTING CHANGES IN PRICES AND FARMERS' INCOMES ON THE POLISH PIG MARKET

Abstract

The paper presents market-based mechanisms underlying changes in pig prices and pig meat producers' income in Poland. The pig prices are determined by supply and demand equilibrium. Farmers are price takers and market price is a parameter which enables them to make economic calculation and verify their individual effectiveness.

This paper comprises also an empirical analysis of the factors affecting pig prices developments in 1997-2012. The analysis based on VAR models indicates that pig prices in Poland are determined mostly by the situation on foreign markets. In the long term, only around 30% of pig prices' variation in Poland depends on national conditions. The Granger causality tests proved that changes in the prices of pork in the marketing chain occur according to a pattern typical of a competitive market – the direction of price signals comes from producer prices towards consumer prices. The farmers margins in pork meat marketing chain have not changed over the analysed period – they fluctuated cyclically and seasonally around the level of 37%.

The collapse of pork production in Poland since 2008 has been caused mainly by structural reasons. Pig production in Poland is very fragmented in comparison with the other EU countries thus small economy of scale is reflected in farmers' low incomes. High cost of production per unit leads to deterioration of the price relationships between foreign and domestic prices and lowers demand for domestic pork.

Introduction

Analysis of market prices is one of the most important areas of economic research. This is due to the fact that prices are the foundation of the two basic principles of market mechanisms: the principle of the market equilibrium and the principle of optimisation (process of allocation and distribution). They de-

cide on the allocation of production factors and regulate production level (Kowalski A., Rembisz W. 2005). The equilibrium principle leads to a continuous adaptation through prices of the amount of products and services purchased by buyers to their quantity offered by sellers. While the principle of optimisation is related to the choice of the best possible variants of conduct by market participants making decisions about the production, sale or purchase of goods. In a theoretical sense it consists in maximising the consumer utility equilibrium between these entities.

Each market is characterised by a certain specificity. One of the more interesting is the pork market. The deregulation of food retail prices and agricultural purchase prices in Poland in 1989, as well as the withdrawal from the state purchase of agricultural commodities, changed the market conditions. It resulted in a stronger dependence of production changes on the market rules, i.e. supply, demand and prices. However, due to considerable price fluctuations, for many years the market was stabilised by a variety of market instruments that underwent modifications. In many cases, the use of instruments was enforced by farmers. After the Polish accession to the EU, regulatory instruments were adjusted to the ones in force in the EU.

Recent years are characterised by a slump in pig production in Poland. In 2007--2011, the total pig population in Poland decreased by 25.9%, while in the EU-15 the decrease was only 1.7%. In 2012, there was a further decrease in the number of pigs in Poland by 14.7%. In the 2007-2012 period, the population of pigs in Poland decreased by 36.8%, while in Germany there was an increase of 4.5%, in the Netherlands – 3.4%, in Denmark pig population decreased by 6.8% (Eurostat). In this context, the question arises: what is the basis for such a large decline in the Polish pig population when compared with small changes in the EU-15?

This issue has both a theoretical and a social dimension because of the importance of pig farming in Poland[1]. Then, from a theoretical point of view, it boils down to issues of market efficiency and competitiveness of its structures, as well as of entities operating there. As for the latter issue, these are often food industry and retail trade that are "accused" of using their market power to impose prices on scattered agricultural producers, which is supposed to lead to the lack of profitability of pig production.

The aim of this paper was to present the mechanisms underlying the observed changes in the prices of pork and pig producers' income in Poland. The issues of determining the market equilibrium, international price linkages and price formation in the food chain were also tackled. The above issues were connected with changes in supply, demand and economic efficiency of pig producers.

[1] In 2010, in Poland there were 397,700 farms conducting pig breeding and pork's share in per capita meat consumption was 60%.

Market equilibrium and theoretical determinants of pork prices and farmer incomes

The market can be defined as all the exchange relations between independent entities representing market supply and demand. Prices are determined, in a free market economy, through the interactions between supply and demand in the marketplace. Any change in one of the aforementioned three elements results in reactions of all the remaining ones.

Market mechanism is a game of supply and demand, which leads to an objective pricing of individual goods and evens the offered quantity of goods and the amount desired. The price is a result of changes in supply and demand, and the whole process of achieving equilibrium is based on mutual relationships of cause and effect between market participants. The essence of competitive equilibrium which determines the efficiency of the market mechanism (in the process of allocation and distribution) is that the entities that constitute the demand side and the supply side reach equilibrium, i.e. maximise their objective functions and do not reach a competitive advantage (Rembisz W., Sielska A., Bezat A. 2011).

The efficiency function of the market mechanism must also be emphasized taking into account the observed changes in the pig market in Poland. It consists in verifying the efficiency of individual economic entities with market standards of rational management. The essence of rational activity is to achieve a given objective at the lowest cost or to maximise a specific aim at stated cost level. Inefficient operators are, therefore, eliminated from the market, allowing for an increase in the scale of production in the case of other entities.

Theoretical description of agri-food market enables identification of three groups of entities whose interactions determine the market equilibrium. We can distinguish the perspective of the consumer, agri-food processor and agricultural producer. These viewpoints form a kind of a circular motion of interdependent entities. The behaviour of each of them determines the behaviour of the others (Rembisz W. 2007). In the case of pig and pork markets these relationships were shown using the scheme presented in Figure 1.

As it was already mentioned, in market equilibrium each entity maximises its objective function. The function of the agricultural producers is to maximise income. The aim of intermediary entities (processing and marketing) is to maximise profit. While the consumers' objective is to maximise their utility.

Always when assessing the possibility of increasing farmer incomes, constraints resulting from demand should be analysed first. Final (consumer) demand determines the conditions for a derived demand (processing) and it shapes demand for agricultural commodities (Fig. 1). It should be noted, however, that the demand for agricultural products is limited compared to the demand for industrial products and services due to low income elasticity of food demand. Also, a relatively low product innovativeness causes agriculture (including pork sector) to struggle with limited demand affecting income. In Poland, per capita pork consumption has remained at a similar level for several years. In this context, the most important way to rise the income of agricultural producers seems to be a growth in production efficiency resulting from an increased scale of production.

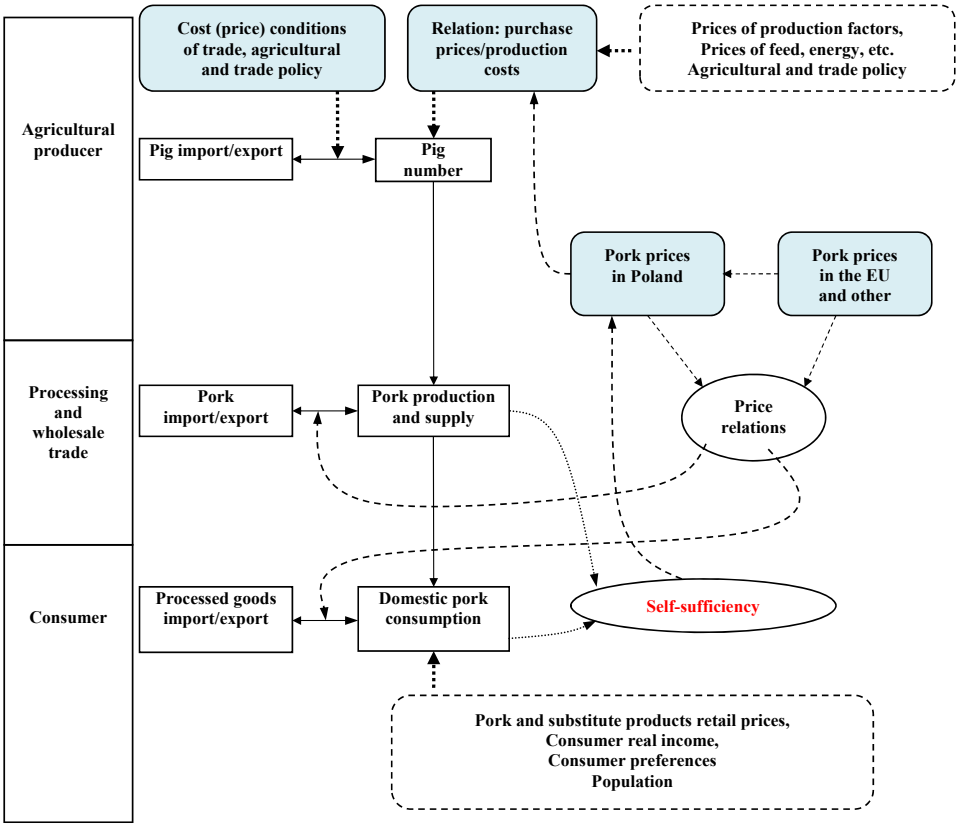


Fig. 1. Relations in the pork marketing chain defining market equilibrium
Source: Own elaboration.

Moreover, with economic development and growth in incomes occurs not only reduction in the share of food expenditure in total expenditure, but also a change in the demand structure. Demand for more processed products with higher utility values, which can be easily stored and quickly prepared for consumption, increases, while demand for products made in the traditional manner and unprocessed decreases.

Before becoming ready for consumption, agricultural products pass through many links in the marketing chain, where they are subject to multiple transformations (Świetlik K. 2008). The structure and length of the chain through which agricultural raw material and products made thereof go through is determined by various factors, such as type of commodity, market structures or level of the economic development. In each of the links in the marketing chain various activities are carried out in order to match agricultural production and food consumption in terms of type of product, place, time, quantity and quality. Activities in the marketing chain can be divided into several groups: supply of products from farmers to manufacturers; the manufacturing, and the distribution of fin-

ished goods through a network of distributors and retailers to a final customer (Heijman W. et al. 1997). The implementation of these functions is associated with incurring costs related to the used factors of production, and this generates the difference between the prices paid by consumers and the ones received by farmers for their products. The size of this difference called a marketing margin (e.g. processor margin and trade margin)[2] depends on the degree of product processing and market conditions. In general, processing and marketing margin includes market-verified costs and profits of companies operating in different links of the marketing chain (middlemen, processors, wholesalers and retailers). Margin is a source of financing of production and services involved in the enrichment of the agricultural raw material creating their value added.

In the developed economies trade and processing margins are major components of the retail price and constitute 70-75% of its level (Urban R. 2002). The share of agricultural production in retail prices of goods varies depending on the degree of processing. For example, in the United States it amounts to: dairy products – 36%, fresh fruit – 17%, fresh vegetables – 20%, bread and cakes – 6%, meat – 30%, poultry – 43% (Cramer G.L., Jensen C.W., Southgate D.D., Jr. 2001). In Germany, in 1990 it amounted to: meat and dairy products – 32.9%; bread and cereal products – 6.9% (Tomek W.G., Robinson K.L. 2001). Urban (2002) describes some similarities between the structure of food prices in the United States and Germany, in which the processing and retail margins are approx. 90% in the case of the products of grain processing, approx. 75% of the price of fats, fruit and vegetables, approx. 65-70% of the price of meat and milk, dairy products and potatoes.

Against the background of the presented observations arises the question of the linkage between the prices in the food chain. This issue is important in assessing the efficiency of the agricultural market. According to Gardner, in competitive market conditions and constant economies of scale determination of the equilibrium in three related markets: retail food and both agricultural and non-agricultural input, should be done in parallel (Gardner B.L. 1975). The flow of price impulses should lead from agricultural producer prices, through wholesale prices to retail prices. In fact, in shorter periods price changes at one level do not necessarily induce full price reaction at other levels, which results from, e.g. adjustment costs of market offer (menu cost) or stocks. It is also expected that the competitive market reactions of retail prices and wholesale prices to fluctuations of the farm prices should be the same (Meyer J., von Cramon-Traubadel S. 2004).

It can be concluded that in the short and medium term the farm prices are a result of sectorial conditions. Prices of live pigs and pork are a result not only of the changes in supply-demand relations in the country, but they are also affected by the market state in the other EU Member States, prices on world markets, as well as the efficiency and effectiveness of various links of the marketing chain.

[2] These differences are generally called marketing margin or farm-retail price spread (Figiel S. 2002; Rembisz W., Sielska A., Bezat A. 2011).

First, we will discuss the basic market mechanism conditioning cyclical price changes. A well-known feature of pig production are fluctuations of pig number, pig production and their prices, known in the theory of economics as pork cycle (or hog cycle). These fluctuations have their own mechanism different from business cycle (Małkowski J., Zawadzka D. 1995). In agriculture, particularly in the case of pig production, fluctuations in production and prices are widespread. This has its origins in the nature of the adjustment processes (*inter alia*, during the sequence of changes in production, demand and prices) (Ferris J.N. 2005; Ritson Ch. 1985; Tomek W.G., Robinson K.L. 2001).

Under conditions of perfect competition, market equilibrium is established at the point of intersection of the supply and the demand curves. In static market equilibrium, any disturbance activates economic adjustment forces that pull price back towards the equilibrium point. Due to the biological and technical nature of breeding pigs, the reaction of production to price changes is delayed. Both price and production may not immediately return to the starting point of equilibrium and will oscillate around it. Cobweb model is a basic theoretical model explaining the relationship between price and quantity over time, linked together by a recursive dependency (Ritson Ch. 1985; Tomek W.G., Robinson K.L. 2001).

Cobweb model is based on three assumptions which lead to cyclical behaviour of prices and quantities. The first one is that there is the time lag between the moment of the production decision-making and the moment when production is ready for sale. The second one is the assumption that farmers make decisions on the basis of current prices or prices from previous periods. This means that production is sold at new prices. The third assumption is that the market prices are resulting from the alignment of the current supply and demand. Based on these assumptions, three equations can be formulated. The first shows the current supply S_t, as a function of the prices of a previous period, P_{t-1}, i.e.: $S_t = f_1 (P_{t-1})$. The second assumes that production Q_t obtained at time t is sold S_t, i.e. $Q_t = S_t$. In the case of the pork market, this assumption is close to the real situation. The third equation determines the market price P_t at which the supply S_t equilibrates demand D_t, i.e.: $P_t = f_2 (S_t = D_t)$.

The cycle is a kind of a pattern that repeats itself regularly in several-year periods. Theoretically, the cobweb model can lead to price-quantity cycles with convergent, divergent or constant amplitudes (Ezekiel M. 1938; Ritson Ch. 1985; Tomek W.G., Robinson K.L. 2001; Woś A. 1996). The main feature of commodity cycles encountered in agriculture is their irregularity. This is due to the fact that spontaneous reactions of agricultural producers to the previous period prices each time create a different market situation in the next year. Psychological characteristics of market participants have a crucial impact on price dynamics in the short and medium periods. Time-varying market expectations of producers make their reactions difficult to predict.

In the open economy, prices in Poland are also influenced by the situation on foreign markets, which complicates, in a certain way, the picture of market dependencies. The flow of price impulses between countries is called horizontal

price transmission and is associated with the Law of One Price (LOP). It says that in the absence of obstacles to the movement of goods and non-discrimination of products, identical and homogeneous goods should have the same price, expressed in the same currency, and adjusted for the costs of transport and storage. Tendency for levelling of prices (within LOP) stems from the fact that arbitration does not allow to obtain extraordinary profits, becoming the cause of the price convergence (Figiel S. 2002).

Polish accession to the EU has changed economic conditions in which individual sectors operate. Lack of customs barriers enables free movement of goods between various local markets. This creates the possibility for purchasing raw materials on the markets with the lowest prices. In the absence of trade barriers, fluctuations in the production and supply, and prices on the separate local markets are converging. The research indicates that there is a clear gradual growth in interdependence and convergence of pork cycles in Poland in relation to Denmark and Germany (Hamulczuk M. 2007). Prior to joining the EU, Polish cyclical price changes were delayed by an average of three months compared to the same fluctuations in Germany and Denmark. Converging cyclical fluctuations on the pig market have a certain impact on the formation of market equilibrium on local markets, which results not only from the supply-demand relations in a given country (region), but also from market conditions in other countries. This means that there is a need for comparison of the effectiveness of economic operators (including farmers) not only at national, but also at international level.

Data and methodology of empirical research

Empirical studies were carried out in several areas. Firstly, an analysis of farm prices in Poland, the USA, Germany and Denmark (these are important markets for world exchange and trade with Poland) was conducted. The data source was the Central Statistical Office (CSO), the European Commission and the USDA. Prices were converted to the carcass weight and Polish Zloty (PLN) using the monthly average exchange rates of the National Bank of Poland (NBP). Then price changes in the pork marketing chain in Poland were analysed. This part of research was based on monthly prices paid to agricultural producers for livestock, retail prices of meat for selected cuts and indices of retail meat prices and CPI (all according to CSO). The final section assesses the changes in pig population, production and concentration of production on the basis of the data from CSO, Eurostat and the European Commission.

Econometric and statistical methods as well as tabular and graphical description were used in the empirical research. Below we present a brief overview of the key research methods applied. Some studies concerning monthly prices were based on the seasonally adjusted data[3]. To remove seasonality an automatic X-12-ARIMA procedure was used, which enables capturing the seasonality evolving in time. More on this subject can be found in the X-12-ARIMA (2011).

[3] Seasonality influences the results. Therefore, it must be eliminated or presented using other variables (parameters).

In order to assess stationarity of the variables several tests were applied: Augmented Dickey-Fuller test (ADF), generalised Dickey-Fuller test (ADF-GLS) and Kwiatkowski-Phillips-Schmidt-Shin test (KPSS). In the first two tests, the null hypothesis postulated non-stationarity of the analysed processes while in KPSS test the null hypothesis stated their stationarity.

In the ADF unit root test the equation is as follows:

$$\Delta y_t = \mu_t + \rho y_{t-1} + \gamma_1 \Delta y_{t-1} + \gamma_2 \Delta y_{t-2} + ... + \gamma_k \Delta y_{t-k} + \varepsilon_t \quad (1)$$

where: μ_t – deterministic component, ϱ,γ – parameters of the model, y_t – the value of the variable being analysed, ε_t – random component, k – the maximum lag and $\Delta y_t = y_t - y_{t-1}$ for $t = 1,2,....$ The significantly lower than zero value of parameter ϱ indicates stationarity of the time series y_t. Rejection of the null hypothesis completes the procedure. In the case of not rejecting H_0, the procedure is repeated for the first increases. The ADF-GLS test is a modification of the ADF test, which involves a two-step procedure. First, we include deterministic component (μ_t) using generalised least squares method, and then the residuals are assessed using the ADF test.

In the case of KPSS test (assuming no linear trend) y_t can be written in the form (Lütkepohl H., Krättzig M. 2007):

$$y_t = x_t + z_t \quad (2)$$

where x_t is a white noise process, $x_t = x_{t-1} + v_t$, while v_t, and z_t variables are stationary with the following properties: $v_t \sim IID\ (0, \sigma^2_v)$ and $z_t \sim IID\ (0, \sigma^2_z)$. Stationarity is tested based on two hypotheses: $H_0: \sigma^2_v = 0$ against $H_1: \sigma^2_v > 0$. Testing statistic for the model with intercept, has the form of:

$$KPSS = 1/T^2 \sum_{t=1}^{T} S_t^2 / \hat{\sigma}_\infty^2 \quad (3)$$

where: $S_t = \sum_{t=1}^{T} e_t$, $e_t = y_t - \bar{y}$, T – length of time series, and is an estimator of long-term process variance z_t (Lütkepohl H., Krättzig M. 2007).

Analysing the direction of price information flow the Granger causality tests were applied. The study was conducted on seasonally adjusted and logarithmic variables. The variable x is a Granger cause for variable y if the current values of y are better explained using the delayed and the current values of x than without them. This problem is discussed in detail in the paper by Charemza and Deadman (Charemza W.W., Deadman D.F. 1997). In this study, a procedure proposed by Toda and Yamamoto was applied to test causality (Toda H.Y., Yamamoto T. 1995). This procedure is insensitive to issues of stationarity and cointegration of variables.

This procedure includes the following steps (Toda H.Y., Yamamoto T. 1995):

1. Testing the integration degree of each variable (e.g. y and x), where the maximum order of integration is m.

2. Constructing vector autoregression model (VAR) for pairs of variables and selecting the optimal lag (p) based on information criteria and tests for autocorrelation of the random component – VAR(p) model.
3. Estimating extended VAR($p + m$) model.
4. Calculating the F statistic of the standard Wald test with the imposition of zero restrictions for the coefficients of the first p lags of exogenous variable x (and vice versa in the second equation). F statistic has a distribution asymptotic to c^2 distribution with p degrees of freedom. The null hypothesis assumes that the sum of the p coefficients by lagged values of x variable is equal to zero (equation 4). Rejection of H_0 means that the variable x is a cause, in the Granger sense, for variable y.

Two-equation VAR (vector autoregression) model for the variables x and y is (Lütkepohl H., Krättzig M. 2007):

$$y_t = \alpha_1 + \sum_{i=1}^{p+m} \beta_{1i} y_{t-i} + \sum_{i=1}^{p+m} \gamma_{1i} x_{t-i} + \varepsilon_{1t} \tag{4}$$

$$x_t = \alpha_2 + \sum_{i=1}^{p+m} \beta_{2i} y_{t-i} + \sum_{i=1}^{p+m} \gamma_{2i} x_{t-i} + \varepsilon_{2t} \tag{5}$$

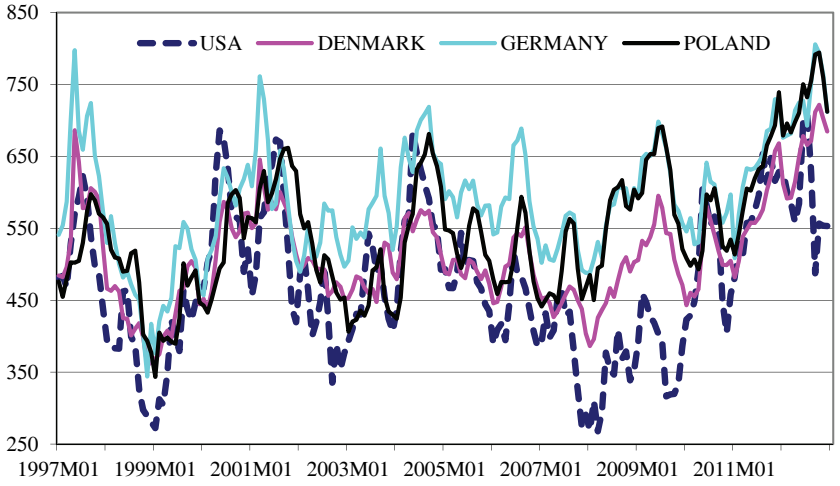
where: α, β, γ are model parameters, e_t – a random component, p – max lag in the VAR model, and m is the maximum order of integration. Number of lags (p) should be chosen so as to reflect the natural dependencies and to eliminate the autocorrelation of model residuals.

The VAR model was also the basis of analysis of the relations between world and Polish prices. Then it included a greater number of variables, *inter alia* the time variable. In this arrangement, the lag was set at p. Based on the structural form of the VAR model, decomposition of forecast errors was calculated. More information on the VAR methodology can be found in (Charemza W.W., Deadman D.F. 1997; Kusideł E. 2000).

Pig prices in Poland vs. European and world prices

In the open market economy, market prices are not only a function of domestic supply-demand conditions, but mainly of the situation on global markets (Hamulczuk M. et al. 2012). Integration with the European Union has strengthened these ties. Figure 2 shows the evolution of prices of pork in carcass weight in Poland, the selected EU countries and the USA. A big concurrency of prices is visible, but the differences between the prices during some periods are quite significant.

The relations between the pig prices in Poland and in the other EU countries are the most important factor for competitiveness. These relations for selected countries are shown in Figure 3. A value of 100 means that the price in Poland is equal to the price quoted in one of the countries of the European Union. Increase in the ratio indicates a deterioration of the competitive position of our country, and a decrease – its improvement.



Note: converted according to the monthly average NBP exchange rates, in the EU class E prices, in the USA Lean hogs 52 (May 1997 corrected due to unusual observations).

Fig. 2. Pig farm prices (carcass weight, PLN/100 kg)

Source: Own elaboration based on CSO, the European Commission and the USDA data.

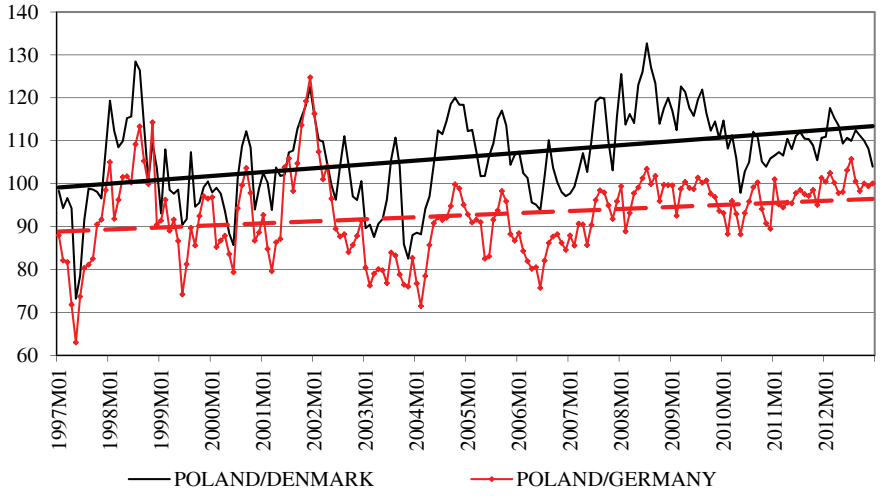


Fig. 3. Polish prices in relation to Danish and German prices

Source: Own elaboration based on data from Fig. 2.

The trends shown in Figure 3 indicate a systematic deterioration of price relations. Polish pig livestock is becoming less attractive on the European market in terms of its price. As of 2000, prices of pigs in Poland are higher than the prices in Denmark (currently over 10%) and the price level in Poland is steadily approaching the price level in Germany. It is not shown in Figure 3, but in 2012 prices in Poland were also by about 8-10% higher than in Belgium, the Netherlands and France. This justifies the economic growth in import of pig meat from these countries. Import of pork and live animals from these five countries, in 2012, accounted for approximately 90% of total imports of live animals (Rynek mięsa... 1997-2013).

Price relations are characterised by significant fluctuations around trends shown in Figure 3. Fluctuations in relative prices are a result of many factors: fluctuations in exchange rates, shifts between the cyclical price movements in individual countries or trade policy instruments (before integration). It can be seen (Fig. 3) that after the Polish accession to the European Union the amplitude of fluctuations around the trend was reduced. This could be one of the symptoms of the increase in price convergence and the growing convergence of pork cycles (Hamulczuk M. 2007).

In the next step a more detailed analysis of the relations between Polish, European and world prices was conducted. For this purpose causality tests and VAR methodology were used. The aim of the study was to answer the questions of the direction of flow of price impulses and to determine the extent to which prices in Poland depend on the situation on the world markets. As seasonality deforms the picture of these dependencies, the study was based on seasonally adjusted data (X-12-ARIMA method). The data was also transformed into natural logarithms because in the case of three out of four time series (except the Polish prices) relations between time series components were closer to multiplicative than additive ones (automatic selection of X-12-ARIMA model).

Analyses began by testing the degree of integration of the time series (seasonally adjusted and log). Three tests (ADF, ADF-GLS and KPSS) were used and the results obtained quite significantly differed from each other. Generally, the unit root tests are very sensitive to the number of lags. Assuming a maximum lag of four months, most of the tests indicated a lack of stationarity of time series. However, with the increased number of potential lags to 8 (optimal lag in the light of the Akaike criterion was five months in the case of Danish prices and 6 months for other prices), the results radically changed. For example, in the case of ADF-GLS test with the intercept, it can be inferred that all of the time series are stationary. Taking into account the trend in the equation, H_0 of the non-stationarity is rejected at a level of 0.05 for Polish prices and at a level of 0.1 for the other time series. In the case of the KPSS test with the intercept, the null hypothesis of stationarity was not rejected ($p = 0.05$) for time series of Danish and US prices, and rejected for Polish and German prices. The inclusion of the trend into the equation results in opposite conclusions to those obtained in the KPSS model with the intercept.

Thus, the stationarity of the variables stands in question. There is a high probability that these are fractionally integrated time series. Thus, it is not known whether VAR or VECM model would be more appropriate in further analysis. The first model is used in the case of stationary variables (or transformed to stationary) and the second one in the case of integrated and cointegrated variables[4].

In the next step, the Granger causality test was conducted to check the dominant direction of flow of price impulse. In the light of the literature (Hamulczuk M. 2007; Rembeza J. 2007) and the market, it should be expected that the world prices influence the Polish prices, not in the opposite direction. This was verified using Toda and Yamamoto test (T-Y), which was not previously used in the analysis of pork prices in Poland. In this test, apart from optimal lags (Table 1) under the Akaike criterion (or their modification based on the assessment of ACF and PACF graphs), one more lag was added because of the potential non-stationarity of time series.

Table 1

Results of Granger causality test (T-Y test, Wald variant)

Lag	Cause	Resullt	*F* statistic	*p* value	Cause	Results	*F* statistic	*p* value
5	Poland	USA	1.041	0.401	USA	Poland	2.102	0.055
7	Poland	Germany	1.656	0.123	Germany	Poland	4.413	0.000
7	Poland	Denmark	1.555	0.152	Denmark	Poland	4.865	0.000
2	USA	Denmark	3.008	0.052	Denmark	USA	4.449	0.013
5	USA	Germany	2.476	0.034	Germany	USA	0.996	0.421
5	Denmark	Germany	1.176	0.323	Germany	Denmark	1.558	0.175

Source: Own elaboration.

The T-Y test results (Table 1) confirm expectations that prices in Poland are shaped by the American, German and Danish prices. Most often the cause, in Granger sense, for other prices were Danish and American prices. In the light of two-way testing, it can be assumed that these two markets have the largest degree of influence on the world prices.

In the next step, the VAR model was constructed for these four time series. A time variable was also included in the model. Optimal lag according to Akaike criterion was 2 months (the other criteria indicated 1 month). In two equations there was statistically significant autocorrelation, hence the number of lags was increased to four months[5]. The fact that the VAR model is adequate to describe

[4] Assuming that variables are non-stationary (integrated to the 1st degree) Johansen test was used to assess presence of long-term dependencies between time series. In a model (with 1 lag according to Akaike criterion) without an intercept, there is one cointegrating vector, while in a model with a restricted intercept there are two cointgrating vectors. These results show that Polish and world prices may be characterised by some common long-term trends. While in a model with unrestricted intercept there is a maximum rank of a matrix (four vectors). The last case suggests that time series can be stationary, implying the use of VAR model.

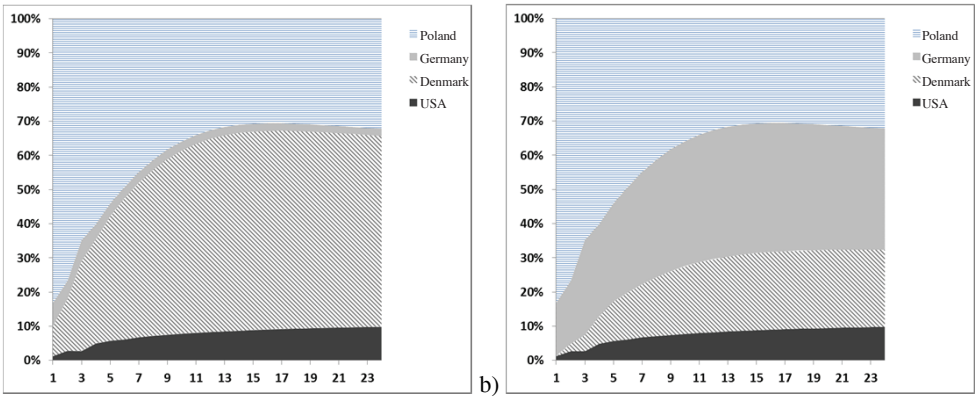
[5] Increasing the number of lags significantly improved the stability of parameters over time.

these relations, *inter alia*, is proved by the parameter stability confirmed by the graph of characteristic roots of the VAR model equations.

The application of this model allowed to obtain, *inter alia*, a graph depicting decomposition of forecast errors, which shows the contribution of particular variables to explaining the errors of a variable in question. In other words, it points to the potential sources of variability of individual prices depending on the time horizon. Decomposition of forecast errors requires structuring the model and it is quite sensitive to ordering variables. To rank variables it is possible to use either researcher's knowledge and conclusions stemming from the causality analysis (Table 1) or an assessment of causality (exogeneity) based on the estimated VAR model.

In the light of causality tests (Table 1), variables representing the pork prices can be ranked as follows: Denmark, the USA, Germany, Poland. This seems to be quite a logical sequence showing the direction of price impulses. However, in the light of the estimated VAR model, it is difficult to specify the order, because all variables are important in explaining American prices, Danish prices depend on American and German prices, German prices depend on American prices (and to a lesser extent, on Danish prices $p = 0.09$), and Polish prices depend on all prices. Thus, in this case German market becomes crucial in the process of price transmission, hence there can be also a different ranking of variables: Germany, Denmark, the USA, Poland.

Figure 4 shows the decomposition of forecast errors for Polish prices based on the VAR model with 4 lags for two variants of variables ranking. General conclusions, regardless of the model, can be formulated as follows: procurement prices of pork in Poland in the long term depend on national conditions in only up to about 30% and the rest of their variability is determined by the situation on foreign markets. Only in the perspective of four-month period domestic factors outweigh the global factors.



a) Denmark, USA, Germany and Poland; b) Germany, Denmark, USA and Poland.

Fig. 4. Variance decomposition of forecast errors for pork prices in Poland (VAR model with a trend, 4 lags)

Source: Own elaboration based on data from Fig. 2 (seasonally adjusted and log data).

Pork prices in the marketing chain

The phenomenon of decreasing share of food expenditure in the total expenditure of households is observed in all countries in the world. For example, in Poland the share of household food expenditure decreased from 38.3% in 1995 to 25% in 2011 (Rocznik Statystyczny 1995-2011). This share is a derivative of the wealth of countries and households, and with the increase in wealth, the food share decreases. According to Eurostat data, in 2011 the share of expenditure on food was the lowest in Luxembourg (10.6%), the United Kingdom (11.8%), Austria (12%) and Germany (12.1%), while the highest was in Romania (35.4%) and Lithuania, Latvia and Estonia (23.3-25.9%). In 2011, in Poland according to HICIP methodology the share of food expenditure in the total expenditure amounted to 21.4%.

This regularity is accompanied by a slower rate of increase in food prices relative to the prices of other goods. During the last decades prices of agricultural commodities (last five years were the exception) were rising even more slowly. Figure 5 shows the growth rates of prices of live pigs, pork retail prices and consumer prices (CPI). It may be noted that in the 1997-2012 period retail prices in the economy (CPI) grew faster than the prices of live pigs and retail prices of pork. This is a typical trend occurring in developed economies. The prices of industrial products or processed agricultural products grow faster than the prices of agricultural commodities (Rajtar J. 1988; Ritson Ch. 1985; Stańko S. 1999), causing certain consequences for the development of income of agricultural producers.

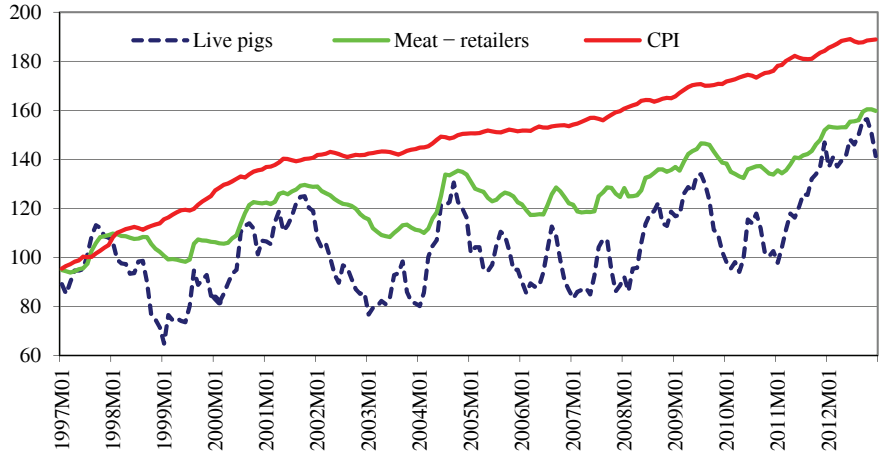


Fig. 5. Dynamics of pig purchase prices, retail pork prices and CPI (year 1997 = 100)
Source: Own elaboration based on CSO data.

Theory of price margins states that the retail price consists of the value of the agricultural commodities used and the value added that contains the costs and profits of processors and trade entities (Figiel S.; Heijman W. et al. 1997; Tomek W.G., Robinson K.L. 2001). Although the theoretical issue of marketing margins is generally explained, the problem is their empirical estimation. This is due to insufficient public statistics in this field (Urban R. 2002). The difficulties stem from the fact that we do not know what is the quantity and the sort of raw material utilised in the final product. In the case of pork products (especially those processed) we do not know how much meat and which cuts of the carcass are in the final product. We also do not know the value of individual elements of the carcass at farm level.

Thus, in empirical research we use certain estimates and assumptions. It is better to assess price relations. This does not change the picture of reality in the short term when the combination of the raw material in the final product is constant (it is not entirely realistic, but there is no other reliable data). Such analyses can be performed for aggregates (sector or basket of products) as well as individual products (e.g. pork, ham, bacon, etc.).

Due to publication limitations only margins for raw meat at an aggregated level were analysed. In order to determine the share of the agricultural producer in the retail price of pork a conversion factor used by the CSO was applied to convert live weight into carcass weight. The conversion factor for live pigs is 78% (Metodyka szacowania... 2008). It allows to express the prices of life pigs in carcass weight. In 1997, the average price of live pigs in carcass weight amounted to PLN 4.86 per kg. In order to determine the share of raw materials in the retail price of meat, a basket of meat products was created including: shoulder, loin with bone and ribs. The average value of retail prices was adopted as the initial value of the basket of meat (in 1997). The value of the basket in 1997 amounted to PLN 10.49 per kg. Changes in the basket's retail prices in 1997-2012 were consistent with the CSO's indicators of retail pork meat prices presented in Figure 5.

Figure 6 shows the evolution of the share of agricultural raw material as well as processing and retail margins (total) in the retail prices of pork meat. In 1997-2012, the share of raw materials in retail prices was in the range of 28-47% depending on the pork cycle (average – 36.9%). The farmers' share in retail prices of pork is higher, when prices of live animals are higher and vice versa. There must, therefore, be periods when prices are lower than the costs and the periods in which there are windfall profits (gained by producers, processors or traders) on the product.

In the analysed period a declining tendency in the farmers share in retail prices of pork was not observed. In 1997-2004, the average share of used raw materials in retail prices was 37.63%, while in 2005-2012 – 36.12%. Similar results were also obtained by Seremak-Bulge (2012). It can be written that the farmers share in the retail price of pork meat is on the level characteristic of developed countries.

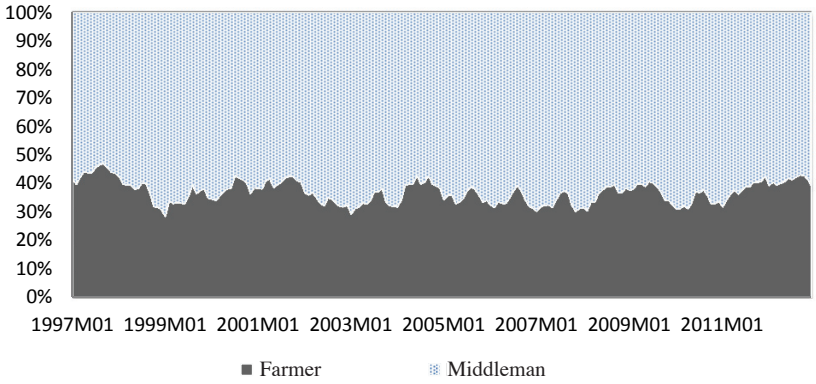


Fig. 6. Farmer and middleman share in the retail price of pork
Source: Own elaboration based on CSO data.

Another way to analyse the relations between pig producer and further links of the marketing chain is the assessment of price impulses, known in the literature as price transmission. The analyses of vertical price transmission enable answering the questions: if, to what extent and after what time changes in the prices in agricultural raw materials lead to changes in processed products and retail prices. Its aim is to identify the potential basis for using market power by the entities from further links of the marking chain. In competitive market it is expected that prices in the further links of food marketing chain respond to prices in the prior links of it.

The basic condition for the absence of competitive advantages is the signal flow from agricultural producer prices to retail prices. To verify that hypothesis in the pork marketing chain, the Granger causality test was used as proposed by Toda and Yamamoto (TY) (1995). Optimal lag for variables (Akaike criterion) is 3 months and it was increased by one month because most of variables contain single unit-root. The values of F statistics and p-values in the T-Y test are as follows: $F = 1.73$, $p = 0.16$ (restrictions on retail prices in the model of live pigs prices) and $F = 25.97$, $p < 0.01$ (restrictions on live pig prices in the model of retail prices). The high value of the test statistics in the second equation shows that the past values of prices of live pigs contribute significantly to explaining the current value of the retail price. Opposite direction of the relation is statistically insignificant. Similar results were obtained by Rembeza (2010) with the use of the model based on first differences of variables.

Another issue is the testing of asymmetric pricing behaviour. It is expected that the reaction of retail prices to increases in prices of agricultural raw material, as well as to their decreases, will be the same. Due to the paper size limitations authors can only present the results of other studies. Rembeza (2010) indicates no statistically significant asymmetry effect. If this is the case then there is no basis for concluding that pork market in Poland operates inefficiently in terms of information flow and that further links in the marketing chain exploit farmers by overtaking the surplus produced in the agriculture.

Changes in production and foreign trade in pork

The number of pigs in Poland is characterised by a downward trend. In 1997--2007, the annual rate of decline was 1.5%. Despite the decline in livestock size, slaughtering (about 0.8% per year) and meat production (by 0.7% per year) were characterised by a positive trend. This resulted from an improvement in the speed of herd rotation. The result of these processes was improvement in the ratio of meat production to the size of the pig population.

A large reduction in the number of pigs occurred in 2008-2012. In this period it was on average decreasing by 7.2%. Such rapid decline resulted from a deterioration of the profitability of production. In these years, breeding pigs was completely given up by a significant number of farms, especially the ones with a small-scale production. Despite the large drop in population, pig slaughtering decreased by 5.9% and pork production by 3.6% on an annual average. This was due to further improvement in the speed of herd rotation and rapidly rising import of live animals (Fig. 7).

Before the EU integration, import of live animals averaged 1.6 thousand animals a year and export amounted to about 22 thousand. As of 2004 import of live animals is characterised by high dynamics (Fig. 7). In 2004, it amounted to 234 thousand animals, in 2009 to 1,997.6 thousand, in 2011 to 2,798.4 thousand (Rynek mięsa wieprzowego 2013) and in 2012 already to 3,735.6 thousand (Handel zagraniczny... 1997-2013). This means that in 2004-2012 the import of live pigs increased almost 16-fold. At the same time, export of live animals was characterised by a decreasing trend. Growing import of pigs, dominated by piglets, is due to different reasons. The basic ones include good feed conversion affecting weight gain and high meat content of porker in the post-slaughter classification.

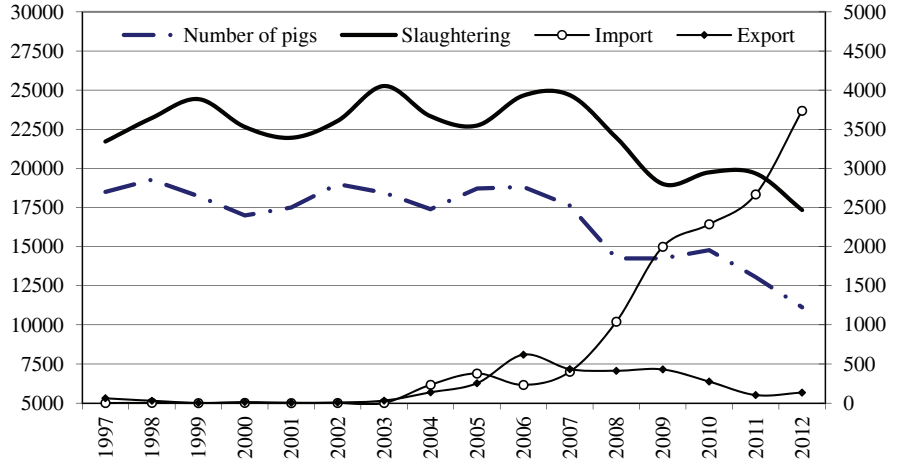


Fig. 7. Pigs number, slaughtering (left axis) and foreign trade in live pigs (right axis) in Poland in 1997-2012 (thousand)

Source: CSO data, (Handel zagraniczny... 1997-2013) and (Rocznik Statystyczny 1995-2011).

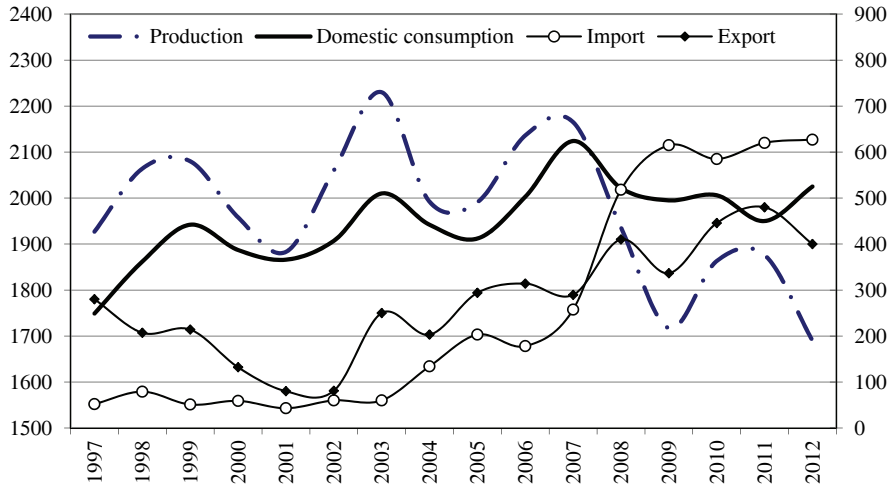


Fig. 8. Production, trade and domestic consumption of pork in 1997-2012 ('000 tonnes)
Source: CSO data, (Handel zagraniczny... 1997-2013) and (Rocznik Statystyczny 1995-2011).

Dynamic changes also occurred in the trade of pig meat (Fig. 8). In the 1997--2003 period, pork import was relatively stable and amounted to approx. 39.2 thousand tonnes. In 2004-2012, pork import increased by 69.7 thousand, i.e. by 23% per year. Such a high growth meant that in those years the imports of pork increased 5.7-fold, and in relation to 2003 – 12-fold. Export in this period also increased, but at a much slower rate, on average, by approx. 21 thousand tonnes, i.e. 8.8%. Such trends in trade resulted in an increase in the negative balance of foreign pork trade in Poland as of 2007. In 2012, main suppliers of pork to Poland were: Germany (29.3%), Denmark (24.1%), Belgium (21 %), the Netherlands (11.8%), the United Kingdom (4.6%), Spain (4%) and France (3%). In 2012, Poland imported from these countries 569 thousand tonnes (97.8% of total import of pig meat).

A question concerning the causes of the significant reduction in the number of pigs in Poland can be formulated. It can be assumed that in a market economy it is not possible for agricultural producers to influence the prices of products sold and the price is an external constraint, to which they must adapt. Polish agricultural producers compete with agricultural producers in other countries of the EU. Due to the deterioration of the relative prices of pork in Poland to the prices in Western Europe (Fig. 3) processors began to use cheaper raw material from those countries. Such behaviour is fully rational, because it maximises their objective function.

Another question concerns the causes of the deteriorating price relations. The relative economic and organisational challenges of production efficiency should be indicated here. Production efficiency and labour productivity in pig production are determined, *inter alia*, by the scale of production. In recent years, there have been significant changes in the concentration of pig production in the EU.

This has been done by reducing the number of pig producers and increasing the average herd size (Table 2). Herds of more than 1,000 pigs dominate in the case of major exporters of meat and live pigs to Poland. At least 3/4 of the total number of pigs (with the exception of Germany, where such herds have almost 2/3 of population) are in such herds. In these countries, pig production in small herds (less than 200 pigs) has a negligible share (from 0.3% in Denmark to 4.9% in Germany). In Poland production in small herds dominates (Table 2). The average number of pigs per farm in Poland amounted to 39 pigs in 2010, while in Germany it was 459 pigs and in Denmark – 2,598. It should also be noted that in 1997-2010 this gap rose.

Table 2

Structure of pig population according to herd size in the EU-15 and Poland in 2010

Country	Herd size in 2010				Number of pigs per farm	
	<200	200-399	400-999	1000≤	1997	2010
Poland	52.8	11.1	10.8	25.3	16[a]	39
Greece	19.0	6.2	11.3	63.5	45	49
Portugal	10.4	3.0	6.9	79.7	18	38
Austria	15.5	22.0	48.8	13.7	37	86
Germany	4.9	6.3	25.2	63.6	118	459
Finland	4.0	11.4	30.7	53.9	239	657
Luxembourg	1.3	5.5	27.0	66.2	138	598
Sweden	1.9	3.0	15.2	79.9	277	894
Spain	3.1	2.8	12.4	81.7	69	354
United Kingdom	2.6	2.9	11.9	82.6	557	445
France	1.9	4.2	17.1	76.8	198	569
Italy	3.4	1.5	5.6	89.5	33	356
Belgium	1.0	3.1	18.3	77.4	629	1,092
Holland	0.7	2.3	8.8	88.2	723	1,743
Denmark	0.3	0.6	3.6	95.5	605	2,598
Ireland	0.6	0.5	2.4	96.5	858	1,253

[a] 1996.

Source: Own elaboration based on Eurostat data.

Breeding pigs in larger herds can reap the benefits of economies of scale. This is confirmed by the estimates of unit costs. They show that an increasing scale of production leads to:

- gradual increase in the sale price,
- decrease of the total cost of production per 100 kg, mainly by reducing the indirect costs,
- reduction in the labour intensity of production (Skarżyńska A., Jabłoński K. 2012).

In this context, it seems that the main way to increase domestic production and incomes of agricultural producers is to increase the concentration of production. This is confirmed, e.g., by Rembisz (Rembisz W., Sielska A., Bezat A. 2011) indicating an increase in labour productivity as the main source of improvement in this respect. If we assume that the annual production of 400 pigs per farm (level similar to Germany) guarantees parity income. Therefore, to obtain the slaughters at the level of 20 million pigs per year in Poland, 50,000 farms will be sufficient. In Poland, in 2011 there were over 350,000 pig farms. Thus, the main problem is to carry out structural changes. There must be conviction among pig producers that this improvement in efficiency is the only way to increase income and not look for non-market sources (political rent-seeking). Large reserves exist in reproduction progress, intensity and effectiveness of nutrition and improving the quality of pig carcasses. These are the factors leading to the Polish production being more expensive than in other countries, despite lower labour costs.

Reducing the production of pigs for slaughter may also have an economically positive impact as lower pig production means lower consumption of cereals – the main fodder in their diet, which has a positive effect on the Polish grain balance. Grain "saved" in feeding the herd can be effectively used in the production of poultry meat. On average, nearly twice more grain must be consumed per 1 kg of pork production than per 1 kg of poultry meat. There may also be positive environmental effects that are not accounted for in the classical economic calculations.

Summary

The market mechanism is underlying economic processes that are taking place in Polish economy. By the relations between supply and demand equilibrium price is determined, which is a parameter for producers enabling them to prepare economic calculation and being a verifier of individual effectiveness.

Pig market is characterised by significant fluctuations in prices and production. This is due to a specific nature of the market related to the pork cycle. Producer reactions to prices from the previous period lead to the formation of a different market situation in the next year, mostly unintentional. The income risk for pig producers is also related to it.

Pork prices in Poland are mainly a function of world and European prices, while the impact of domestic conditions on the price of pork is small. In 1997--2012, the relations between Polish and Danish and German prices deteriorated, which caused a decrease in the attractiveness of Polish pork not only on foreign markets but also on the domestic one. Hence, in Poland we observe an increase in import of pork.

The analysis did not lead to stating any decline in the share of agricultural producers in the retail prices of raw pork meat. Price transmission analysis also did not provide evidence leading to a conclusion that the processors or retailers use their power in relation to agricultural producers taking over the surplus produced by farmers.

The collapse of pig production in Poland in 2008 led the country to become a net importer of pork. Structural reasons played the main role in this drop in production. Pig production in Poland is very fragmented in comparison with countries from which Poland imports pigs and pork meat. Production in larger herds allows farmers to gain the benefits of economies of scale, which is important in the conditions of the common market, with a similar level of market prices. Hence, the most important challenge for the Polish pig production is restructuring the sector.

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