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VOLATILITY OF MILK PRICES AND THE FORMATION OF THE SURPLUS ON THE SELF-FINANCING OF INVESTMENTS IN DAIRY FARMS

Abstract

The article is devoted to a research on the development of the surplus on the self-financing of investments on farms specialising in milk production. The study used model farms built on the basis of FADN information on average production and economic parameters of average dairy farms. In order to obtain the distribution of the expected value of the surplus on self-financing of investments, the milk price was given stochastic character and simulations using the Monte Carlo method were concluded. The results show that for all farms the average expected value of the surplus in 2016-2020 will be lower than in 2013. The level of surplus on the smallest farms can only allow for investments with a very low value. Economically stronger farms will be able to increase their production capacity by development investments.

Keywords: dairy farms, investments, self-financing surplus, income risk, price volatility.

JEL codes: Q12, Q11, Q14.

Introduction

Farms – just like any economic entity operating on the market – have to develop. Financing agricultural activity is characterised by certain specific features. The dependence of agricultural production on climatic factors, seasonality of economic processes and major discrepancy between time of incurring inputs and time of achieving products cause that the decisions of farmers are taken in the conditions of incomplete information, thus achievement of effects involves

major risk. These characteristics are very important especially with the view to long-term financing, mainly given high risk of changes in cashflows of farms financing their development from internal sources (financial surpluses) and external sources (bank loans and subsidies under the EU programmes). Despite incentives from the state and the EU to develop farms, farmers have to remember about changes in prices for products manufactured on farms. Price fluctuations are especially dangerous for the financial condition of specialised farms whose range of products is very narrow. Polish dairy farms are an example of such entities; in the last two decades they have went from free market operations in the 1990s through production limits in the form of milk quotas and price protection, upon entry into the EU, all the way to abolition of production limits in 2015. These serious reforms were accompanied by changes on the very farms, mainly linked to incurring high capital expenditures enabling to increase production scale and meet the EU requirements as regards environmental protection, animal welfare and food security. These investments will still be indispensable, given the need to compete on the international market in order to reduce production costs and increase production potential of farms.

Objective, data sources and research methodology

The paper aims at determining the development of investment opportunities from internal sources on farms of different economic size specialising in milk production between 2016 and 2020. The research intentionally ignores State aid, which is *ex post* financing, i.e. financing granted after incurring costs on investment implementation on the farm, therefore, finding the surplus for investment self-financing largely determines the investment intentions of a farmer. Knowing the likely directions of changes in the self-financing opportunities of economic development is important both from the perspective of farm owners and institutions ensuring external financing sources for investments realised on farms.

Research covered farms monitored by the Polish FADN whose type of farming is dairy cows (type 5 TF8). The time frame covered two periods from 2010 to 2013 and from 2016 to 2020. In the first period, analysis covered amount of capital expenditures and their sources of financing on farms specialising in milk production in 2010-2013. The second analysis period concerned estimation of the impact of changes in milk prices on the possibilities of generating surplus on investment self-financing. Prospective research were conducted based on model farms which were structured relying on technical and economic information about farms taking part in the Polish FADN in 2013 (Goraj et al., 2015). Five basic models of farms were constructed which differed by economic size. The constructed models were based on FADN information about average resources at the disposal of farms, their production structure and amount of costs and prices of products manufactured in 2013.

Model farms differed materially between each other as regards production potential and achieved results (Table 1). Along with a growth in their economic size, the cow herd and total flow balance also grew, while the importance of total assets dropped. On smaller farms, payments accounted for nearly 80% of income, while on larger farms this level was around 23%. Larger farms were characterised by higher share of long-term liabilities in the capital.

Table 1

Basic parameters of model farms in 2013

Specification	UoM	Farms				
		very small	small	medium small	medium large	large
Economic size (standard production)	EUR thousand	2≤EUR<8	8≤EUR<25	25≤EUR<50	50≤EUR<100	100≤EUR<500
Number of cows	unit	3	9	19	34	69
Own and leased utilised agricultural area	ha	6.71	14.44	25.24	44.14	86.71
Total output	PLN thousand/ ha	3.62	5.18	6.86	8.59	10.71
Family farm income	PLN thousand	11.19	31.78	72.45	160.76	400.34
Share of total subsidies in family farm income	%	79.85	60.85	43.48	32.56	24.31
Total flow balance from a farm	PLN thousand	15.33	34.44	68.78	112.22	228.03
Equity	PLN thousand/ ha	16.38	20.58	23.39	26.12	27.31

Source: own study based on Goraj et al. (2015).

The constructed models were verified in respect to the economic results achieved in the reference year (2013) to results of farms of corresponding economic size participating in the Polish FADN. This allowed to conduct another research stage linked to analysis of the impact of changes in prices, costs and payments on the economic results of farms.

The research took into account the direct payment scheme applicable in 2015--2020, considering single area payment, greening payments, coupled payments and redistributive payment. To keep the differences between farms in the reference year, chain indices were used to determine the amount of prices and costs in respective years of the analysis. Prices of products and means of production in 2014 and 2020 were determined on the basis of ratios of their changes against the previous year, using the data published by the Institute of Agricultural and Food

Economics (Seremak-Bulge, 2015; Abramczuk et al. (ed.), 2014) and the Central Statistical Office of Poland (*Główny Urząd Statystyczny*, *GUS*). In case of diesel oil, World Bank forecasts were used (World Bank Group, 2016). As noted before, prices of products manufactured on farms were taken on a varied level considering the forecasts of the European Commission for 2015-2025 (European Commission, 2015). The value of capital instalments of repaid bank loans, interest and on-farm consumption was adopted as a constant at the 2013 level.

Taking into account the restrictions of the deterministic model in estimation of the future economic phenomena, it was decided to apply stochastic simulations using the Monte Carlo method. By making selected input data random, it is possible to observe the full range of results achievable on farms. Research usually uses a small number of variables. For dairy farms, milk price is the basic/core random variable and the selection of other variables depends on the research objectives (El Bennii Finger, 2013; Shalloo et al., 2004; McDonald et al., 2013; Neyhard et al., 2013). Polish research concerning the future economic situation of farms, which considered the random characters of selected variables, most often took as independent parameters prices and crop yields (efficiency and unit) of products manufactured on farms (Kaczocha et al., 2003; Majewski et al. 2007; Kołoszycz and Wilczyński, 2015; Sulewski and Czekaj, 2015). This study takes milk prices as the random variable. Distribution of this variable was estimated on the basis of historical GUS data from 2004 to 2015. The research uses triangular distribution which was the best suited type of distribution to the actual data based on the used Akaike Information Criterion (AIC=-131.10). The @Risk6.0 software was applied to determine the distribution of the self-financing surplus of a farm in the future. For each farm 10 thousand iterations were conducted; this allowed to precisely determine the probability distribution of the surplus for investment self-financing in respective years.

For comparisons over time, the expected value of the surplus for investment self-financing was used which was calculated according to the following[1]:

$$E(NS) = E(D_{gr}) + A - D_i - R_k - K$$

where:
$E(D_{gr})$ – expected value of family farm income;
A – depreciation;
D_i – payments to investments;
R_k – loan instalments;
K – consumption of farmer family.

[1] The research focused on the investment opportunities resting in farms and effects of payments to investments were not considered. Taking into account such support in the farm income, increases the amount at the farm's disposal; hence, the amount of payments to investments was deducted upon calculation of the value of expected surplus for investment self-financing.

The surplus for investment self-financing defines the amount of funds that can be allocated as own contribution in the investment process. It is the value of funds at the disposal of the farmer after repayment of capital instalments and after transfer of some part of funds for consumption of the farmer's family.

The expected value of family farm income $E(D_{gr})$ was calculated according to the following:

$$E(D_{gr}) = \sum_{i=1}^{n} E(P_z) + P_r + P_p + D_o - Z_p - A - K_{cz} + D_i$$

where:

$\sum_{i=1}^{n} E(P_z)$ – sum of the value of expected production from *i*-th activities under the animal production branch;

P_r – value of plant production;

P_p – value of the remaining on-farm production

D_o – payments to operating activities;

Z_p – direct consumption;

A – depreciation;

K_{cz} – external costs of factors of production;

D_i – payments to investment activities.

The expected value of animal production on farms was calculated as per the following:

$$E(P_z) = E(S_m) + S_z + S_{ppz}$$

where:

$E(S_m)$ – expected value of returns on milk sales (calculated as the product of the number of cows and their productivity and milk prices);

S_z – returns on sales of cattle;

S_{ppz} – other returns on sales of animal production.

Specification of production and investment conditions on dairy farms

European market of milk production is a market hedged by many legal regulations. From 1984 to 2015 the EU used the milk quota system. It was introduced to stabilise the situation on the milk market in the European Union. The key advantages of the system include, upholding the milk prices and growth in farmer income as well as protection of farms in the less-favoured areas. The fundamental flaw of the regulation was slowdown of production concentration processes and structural transformations on the milk market and hindering the process of milk production polarisation (Malak-Rawlikowska,

2006). Abolishment of the quota system on the market and introduction of the so-called milk package caused a growth in production and a drop in milk prices as of 2014, which was predicted in former research (Helming and Berkum, 2008; Patton et al., 2008; Baer-Nawrocka and Kiryluk-Dryjska, 2010). A crucial factor affecting the level of income on farms is a change in the principles of awarding direct support which are targeted primarily at support to producers of lower production potential. This is to improve their development possibilities by supporting income of specific types of farms (Wilczyński et al., 2016; Potori et al., 2013).

Upon abolishment of the quota system in the EU and strong market protection, the milk industry in the country should be analysed primarily from the perspective of the global scale, given a strong concentration in production and in export and import of dairy products (Hemme (ed.), 2015). The global milk production is characterised by an upward trend. In the last 10 years, only in one half-year period (from February to June 2013), there was a decrease in production against a similar period from the previous year. This is linked to a growing demand for dairy products. With stable growth in milk consumption worldwide, the market equilibrium was achieved, above all, by minor restrictions in production growth and considerable milk price fluctuations (Fig. 1). However, release of milk production in the EU in 2015 caused a growth of this production worldwide, despite a continuing unfavourable price situation. The formation of the price situation in countries reflected the trends in the world price. On the domestic market, the price fluctuations were less marked against the world price and there were slight delays in transmission of the changes to the local market.

Production specialisation has multiple advantages, especially linked to the possibility to increase production and reduce its costs, improve quality, etc. But specialisation involves some risk connected to dependence of the economic result on changes in the price for the product sold on the market. Agricultural income of farms specialised in dairy cattle breeding and level of milk prices are strongly correlated (r-Pearson=0.97). From the FADN information and data, it follows that annual income of an average-sized farm specialised in cattle breeding changed along with changes in milk prices. It should be noted that a cow herd (production potential) increased from 10.65 to 15.36 Livestock Units on an average farm specialised in dairy cow breeding (Fig. 2).

Considering the fluctuations in financial surpluses, investment decisions on farms are especially difficult. Agricultural investments cover increase and reproduction of fixed assets. These measures are to, e.g., generate or increase production, farm incomes, and reduce risks and arduousness of work (Stachak, 1998). Deciding to make investments (reproduction, adaptation, incremental), the farmer decides also on the choice of their sources of financing. These can be own or borrowed. Equity may be saved up during the production process (financial surpluses, depreciation charges, sales of redundant assets) or it may come

from emission of shares or start-up contributions (this does not happen in case of individual farms). Borrowed capital may have the form of repayable capital (e.g. loans, leasing) or non-repayable capital (budget funds or special purpose funds) (Michalak, 2007).

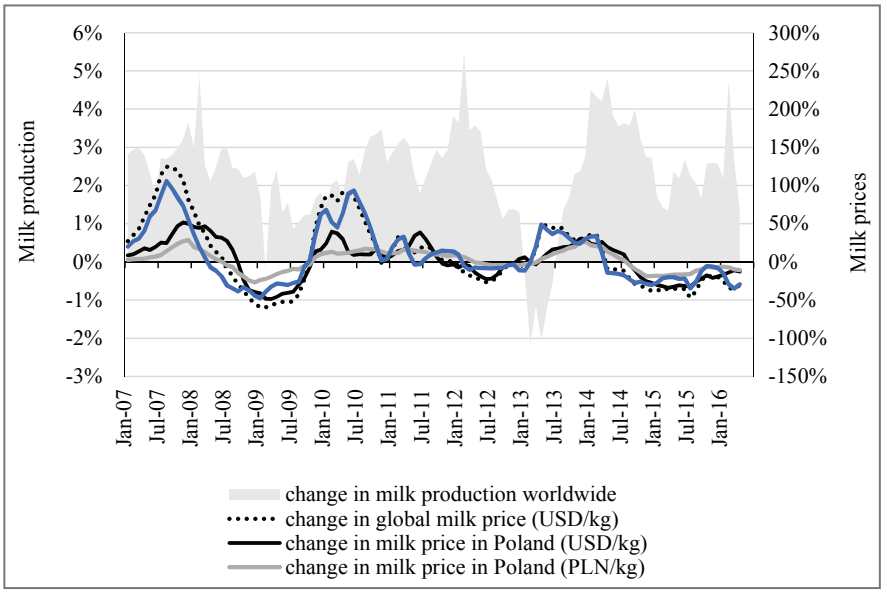

Fig. 1. Development of world milk price and changes in milk prices worldwide and in Poland between 2007-2016 (month-to-month of the previous year).

Source: own study based on data of the International Farm Comparison Network.

Given the specific features of agricultural production and its dependence on the natural factors, farms predominantly drive at minimisation of the share of debt in the farm capital. Thus, farmers avoid problems with on-time settlement of debt – loan instalments and interests. However, it needs to be remembered that the use of equity only, may prevent or much prolong the investment process for farms. To boost farm development, adequate loan policy is being formulated, enabling to exercise spatial, subjective and objective impact on agriculture. Preferential loans allow the state to prevent the deterioration of income situation in agriculture (Podstawka, 2000).

The research on farm investments shows that the value of capital expenditures is linked to the value of generated production. Economically stronger farms, which have higher cashflows, demonstrate higher value of capital expenditures (Felczak and Domańska, 2014) and most often also extended reproduction (Grzelak, 2014). Despite the fact that the basic type of farm financing is the so-called self-financing (Marcysiak and Marcysiak, 2009;

Mądra, 2010), the growth in investment value causes that it is not sufficient and thus farmers seek external sources of financing. Structural funds of the EU are of major significance at this point, as they contribute to a growth in equity value and reduction of financial risk on a farm (Kusz, 2014). Bank loan is also a crucial source of financing for farms. Farms of the highest level of debt, realise the highest capital spending financed by borrowed capital. The level of share of this debt in capital, drops along with an increase in cash surplus on operating activities (Mądra, 2011). Limiting loan costs and risk of its repayment, farmers choose long-term preferential loans (Kusz, 2008; Marcysiak and Marcysiak, 2009), which are quite a popular source of financing fixed assets (Felczak, 2015; Felczak and Domańska, 2014). Analysis of research on investments carried out by farms of different type of farming shows that dairy farms and beef farms were characterised by high capital expenditures, which was connected to availability of structural funds under the CAP (Felczak and Domańska, 2014). On farms specialising in milk production in the period from accession to the EU to 2011, the investment processes ensured extended reproduction (Grzelak, 2014).

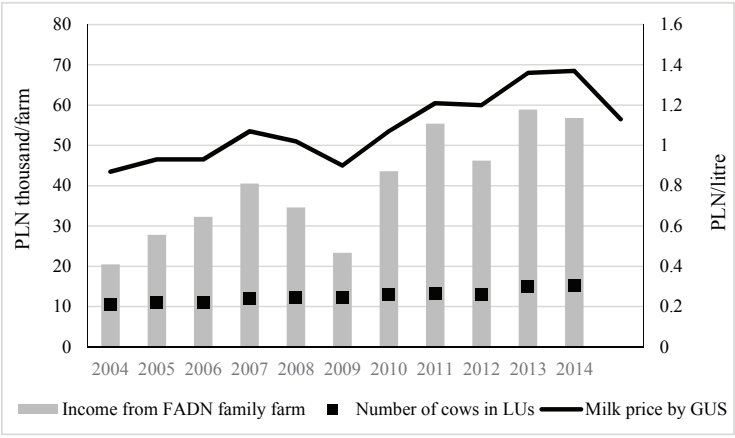

Fig. 2. The level of agricultural income on farms specialised in milk production, number of cows and formation of milk price between 2004 and 2014.

Source: own study based on the data from FADN and GUS.

Formation of surpluses for self-financing of investments and investment volume on dairy farms between 2010 and 2012

Selected economic results of farms between 2010 and 2013 were characterised by different trends depending on the economic size of the analysed entities (Table 2). For farms with the economic size from EUR 8 thousand to EUR 100 thousand the family farm income in 2011 and 2012 was at higher levels than in 2010 and 2013. Very small farms were characterised by stable, but very low, economic results over the entire period of the analysis. From the groups of analysed farms, the largest farms stood out which in 2013 acquired higher agricultural income than in 2010. Not only income grew, but also the possibilities of investment self-financing improved and, simultaneously, long--term debt was reduced. For the remaining farms, in 2013 the agricultural income reached the lowest level and ranged from 82% to 94% of the income from 2010.

Between 2010 and 2013 the level of surpluses on investment self-financing dropped. The level of debt decreased the most on farms from EUR 25 thousand to EUR 50 thousand of Standard Output, at the same time, the volume of investments in this group decreased to the most in 2013. In 2013, the average value of investments in this group of farms was at approx. PLN 28.6 thousand. Over the same period, the possibility of investment self-financing on these farms dropped almost by half compared to 2010. Farms from the group with economic size from EUR 50 thousand to EUR 100 thousand of Standard Output, despite lower income and surpluses for investment self-financing, were characterised by minor growth in investment value in 2013 against 2010. The share of capital spending in the structure of total expenditures on farms dropped and in 2013 it was at the lowest level (apart from the largest farms). The highest drop in the value of investments and the share of capital spending in the total expenditures was noted for farms from EUR 25 thousand to EUR 50 thousand.

Table 2

The selected average economic parameters in groups of farms of different economic size specialised in dairy cow breeding in 2010-2013

Years	Family farm income (PLN thousand)	Long-term liabilities (PLN thousand)	The share of capital spending in total expenditures (%)	Surplus on investment self-financing (PLN thousand)	Volume of investments (PLN thousand)
ES6 2000 ≤ EUR < 8000					
2010	11.9	0.0	4%	1.37	0.61
2011	12.8	0.5	5%	1.13	0.97
2012	10.6	0.4	6%	-1.14	1.06
2013	11.2	0.0	1%	-0.35	0.08
2013/2010	0.94	-	0.15	-	0.13
ES6 8000 ≤ EUR < 25 000					
2010	35.7	12.0	22%	9.2	10.8
2011	40.9	12.0	23%	13.6	13.2
2012	40.0	12.7	30%	10.2	20.9
2013	31.8	10.1	19%	4.4	10.1
2013/2010	0.89	0.84	0.90	0.48	0.93
ES6 25 000 ≤ EUR < 50 000					
2010	88.8	54.0	29%	31.9	39.0
2011	93.3	49.7	28%	36.3	41.1
2012	94.1	49.5	32%	31.8	57.4
2013	72.5	38.8	23%	16.7	28.6
2013/2010	0.82	0.72	0.79	0.52	0.73
ES6 50 000 ≤ EUR < 100 000					
2010	177.7	166.6	29%	74.2	88.9
2011	198.0	152.5	31%	102.8	109.9
2012	192.5	155.3	30%	80.1	114.9
2013	160.8	123.4	29%	68.1	91.5
2013/2010	0.90	0.74	0.98	0.92	1.03
ES6 100 000 ≤ EUR < 500 000					
2010	374.9	399.0	30%	192.4	208.6
2011	406.8	417.9	24%	179.0	177.4
2012	395.1	441.4	28%	210.2	265.4
2013	400.3	380.7	29%	216.5	230.8
2013/2010	1.07	0.95	0.95	1.13	1.11

Source: own study based on Goraj et al. (2015).

Possibilities of investment self-financing from financial surpluses of dairy farms between 2016 and 2020

The probability distributions of the surplus for the investment self-financing on model farms between 2016 and 2020 was presented on box plots (box-and--whisker diagrams).

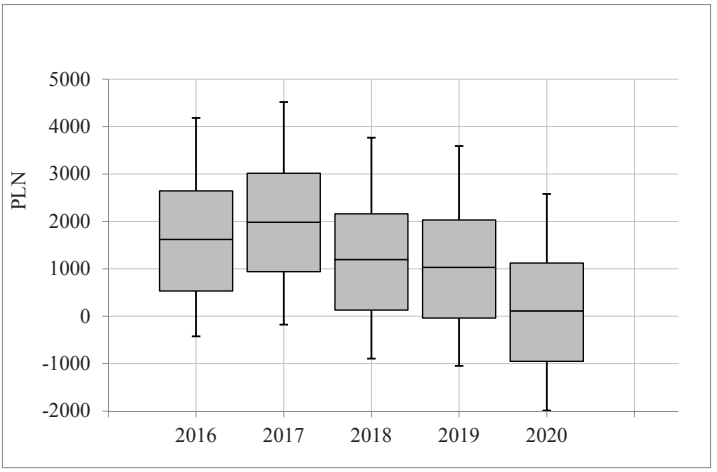

Fig. 3. Distribution of the expected value of the surplus for the investment self-financing on very small farms.

Source: own study.

For a very small farm representing the group of farms of the smallest economic size (EUR 2-8 thousand), it is clear that the average expected value of the surplus for investment self-financing dropped after a growth in 2017 (Fig. 3). In 2016, the average expected value of the surplus for investment self-financing amounted to approx. PLN 1.6 thousand, while in 2020 this value can drop to the level of only PLN 113, which practically prevents changes in fixed assets based on equity. The obtained research results showed also that the expected value of surplus in the area of interquartile range by 2018 will take on only positive values, while in 2020 – around half of observations will fall into the area below zero. The distribution of the value of the expected surplus points to right-sided asymmetry, which means that a larger part of the group takes on the values above average. This is linked to a high share of payments in income, which stabilise its amount. A drop in income in 2020 results mainly from a decrease in the level of payments to operating activities, in line with the agricultural budget of the EU for 2014-2020.

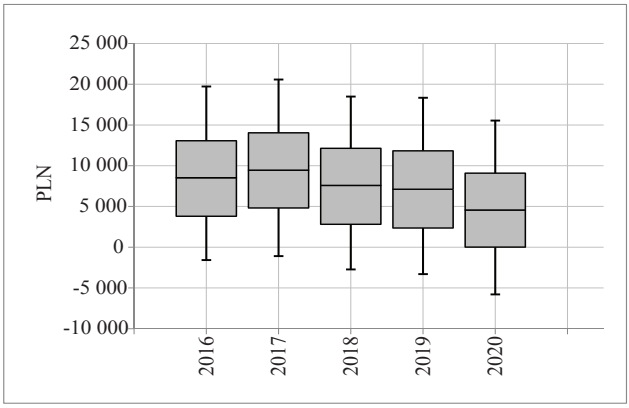

Fig. 4. Distribution of the expected value of the surplus for the investment self-financing on small farms.

Source: own study.

On a small farm (representing farms of EUR 8-25 thousand in economic size) over the entire period of the analysis the average expected value of the surplus was from PLN 4.5 thousand in 2020 to approx. EUR 9.5 thousand in 2017 (Fig. 4). The interquartile range in each year of the analysis had values above zero. In 2020, 20% of observations shows that the farm will not be able to save up the surplus for investment self-financing. Distribution, just like on a very small farm, is slightly right-skewed.

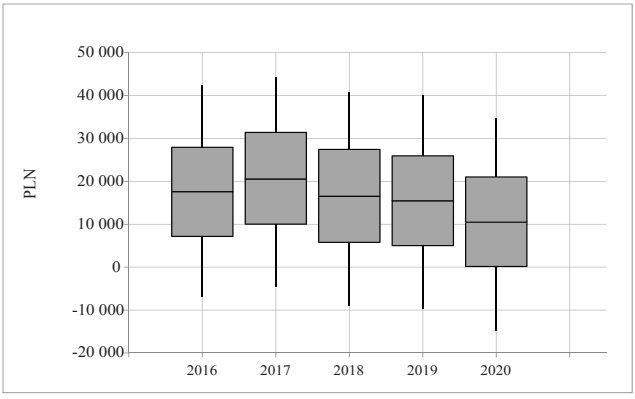

Fig. 5. Distribution of the expected value of the surplus for the investment self-financing on medium small farms.

Source: own study.

On a medium-small farm (Fig. 5) the interquartile distribution covered only values above zero. Average expected value of the surplus for self-financing – after a growth in 2017 to the level of approx. PLN 20.5 thousand – in 2020 will fall

to PLN 10.5 thousand. Just like for a farm presented below, the largest number of observations with funds deficit for investment purposes will be in 2020.

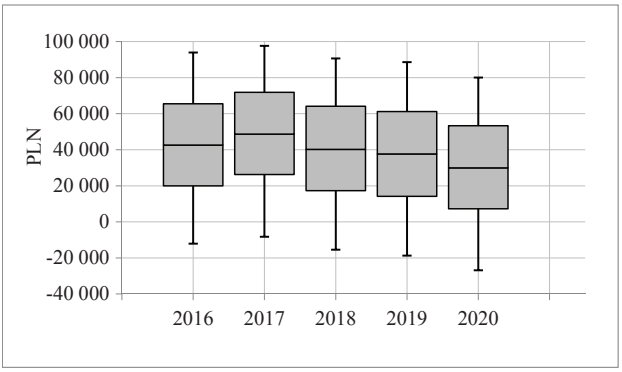

Fig. 6. Distribution of the expected value of the surplus for the investment self-financing on medium large farms.

Source: own study.

A growth in farm size, as compared to former entities much, improves investment possibilities based on equity. Average value of surplus on medium large farm allows for investment financing in the amount of PLN 30 thousand in 2020 to PLN 46 thousand in 2017 (Fig. 6). Over the entire period of the analysis, the surplus values in the area of quartile deviation took on positive values, above PLN 7 thousand and did not exceed PLN 70 thousand. The risk of failure to achieve the surplus was from 5% in 2017 to 15% in 2020. A larger part of the group in the distribution of the surplus for self-financing was below its average value.

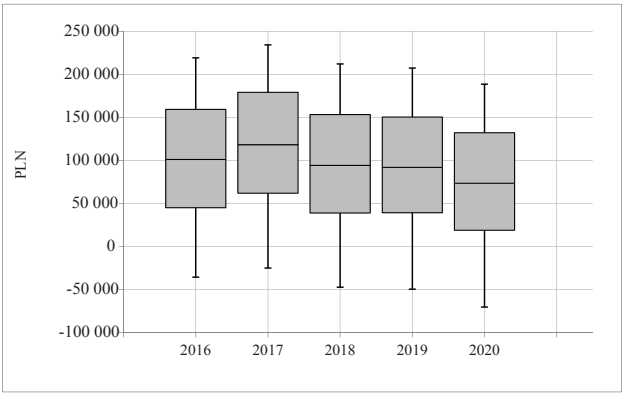

Fig. 7. Distribution of the expected value of the surplus for investment self-financing on large farms.

Source: own study.

Investment possibilities on the basis of financial surpluses saved up on a large farm in 2016-2019 fluctuated around PLN 100 thousand (Fig. 7). It can be assumed that this is a value enabling self-financing of development investments on a farm. Interquartile deviation of the surplus was at the level from approx. PLN 20 thousand in 2020 to PLN 180 thousand in 2017. The maximum risk of failure to achieve the surplus amounted to 15% and was recorded in 2020. The variable distribution is left-side asymmetric.

Conclusions

The investment decision-making on farms is a complex process conditioned upon many factors. The conducted analysis indicated the relationship between milk price variability and the possibilities of investment self-financing on farms. The amount of investments made on dairy farms in 2016-2020 will be determined by the level of achieved economic results, just like in 2010-2013.

From the conducted analysis on formation of the surplus for investment self-financing in 2016-2020, it results that the average expected value on all model farms will be on a lower level than in 2013. This situation will be the consequence of higher variability of milk prices and changes in the level of payments to operating activities in 2015-2020.

Based on the conducted analysis, it can be inferred that given a very low and dropping level of saved up surplus for investment self-financing on the smallest farms (very small and small), investments on these farms will not be made or will have the form of replacements. The level of saved up surplus will probably exclude most of very small and small farms from the possibility to apply for payments to investments, given the insufficient funds to investment implementation (from own and external sources). In case of very small farms, it can lead to ceasing production and leaving the market.

The level of achieved surplus for self-financing on other model farms in 2016-2020 will pave the way for making replacement investments. Moreover, with adequate use of the borrowed capital, these farms will most probably be able to implement development investments and benefit from support to investments. The most beneficial situation in terms of the achieved surplus for investment self-financing was observed on large farms, i.e. farms of the highest production potential.

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ZMIENNOŚĆ CEN MLEKA A KSZTAŁTOWANIE SIĘ NADWYŻKI NA SAMOFINANSOWANIE INWESTYCJI W GOSPODARSTWACH MLECZNYCH

Abstrakt

Artykuł został poświęcony badaniom na temat kształtowania się nadwyżki na samofinansowanie inwestycji w gospodarstwach specjalizujących się w chowie bydła mlecznego. Do badań wykorzystano gospodarstwa modelowe zbudowane na podstawie informacji FADN o średnich parametrach produkcyjnych i ekonomicznych gospodarstw mlecznych. Nadano stochastyczny charakter cenie mleka i przeprowadzono symulacje metodą Monte Carlo w celu uzyskania rozkładu wartości oczekiwanej nadwyżki na samofinansowanie inwestycji. Wyniki wskazują, że we wszystkich gospodarstwach średnia wartość oczekiwana nadwyżki będzie w latach 2016-2020 niższa niż w 2013 r. Poziom nadwyżki w gospodarstwach najmniejszych może pozwolić jedynie na inwestycje o bardzo niskiej wartości. Gospodarstwa silniejsze ekonomicznie będą w stanie zwiększać swój potencjał produkcyjny przez inwestycje rozwojowe.

Słowa kluczowe: gospodarstwo mleczne, inwestycje, nadwyżka na samofinansowanie inwestycji, ryzyko dochodowe, zmienność cen.

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