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Modeling the partial equilibrium in the milk and dairy market in Ukraine

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ABSTRACT

The goals of the article are definition of patterns of change in demand and supply of milk and dairy in the market of Ukraine and revealing the regularities of establishing of partial equilibrium state. The scientific methods which used in the process of the research: simulation was used for defining trends of supply and demand changing and their balancing in the dairy market; economic and statistical method was used for estimation of tendencies of production and consumption of dairy products in Ukraine; analysis and synthesis were used to find out the reasons that determine the trends of supply and demand changes; tabular and graphical methods were used for clearness of the image of the obtained research results; abstract-logical method was used for formulation of conclusions. Results of the researching: Trends of demand and supply changes in the dairy market in 2016 year was estimated. Specifics of establishing the state of partial equilibrium in that market were characterized relatively to the main groups of its participants as producers and consumers. Development of methodological and practical aspects of features of establishing the state of market equilibrium in the dairy market, unlike existing, is based on a model basis is still actual. Practical significance of those results consists in working out of the tool of justification of managerial decisions for assessing the state and creating regulatory measures for sectoral development.

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INTRODUCTION

Dairy market as system of commodity-money relations between economically separated producers of dairy raw materials, processing enterprises and consumers that covers the whole social reproduction process including producing, distribution, exchanging and consumption with goal as daily maintenance of the most important food and obtaining expected income by all market participants is one of the most important element of the Ukrainian food market. A number of problems which hinder development of agriculture were arisen as in other branches of industry. Dairy industry is one of the main branches of agricultural sector. It accounts for 15% of food and process industry. Enterprises have a possibility to process up to 20 million tons milk per year. But in fact, only 5 million tons have been processed on average dairy raw materials during the last 5 years. Increase production of high quality dairy products is the problem that don't lose its topicality, what is due to the growth of the population of our planet and the satisfaction of humanity's needs in food. The works of domestic scientists are devoted to theoretical and applied issues of the development of the dairy market: Ilchuk M.M. (Ilchuk *et al.,* 2015), Kernissyuk Y.V. (Kernissyuk, 2015), V.M. Mykytiuk (Mykytiuk, 2012), Mostenskaya T.L. (Mostenskaya *et al.,* 2013), Tsikhanovskaya V.M. (Tsikhanovskaya, 2016), Fedulova I.V. (Fedulova, 2018) and others. Problems of modeling and creating of a model, which can formulate an entrepreneurial system and get optimal managing decisions, are actual. Many theoretical and practical publications are devoted to this topic on the simulation of market situations of domestic and foreign scientists (Cardenete *et al.,* 2012; Bellú, 2012; Kvasha *et al.,* 2016; Zhhemeda *et al.*, 2013; Babenko, 2013 and Shorikov *et al.*, 2014). A lot of models have been developed for analysis of entrepreneurship. Relevant databases have been created for their support both in individual countries and in individual markets and branches of industry of economy. Models of partial equilibrium are strongly disaggregated and focused on the market for a particular product, in particular, on the relationship between demand and supply on it. This study has been carried out in Ukraine in 2018.

MATERIALS AND METHODS

Using of partial equilibrium models, which allow us to make a substantive description of the research object (industry or market) in the specified macroeconomic conditions, are adequate for solving some local problems of individual branch of industry or relevant product market. In turn, the main advantage of use of partial equilibrium models is their opportunity for appreciating of policy scenarios in different macroeconomic variants of development. Starting position of choosing the tool of the model of general or partial equilibrium for solving a certain scientific or economic task is a correlation of time expenditures for the development of complex and less transparent models compared with the use of simpler modeling methods. In models of partial equilibrium, factors, which are as the basis of formalization of relations in models of partial equilibrium, aren't taken into account (Lukyanenk *et al.,* 2015). This circumstance of constructing models of partial equilibrium is both a disadvantage and their advantage, among which the following can be noted:

- Comparetively high availability of data and necessary information for the formation of the model and most points of reliability of their elements;
- Greater simplicity of presentation and frivolity of model algorithms;
- A greater possibility of adequate economic interpretation of decisions based on the model and efficiency of the analysis of many problems of economic policy.
- Herewith, it should be noted, the conditional disadvantages of models of partial equilibrium, which, in particular, don't allow evaluating:
- Some macroeconomic effects, such as changes in the level of national income or employment;
- The comparative advantage of estimating the flow of resources (labor, capital, etc.) between industries;
- The macroeconomic consequences of the use of cheaper imported raw materials in the processing industry, with the possible reduction of domestic tariff barriers, compared with the more expensive domestic; by level of employment, the volume of incomes of domestic workers, the level of created value added (Cardenete *et al.,* 2012; Kvasha *et al.,* 2016).

The functioning of agro-industrial production isn't isolated from other sectors of the economy. The inputs that determine the competitiveness of the agrarian sector products are the fixed assets and

circulating assets that come to the agricultural sector from other sectors of the economy. In many cases, entrepreneurs of the agrarian sector are not able to influence the prices of resources only from the positions of the sector. For a model solution of certain economic tasks, models of partial equilibrium are often complemented to characterize macroeconomic processes. This add-on can be formed as an additional analysis of the tables «cost-release» or as a SAM analysis matrixes of financial flows (Cardenete *et al.,* 2012; Bellú, 2012). It is expedient to use models of partial equilibrium to solve certain social tasks. The main organizations that effectively use this type of model are the FAPRI Institute - Institute for Food and Agriculture Policy Studies; IIASA – International Institute for Applied Systems Analysis. The FAPRI Institute is part of the Center for Agricultural and Rural Development (CARD Center for Agricultural and Rural Development) of the University of Iowa (Westhoff *et al.,* 2017).

RESULTS AND DISCUSSION

The agricultural market of Ukraine is an important component of the national economy, which fundamentally affect the course of socio-economic processes and mediates the issue of food security of the population and the competitiveness of the functioning of economic units. Market can be generally determined as a system of economic relations that arises in the process of exchange between product producers and consumers. The condition for implementation of these relations is free access to the market and the competitive basis of interaction between producers and consumers or the subjects of supply and demand (Ivanko, 2015). In turn, the disclosure of the features of interpretation of dairy market is related to the characteristics of the totality of economic relations on it, taking into account the influence on the conditions and results of economic activity of environmental factors. Regarding markets, it should be noted that there are multiple approaches to group them. Classification of markets can be carried out according to different approaches. Herewith, it shoud be noted that there is an interest in grouping the market in relation to the degree of its saturation and its characteristics according to the criteria for assessing the demand, supply and the level of their balancing due to the subject of this study. The analysis of the differences of market structures in accordance with the level of market saturation necessitates the study of market conditions with insufficient, excessive and equilibrium supply and satisfied or dissatisfied demand (Westhoff, *et al.,* 2017; Ivanko, 2016). So Kvasha S.M. (Kvasha, 2011) give off 3 groups of markets: 1) market, in which total supply exceed total demand; 2) markets, based on the market equilibrium; 3) markets with deficit of supply – internal demand isn't satisfied by the level of supply of domestic producers. For example, the first group of markets includes the grain market, the market for oil, and partly the market of milk; the second group includes the potato market, the third group includes the market of meal, dairy market etc. Supply and demand in the market are characterized by the volumes of the proposed product, volumes of purchased or sold goods and price levels. A complete analysis of real demand and real supply without price aspects is impossible. In relation to this, it can be noted the presence of demand prices, supply prices and equilibrium prices as characteristics of the level of their balancing. Herewith, when considering the price of equilibrium, it can be noted that it is out of demand and supply. But at the same time, it is simultaneously included both in the volume of equilibrium demand and in the amount of equilibrium supply, serving as their main feature. For example, the interpretation of demand in the price context in a market equilibrium can be carried out through a certain volume of goods that can be bought by the subjects of demand at a price at which it can be sold by the subjects of the offer. In a simplified interpretation, at the market equilibrium, the levels of demand and supply are equivalent, because they are measured by the same volume of real goods that are bought and sold at the same price. The characteristics of the dairy market require an awareness of the features of its organizational structure and the specifics of the manifestation of its demand and supply trends. The specificity of conducting research in relation to any market, in particular the dairy market, is conditioned by the tendency of European integration of Ukraine and the need to adapt its economic mechanism to European standards and business rules (Tivonchuk, *et al.,* 2017). Thus, when analyzing the tendency of supply of milk, it is necessary to take into account the fact that the overwhelming part of it, although it is produced in households, the share of its receipt in milk processing enterprises is much smaller than in

agricultural enterprises (Table 1).

The analysis of data in Table 2 confirms that the dairy market, aimed at satisfying the demand of the population in this group of foodstuffs at the present time, does not ensure the adequacy of consumption of dairy products and is characterized by the deficit supply - in 2016, the indicator of the adequacy of consumption was 55.3% to the rational consumption rate.

By the way, the average annual consumption of dairy products in 2015 was one of the lowest rates compared to other types of food (except fish products) and varied significantly in the regions of Ukraine (from 171,2 kilos in Donetsk region to 259,3 kilos in Ivano-Frankivsk region) (Food security in Ukraine, 2015). Taking into account the aforesaid, the study of the dependence of supply and demand on the market for dairy raw materials was carried out using methods of economic-mathematical modeling. Statistical Reporting was used as the information base for constructing mathematical models of demand and supply on the milk market in Ukraine. (form № 50-ah in 2015-2016 years) from database of State Statistics Service of Ukraine. The criterion of division of the total set of agricultural enterprises into the groups is the price of sale of 1 ton of milk. At the initial stage, the sorting of the total population of agricultural enterprises was carried out in order to select those who were engaged in the production and marketing of milk. As a result, from the general population in 2015, significant 1563 enterprises out of 8502 enterprises with a wide variation of the price level from 1613 to 8514 UAH/tone were allocated. Identification of demand and supply trends in the dairy market is one of the objectives of this research. Graphically, a trend can be formed by all aggregates or selected ones. It is advisable to formulate graphical trends in a generalized way according to groups' indicators. The number of groups, according to the next step of calculations, was determined by the Sterjes using Eq. 1.

$$n = log_2 N + 1 \quad (1)$$

Where, N= the number of units studied in the population;

n= number of groups.

$n_{2015} = \log_2 1563 + 1 = 11$;

Table 1: Dynamics of milk production by major categories of producers in Ukraine in 2010-2016 years (thousands of tons) (Prokopenko, 2016; Vlasenko, 2016; OWSSCU, 2017)

Indexes	Year				2016 p. in % to	
	2010	2014	2015	2016	2010	2015
Milk production - total	11249	11133	10615	10387	92,3	97,9
Including:						
Agricultural enterprises	2217	2648	2669	2711	122,3	101,6
Households	9032	8485	7946	7676	85,0	96,6
Share of households in total milk production, %	80,3	76,2	74,9	73,9	-	-
Milk that was received by the processing enterprise, - total	4793	4647	4551	4182	87,3	91,9
Including:						
Agricultural enterprises	1890	2428	2198	2494	132,0	113,5
Households	2544	1737	2353	1688	66,4	71,7
Share of households in total sales of milk to processing enterprises, %	53,1	37,4	51,7	40,4	-	-
The level of milk marketability, %:						
Agricultural enterprises	85,3	91,7	82,4	92,0	-	-
Households	28,2	20,5	29,6	22,0	-	-

Table 2: Dynamics of dairy consumption in Ukraine in 2010-2016 pp (1 person/y/kg) (Prokopenko, 2016; Vlasenko, 2016; OWSSCU, 2017)

Indexes	Year				2016 p. in % to	
	2010	2014	2015	2016	2010 p.	2015 p.
Dairy consumption by 1 person per year	220	223	210	210	95,5	100,0
Indicator of consumption adequacy, % * (the ratio of milk consumption to the estimated consumption rate)	57,9	58,7	55,3	55,3	-	-

$n_{2016} = \log_2 1470 + 1 = 11$.

A criterion for grouping data by aggregate agricultural enterprises was the price of milk, expressed in UAH/tone. Determination of intervals of groups when grouping the totality of the explored enterprises was performed according to the traditional Eq. 2.

$$i = (x_{max} - x_{min}) / n \quad (2)$$

Where, x_{max} – maximum value in the aggregate; x_{min} – minimal value in the aggregate; n– number of groups. Calculations of supply and supply prices on the market of dairy raw materials were made based on the conducted grouping. The generalized calculations of milk supply in the Ukrainian market for 2015-2016 years are presented as the current study source calculations on the basis of analysis of the form № 50-ah of agricultural enterprises in Table 3. The study of the milk market would be incomplete, provided there is no disclosure of demand trends. The curve of national demand for milk consists of individual curves of demand, including demand curves for dairy processing enterprises, consumer demand and export curve. The model did not investigate the demand of each particular group, but determined one overall demand curve.

A linear function of general type was used to model the demand for milk in the Ukrainian market, which is described by Eq. 3.

$$Y=a-bp, \quad (3)$$

Where, a – consumption of dairy raw materials, tons; p - the average-weighted price for milk, UAH/tone; b – angular coefficient of slope of the demand curve.

Table 4 shows the components of the calculation of

Table 3: Characteristics of the supply of milk agricultural enterprises for 2015-2016 years

	Groups of agricultural enterprises										
	1	2	3	4	5	6	7	8	9	10	11
2015											
Level of sales price, UAH/tone	2335	2596	3208	3829	4297	4424	4436	4436	4438	4440	4442
Offer volume, kilotone	1	7	66	535	2061	2578	2607	2607	2611	2613	2614
2016											
Level of sales price, UAH/tone	2265	2693	3209	3870	4493	5098	5478	5603	5613	5620	5621
Offer volume, kilotone	1	4	16	83	304	1139	2201	2574	2590	2598	2600

Table 4: Components of calculation of the function of demand for milk in 2015-2016

Indexes	2015	2016
Average-weighted price of milk sales, UAH/tone	4442,0	5621,0
Volume of consumed milk at the average-weighted price, kilotons	1152,3	1117,6
Elasticity of demand for the price	0,842	0,798
Demand function	Y = 1152,3 – 0.218*p	Y = 1117,6 – 0,159*p

Table 5: Characteristics of the demand for milk for 2015-2016

	Groups of agricultural enterprises										
	1	2	3	4	5	6	7	8	9	10	11
2015											
Level of sales price, UAH/tone	2335	2596	3208	3829	4297	4424	4436	4436	4438	4440	4442
Offer volume, kilotone	643	586	453	318	216	188	185	185	185	184	184
2016											
Level of sales price, UAH/tone	2265	2693	3209	3870	4493	5098	5478	5603	5613	5620	5621
Offer volume, kilotone	758	689	607	502	403	307	247	227	225	224	224

the function of demand for milk which was calculated by the current study on the basis of analysis of the form № 50-ah of agricultural enterprises.

A separate component of the analysis in the process of this study is the interpretation of the characteristics of the demand for milk, in particular the levels of elasticity of demand for milk depending on the price level. The level of demand elasticity in 2015 is 0.842, and in 2016 it is 0.798 and is less than one, what means that there is no elasticity in demand for milk.. In turn this is explained by the low level of satisfaction of demand for milk and dairy products from the population. The parameters were calculated according to the determined functions of demand for 2015-2016; which were calculated by the current study on the basis of analysis of the form № 50-ah of agricultural enterprises (Table 5).

According to the determined characteristics of demand and supply for milk, their schedules will be formed for 2015 (Fig. 1) and 2016 (Fig. 2), define

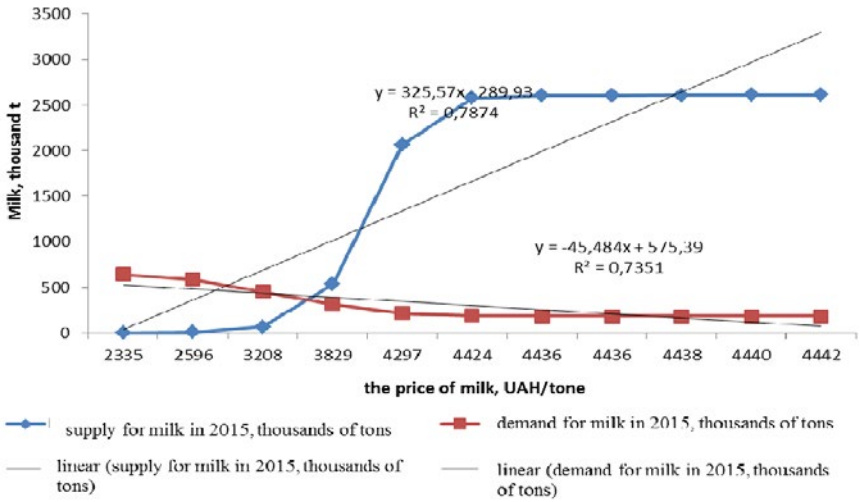


Fig. 1: Correlation of supply and demand for milk in 2015

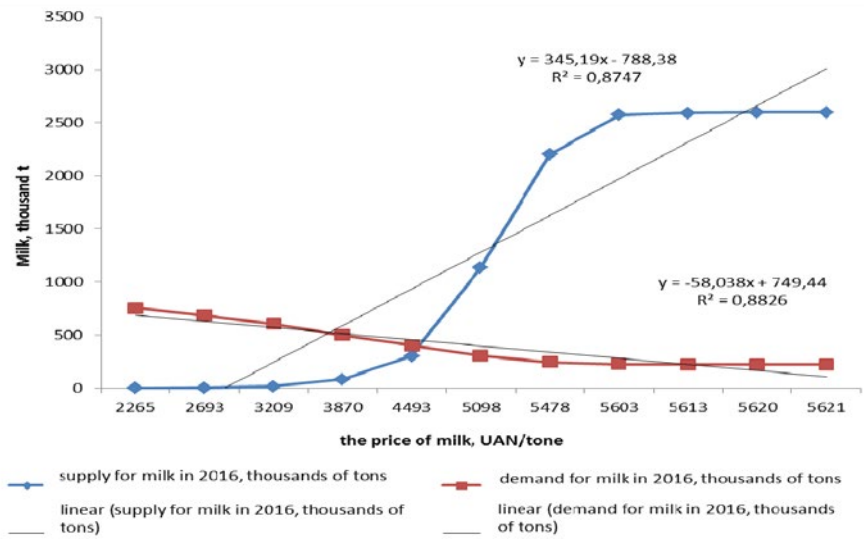


Fig. 2: Correlation of supply and demand for milk in 2016

Table 6: Characteristics of the equilibrium state in the milk market under research conditions for 2015-2016

Characteristics	Demand		Supply
		2015	
Equation	Y = -45,484*x + 575,39		Y = 325.57*x–289,93
R^2	0,7351		0,7874
X		**2,33**	
Equilibrium state	469		469
		2016	
Equation	Y = -58,038*x + 749,44		Y = 345,19*x–788,38
R^2	0,8826		0,8747
X		**3,81**	
Equilibrium state	528		527

the trend lines, the point E (equilibrium) and the equilibrium volumes of demand and supply. In the process of solving the equations for 2015, when balancing supply and demand, (−45.484*x + 575.39 = 325.57*x – 289.93) the value of x is set equal to 2.33. Visually, the equilibrium point is located on the graph of Fig. 1 at the intersection between the supply and demand lines. This point characterizes the equilibrium volumes of demand and supply, which for the conditions of 2015 and the conditions of the study is equal to 469 kilotons (Table 6). linear (supply for milk in 2015, thousands of tons). The value of x set equal to 3.81 in the process of solving the equations for 2016 when balancing supply and demand (−58.038*x + 749.44 = 345.19*x – 788.38). Visually the equilibrium point is located on the graph of Fig. 2 at the intersection between the supply and demand lines. This point characterizes the equilibrium volumes of demand (528 kilotons) and supply (527 kilotons) for the conditions of 2016 and the conditions of the study (Table 6).

In general, models of partial equilibrium, in essence, are multifunctional. Their specified property means the ability to select different functions to get a solution by model. It is generally accepted that the independent factor is placed on the horizontal axis (x) and the dependent variable on the vertical axis (y). At the same time, in accordance with the objectives of economic research, it is completely permissible to replace the places of factors along the axes. Thus, consideration of the relationship between two factors, such as the price and volume of the offer, can be made in two approaches. In accordance with the first approach, which function is the price, the emphasis of the study is establishment of the regularity of price changes depending on the volume of supply. According to the second approach, function of which is the volume of the proposal, the focus of the research is focused on identifying tendencies for changing the supply depending on price changes. These models are multilevel. At the first level, the trends of demand and supply changes can be determined by model, on the second one, its , а на другому рівні – features of establishing equilibrium in a separate market or in the economy.

Depending on the depth of the market research of dairy, it is expedient to establish trends in demand changes based on the following factors: income level of population, population structure by age groups, levels of prices for other goods (food and non-food group, including substitutes goods), tastes of the population during the year, etc. In turn, in determining the regularities of the proposal's change, it is important to consider the following factors: technological level of production, prices for different resources, components of the state agrarian policy (on the volume of state procurement, import and export tariffs, quotas) and so on.

CONCLUSION

Dairy market is industry market, aimed at ensuring national food security by meeting the needs of the population in this product group. The investigated market is characterized as a market with demand dissatisfaction - the demand of the population in this product in 2015 was satisfied only by 55%. At the same time, the prevailing group of producers on the market of dairy raw material production in Ukraine for 2010-2016 was Ukraine's households, producing almost ¾ of its volumes. Partial equilibrium models are an effective tool for studying the state of the market, substantiating the measures of economic

policy and analyzing the results of its implementation. Depending on the research objectives, these models can be used for: determination of the influence of the factor characteristic on the functional; a more in-depth study of the laws of change in demand, supply and the level of their balancing; determining the consequences of establishing a market equilibrium for key market participants, in particular for producers, consumers, etc. The milk market model can be used to assess the impact of existing regulatory decisions on the change in the rate of return of business entities in the production of dairy products, welfare of the population and on the economy of the country as a whole. The forecast of changes in the prices of products makes it possible, with the help of the model of this market, to facilitate the establishment of optimal volumes of demand and supply for this type of product. The indicated situation shows that it is inappropriate to stabilize this market the reliance on the liberalization as the mechanism for its regulationTherefore, moving towards a European integration course, Ukraine must form an ideological strategy for the agrarian development, in particular the dairy industry, which is adaptive with the EU. The correcting the situation in this market is probably due to the application of regulatory measures that clearly define the parameters of development and the efficiency of the functioning of the milk market.. In particular, measures that will contribute to increased demand for products can be attributed: increasing the capacity of the domestic market of dairy products by improving the purchasing power of the population; diversification of activities in the market; expanding geography and increasing exports of finished products; improving quality and reducing the cost of dairy raw materials, etc. At the same time, the development of cooperation and integration processes can positively influence the proposal (for example, the creation of integrated cooperatives and mini-farms and their use in their activities of innovative management, modern marketing activities, systems of professional training of employees); the introduction of international quality standards into the production process; construction of new and reconstruction of existing farms; improving the genetics of animals, etc.. Ultimately, all this will contribute to the fact that an effective supply will respond to solvent demand, that is, the establishment of a market equilibrium in the milk market.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

ABBREVIATIONS

%	Percent
ah	Agriculture
Eg	Equation
EU	Enropean Union
FAPRI	FOOD and Agricultural Policy Research Institute
Fig.	*Figure*
IIASA	International Institute for Applied Systems Analysis
n	number of groups
point E	equilibrium
SAM	Social Accounting Matrix
UAH	Ukrainian hryvnia

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