

UDC 519.86:338.55:636/639

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Economic and mathematical evaluation of Ukrainian agrarian market by branches

Abstract. This research is dedicated to identifying of misbalances on the agrarian market of Ukraine in the areas of grain, vegetable, fruits and berries, meat, milk and egg production. The analysis of their demand and supply dependence during the 2007–2014 period was conducted by means of coefficients of correlation, limit effectiveness and elasticity. It is determined that volumes of production are more sensitive to consumption levels. The worst misbalances are related to meat, fruits and berries, where production does not cover even the limited solvency of the Ukrainian population. Consumption has the greatest impact on vegetable production in crops-growing and meat production in animal-breeding.

The stimulation of production development by the price factor is considered by types of agricultural holdings. According to calculations, the increase of wages in agriculture caused the growth of grain and meat production. Growing incomes allowed the population to substitute the consumption of bread with a more useful consumption of vegetables, fruits and berries. However, the consumption levels for fruits and berries, meat and milk in Ukraine do not correspond to the international nutrition standards. It has been found out that the consumer price index demonstrates the strongest correlation with egg consumption, whereas the worst situation is observed regarding the demand for milk.

The obtained results are the basis for further development of the mechanisms for addressing imbalances in various branches of the Ukrainian agriculture.

Keywords: Agrarian Market; Production; Consumption; Prices; Statistic and Econometric Analysis

JEL Classification: C10; Q11

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Економіко-математична галузева оцінка аграрного ринку України

Анотація. Дослідження присвячено визначенню дисбалансів на аграрному ринку України по галузях виробництва зерна, овочів, плодів і ягід, м'яса, молока та яєць. Аналіз залежності їх попиту та пропозиції у 2007–2014 роках проведено за допомогою коефіцієнтів кореляції, граничної ефективності та еластичності. Встановлено, що обсяги виробництва мають більшу чутливість до рівнів споживання. Найгірший дисбаланс виявлено по м'ясу, плодах і ягодах, де виробництво навіть не покриває обмежену купівельну спроможність населення України. Споживання найбільше впливає на виробництво овочів у рослинництві та молока у тваринництві. Стимулювання розвитку виробництва ціновим чинником розглянуто по категоріях господарств. Розрахунки вказують, що підвищення заробітної плати в аграрному секторі призвело до збільшення виробництва зерна та м'яса. Зростаючі доходи дозволили населенню замінити споживання хліба на споживання більш корисних овочів, плодів і ягід. Проте рівень споживання плодів і ягід, м'яса та молока в Україні не відповідає міжнародним нормам раціонального харчування. Встановлено, що індекс споживчих цін найбільше корелює зі споживанням яєць, а найменше – із попитом на молоко. Одержані результати є підґрунтям подальшої розробки механізмів подолання диспропорцій по галузях сільського господарства України.

Ключові слова: аграрний ринок; виробництво; споживання; ціни; статистичний та економетричний аналіз.

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Экономико-математическая отраслевая оценка аграрного рынка Украины

Аннотация. Исследование посвящено определению дисбалансов на аграрном рынке Украины по отраслям производства зерна, овощей, плодов и ягод, мяса, молока и яиц. Анализ зависимости их спроса и предложения в 2007-2014 годах проведен посредством коэффициентов корреляции, предельной эффективности и эластичности. Установлено, что объемы производства имеют большую чувствительность к уровням потребления. Наихудший дисбаланс выявлен по мясу, плодам и ягодам, где производство даже не покрывает ограниченную покупательную способность населения Украины. Потребление оказывает наибольшее влияние на производство овощей в растениеводстве и молока в животноводстве. Стимулирование развития производства ценовым фактором рассмотрено по категориям хозяйств. Расчеты указывают, что повышение заработной платы в сельском хозяйстве привело к увеличению производства зерна и мяса. Возрастающие доходы позволили населению заменить потребление хлеба на потребление более полезных овощей, плодов и ягод. Вместе с тем, уровень потребления плодов и ягод, мяса и молока в Украине не соответствует международным нормам рационального питания. Установлено, что индекс потребительских цен наиболее коррелирует с потреблением яиц, а наименее – со спросом на молоко. Полученные результаты являются основой дальнейшей разработки механизмов преодоления диспропорций по отраслям сельского хозяйства Украины.

Ключевые слова: аграрный рынок; производство; потребление; цены; статистический и эконометрический анализ.

1. Introduction. The agrarian market presents a category of commodity economy as a complex of economic relations aimed at purchasing and selling of agricultural products. The state's regulatory role with regard to the Ukrainian agrarian market is to meet consumer demands for high-quality food products. On the other hand, the tax and customs mechanisms should ensure effective operation of agrarian enterprises without any essential restrictions concerning their constructive competition. In modern conditions of strong impact of crisis phenomena and destabilizing factors, the state of the Ukrainian agrarian market needs a detailed monitoring of the demand and supply levels, prices, volumes of sales, solvency of the population and the overall dynamics of production and consumption of agricultural products. The relevance of the given research determines a need for the study of sector-specific differences of the Ukrainian agrarian market in the leading segments of crop and livestock production, which will be clarified by means of economic and mathematical tools [1].

2. Brief Literature Review. The Agrarian Markets Development Institute headed by V. Ye. Andriievskiy is a specialized institution in Ukraine established to address the issues relating to the theme of the conducted research [2]. Together with Ye. M. Kyrlyuk and T. O. Ostashko they investigated problems related to the agrarian markets transformation under the influence of the world integration processes and adjustment of the regulatory framework for the agrarian sphere to European standards [3; 4].

Scientists of the Institute of Economics and Forecasting of the National Academy of Sciences of Ukraine are also focused on the problems of the national agrarian markets development [5]. Fundamental results relevant to innovative modernization of the agrarian sector, determination of production potential in the Ukrainian agriculture, food product pricing, state regulation for food sphere in the context of crisis belong to V. M. Heiets, V. O. Tochilin, B. Y. Paskhaver, O. M. Borodina, O. V. Shubravska and other famous scientists [6-9].

Scientific researches on agrarian market development under the auspices of the National Academy of Agrarian Sciences of Ukraine are carried out in the Institute of Agrarian Economics, in particular, by B. K. Supikhanov [10; 11]. The prominent drafters of the Strategy of development of agriculture sector of Ukraine till 2020 were P. T. Sabluk, Yu. O. Lupenko, V. Ya. Mesel-Veseliak, L. V. Moldavan, O. G. Shpikuliak, O. M. Shpichak. The main directions of the agrarian sector development include the increase of effectiveness of multi-structural agrarian production, improvement of land relations, support of business and cooperation, reno-

vation of material and technical base of agriculture, upgrade of its financial and credit, investment and innovative, information and analytical maintenance, as well as active development of the agrarian market and its infrastructure [12]. In such a context the corresponding aims are related to price stabilization and balancing of agrarian production and food markets; the increase of profitability of agricultural sectors by means of their expanded production; a reduction of imbalances between agriculture and industrial branches; the formation of the optimal agrarian market infrastructure, which will balance volumes of demand and supply [12, 66-68]. A reliable estimation of their achievement by using economic and mathematical tools is still an open question.

3. The purpose of the research is to make estimation of factors stimulating agriculture development and balancing the state of the Ukrainian agrarian market, which will allow us to define directions for the agrarian sector development.

4. Results. Let us consider the essential elements of crop (grain, vegetables, fruits & berries) and livestock production (meat, milk and eggs), as they are the most important agri-food products. Each of them has own balance of demand and supply. In particular, the national grain production provided the norm of rational consumption of bread products in Ukraine with the average surplus of 11% during the 2007-2014 period. It means that most part of the Ukrainian grain could be exported. In 2014, its main buyers were Egypt, Spain, Pakistan, Korea, China and the Netherlands [13]. Therefore, it is natural that the demand and supply in the food segment of grain production go in reverse directions with the correlation coefficient between production and consumption equal to -0.68.

On the contrary, the demand and supply in vegetable production during 2007-2014 were correlated with 0.98. Positive results relevant to the saturation of the inner market with vegetable products were obtained due to the international nutrition standards preservation with 3% surplus for the analyzed period. The greatest export volumes of Ukrainian vegetables reached 40% in 2012. Production is more sensible to changes in the consumption of vegetables with the limit effectiveness and elasticity equal to 1.47 and 1.13, accordingly [14].

The national agriculture produces only 51% of the needs of the Ukrainian population in fruits and berries. In such a case, exports cover additional 13% of demand. A strong linear tie with the correlation coefficient equal to 0.98 was observed between production and consumption of fruits and berries during 2007-2014. Similar to vegetable production, the one related to fruits and berries is more sensible to changes in consumption with the limit effectiveness and elasticity equal

to 1.15 and 1.43. For comparison, the corresponding indices of consumption dependency on fruits and berries production are equal to only 0.83 and 0.67, respectively [14].

The situation appeared to be even worse in the meat subcomplex of the livestock complex, where only pig-breeding demonstrated 6% of profitability in 2014. The production of beef, poultry, mutton and caprine were unprofitable at the levels equal to -35.6%, -9% and -43%, respectively [13]. Thus, the Ukrainian population was supplied with meat only by 61%. Exports covered additional 5% of the demand for meat.

A feasibility study of sustainable development in the Ukrainian livestock complex requires economic and mathematical tools [15]. In particular, a strong linear tie with the correlation coefficient equal to 0.89 was observed between production and consumption of meat during the 2007-2014 period. It confirms the focus on the national producers on the domestic market and it also shows that the population prefers meat products of the Ukrainian agriculture. Supply is more dependable on changes in the demand for meat with the limit effectiveness and elasticity equal to 1.24 and 1.39. The corresponding indices of consumption dependency on meat production are equal to only 0.64 and 0.57, respectively [16].

The milk subcomplex proposes products with a surplus of 10% to the volumes of solvent demand of the national consumers. In 2014, the export of milk exceeded its import by USD 174.8 million which resulted in the profitability of milk products equal to 11.2% [13]. During the 2007-2014 period, the demand and supply in the domestic milk subcomplex did not have any essential disproportions and were characterized by the coefficients of the limit effectiveness and elasticity equal to 0.63; 0.6 and 0.73; 0.52, respectively [16].

Egg production is the most lucrative segment of the Ukrainian livestock complex with a profitability of 54.9% in 2014, which increased by 7.9%. Furthermore, the export of eggs in 2014 dominated over their import by USD 121.9 million [13]. At the same time, eggs producers are focused on the domestic market which is verified by the coefficients of correlation equal to 0.99, the limit effectiveness of demand impact corresponding to 2.05 and elasticity relevant to 1.56. The saturation of the domestic demand correlates with the limit effectiveness of supply impact (0.48) and elasticity of production (0.62) [16]. By means of egg consumption the Ukrainian population compensated a lack of animal protein, which caused a misbalance by 17% in comparison with the consumption of an optimal 265 eggs per capita yearly [13].

Let us further consider price elasticity of demand and supply in the domestic agrarian market, since price regulates relations between sellers and buyers. The production of grain prevailed with regard to the Ukrainian agricultural enterprises and comprised almost 80% [13]. Grain selling prices and its production volumes in agricultural enterprises and households were correlated with the coefficients equal to 0.76 and 0.68, respectively. The price factor for agricultural enterprises during the 2007-2014 period was stronger, which is confirmed by the limit effectiveness and elasticity equal to 21.5 and 0.7. The production of grain in households had a less strong connection with the selling price, therefore the corresponding limit effectiveness and elasticity are equal to 3.71 and 0.45, respectively. It is explained by a stronger dependence of grain harvests in households on natural and climatic factors and orientation at the least total cost of production.

The domestic households specialize in vegetable production with a structural part over 85% in 2014 [13]. The price factor does not bring a proportional correction to the production development trends in agricultural enterprises, which mainly produce vegetables grown in the open, do not have long-term storage facilities and, thus, had to sell vegetables cheaper on average by 27% during the 2007-2014 period and even cheaper by 50.5% in 2014, as compared to the domestic households [17]. On the contrary, the price factor brings a positive impetus with regard to vegetable production development in households, which is verified by coefficients of correlation equal to 0.7, the limit effectiveness corresponding to 1.01 and elasticity relevant to 0.36.

The domestic households also specialize in fruits and berries production with a structural part over 80% in 2014 [13]. The production volumes of domestic households and agricultural enterprises have almost equal sensibility to a price factor, according to the coefficients of correlation and the limit effectiveness equal to 0.81; 0.89 and 0.14; 0.12, respectively. But the scale of production in the domestic households eliminates their more favourable selling prices and determines a lesser price elasticity of fruits and berries production (0.41), compared to the production of agricultural enterprises (0.94). O. P. Velychko grounds, that logistics and cooperation of the domestic households can solve this problem [18].

Ukrainian agricultural enterprises produced 62% of meat in 2014, in particular, 84% of poultry and 51% of pork. At the same time, the domestic households produced 76% of beef and veal [16]. A selling price is an influential factor of meat subcomplex renovation in agricultural enterprises, which is verified by the coefficients of correlation and elasticity equal to 0.9 and 0.64. The meat segment of domestic households hardly show any sensibility to the selling price, whereas their average prices were higher by 20%, if compared to the prices set by agricultural enterprises during the 2007-2014 period.

The domestic households maintained their leadership in milk production with a structural part over 75% in 2014. But they had a lower level of productivity by the annual average milk yield per cow (4,364 kg), if compared to the indicators of agricultural enterprises (5,027 kg) [16]. The domestic households demonstrated a reverse relationship between the price and the supply of milk with the correlation coefficient equal to -0.95, which means that the higher is the selling price, the less volumes of production we observe. On the contrary, the selling price set by agricultural enterprises stimulated their milk segment development, which is confirmed by the coefficients of correlation equal to 0.73, the limit effectiveness corresponding to 0.21 and elasticity relevant to 0.24.

Egg production in Ukraine was concentrated in agricultural enterprises with a structural part which comprised 63% in 2014 [16]. The selling price for all types of producers increases supply, which is verified by equal correlation coefficients comprising 0.95. At the same time, the domestic households, setting even higher prices by 60% than those of agricultural enterprises during the 2007-2014 period, yield them by coefficients of the limit effectiveness (1.44 and 10.65) and elasticity of egg production (0.17 and 0.52).

From the price-and-supply ratio, let us proceed to the analysis of the price and population solvency impact on demand. Hence, the consumption of bread declined during 2007-2014, whereas the average salary of the population increased within the same period which is illustrated by the correlation coefficient equal to -0.94. The consumer price index influenced the level of demand with the limit effectiveness equal to 0.19 and with the same coefficient for elasticity.

The growth of the average salary also had a positive impact on the consumption of vegetables which is confirmed by the coefficients of correlation and elasticity equal to 0.95 and 0.38. The average decrease of consumer price index led to the growth of the consumption of vegetables. This trend is proved by the coefficients of correlation, the limit effectiveness and the elasticity which are equal to -0.56; -0.43; and -0.28, respectively. The consumption of fruits and berries is relevant, too. In this case, the coefficients of correlation and elasticity are equal to 0.96 and 0.34. The increase in consumption of fruit and berries under a slight fluctuation of the consumer price index is reflected in the coefficients of correlation, the limit effectiveness and elasticity equal to -0.73; -0.15; and -0.36, respectively. A gradual increase in meat products prices did not affect the consumption of meat, since the correlation coefficient was only 0.16.

The consumption of milk in Ukraine was almost stable fluctuating within $\pm 4\%$ during 2007-2014. Thus, the increase in salaries did not become an influential factor determining the demand for milk with the correlation coefficient equal to only 0.12. The same situation was observed with regard to the fluctuation of the consumer price index, when the coefficients

of correlation, the limit effectiveness and the elasticity got values -0.11; -0.06; -0.03, respectively.

Similar to the consumption of meat, the demand for eggs was positively affected by the increase of salaries, which is verified by the coefficients of correlation and elasticity equal to 0.94 and 0.2. The priority of the consumption of eggs, as compared with other types of animal products, was caused substantially by a lesser consumer price index in 2007-2014. In coefficients of correlation, the limit effectiveness and the elasticity this trend equals to -0.79; -1.08; -0.4, respectively.

Ukrainian economics is transforming from industrial to postindustrial. Capital and energy sources form the basis for the industrial type of economy, whereas the well-being in the postindustrial era is grounded on scientific technologies, information and knowledge, which are considered to be the main production resources, as well as on the fact that human resources require constant enhancement of their qualifications. Professional development is extremely necessary for modernization and intensification of the Ukrainian agriculture. Creation of incentives is a powerful driver of labour productivity and quality enhancement. The main incentive in this case is the amount of money earned. During the 2007-2014 period, the average wages in the Ukrainian agriculture increased by 3.32 times. Nevertheless, workers of agrarian sector receive one of the lowest wages (UAH 2,476 which is equivalent to USD 100 per month) as compared to other kinds of economic activity in our country [13].

The performed analysis of the agrarian markets by the 6 lines of production confirms the existence of a close link between supply and the average wages in the Ukrainian agricultural enterprises during 2007-2014. Namely, the correlation coefficients for grain, vegetables, fruits & berries production are 0.91; 0.7; and 0.89. They are even higher for meat, milk and egg production: 0.9; 0.9; and 0.97, respectively.

Taking into consideration the impact of the limit effectiveness regarding the average wages in agriculture on volumes of crop production, we can state that the production of grain is the most potent (with its index of 15.75), whereas the production fruits and berries is the weakest (with its index equal to 0.12). A similar situation was observed in livestock production. The limit effectiveness of the average wages in agriculture affect production volumes most if we consider the production of eggs in agricultural enterprises (with its index of 2.99), whereas the weakest is the production of milk (with its index equal to 0.7).

A relative dependency volumes of production on monetary valuation of work is characterized by elasticity. The highest level of elasticity corresponds most to the increase of the average wages in agriculture during the 2007-2014 period is related to grain, fruits & berries and meat production with the indices of 0.7; 0.66; 0.64, respectively. The increase of average wages in agriculture brought the least gains for egg, vegetable and milk production, which is verified by the elasticity coefficients equal to 0.46; 0.43; and 0.21.

5. Conclusions

Summarizing the conducted economic and mathematical analysis of the state of Ukraine's agrarian market, we can conclude the following:

1. It has been determined that Ukrainian agriculture has a positive branch disproportion between supply and demand in grain, vegetable and egg productions. Meat and fruits & berries subcomplexes lagged behind the needs of the population, even if its limited solvency is considered.

2. The strongest link between production and consumption was revealed regarding vegetables, fruits and berries, meat and egg products with their correlation coefficients ranging between 0.9 and 0.99, the limit effectiveness ranging between 1.15 and 2.5 and the elasticity ranging between 1.13 and 1.56. The most positive dependence of consumption on production was detected for the vegetable and milk subcomplexes, where the limit effectiveness and elasticity are equal to 0.66; 0.86 and 0.63; 0.73, respectively.

3. It has been clarified that the domestic households use their income growth most effectively to increase crop produc-

tion, whereas for agricultural enterprises it results in the enhancement of grain and egg production. The average wages growth has the weakest impacts on productivity in the vegetable and milk subcomplexes.

4. The strongest resilience in to the increase of consumer prices is observed with regard to meat and milk products, whereas the increase in the solvency of the population caused a reduction of bread consumption (with the coefficients of correlation and elasticity equal to -0.94 and -0.08) and accelerated demands for vegetables, fruits & berries (with the coefficients of correlation and elasticity equal to 0.95; 0.96 and 0.38; 0.34, respectively).

5. It is appropriate to carry out further scientific researches with regard to the development of branch mechanisms which will help to increase the Ukrainian agrarian markets.

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Received 6.10.2015

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Стаття надійшла до редакції 6.10.2015