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SPATIAL DEVELOPMENT MODELING OF THE POLTAVA REGION

Spatial development characterizes and coordinates all elements of the region: economic, social, ecological, innovative, technological and other spheres in a certain territory, and takes into account all interrelations between them, directions of their growth.

The modeling basis of the region spatial development is the types of economic activity, the result of which is the obtained gross of regional product, and the result of effective regional policy, that is, balanced use of available natural, material, financial resources is not only the economic growth of the region, and the social, ecological effect, that is, increase jobs, incomes, improving infrastructure and reducing environmental pollution.

By the instrumentality of constructed models, it is possible to determine the economic activity priority types, which will allow to build a strategic plan of region spatial development.

The models are reliable and adequate, which were checked by the determination coefficient and Fisher's criterion. Dependence of the two economic activity types, which will provide the relationship of the gross regional product in the amount of 100000 million UAH, 115000 million. UAH., 130000 UAH are graphically depicted.

The dependence modeling of the agriculture, forestry and fisheries and wholesale and retail trade are presented in the following way and is graphically depicted on Fig. 1:

$$y = 74,512447 \times x_1^{0,35599} \times x_6^{0,4189} , \tag{1}$$

where x_1 – agricultural, forestry and fishery in the GRP;

x_6 – wholesale and retail trade, repair of vehicles in GRP.

Model verification: $R^2 = 0,84755$; $F_p = 36,136 \rangle F_{кр} = 3,806$.

Isoquant dependence of agriculture, forestry, fisheries, wholesale and retail trade is declining, that is, with the growth of agriculture in the GRP, trade volumes are decreasing. This explains the necessity of ensuring priority investment in agriculture, because Poltava region has great potential land resources.
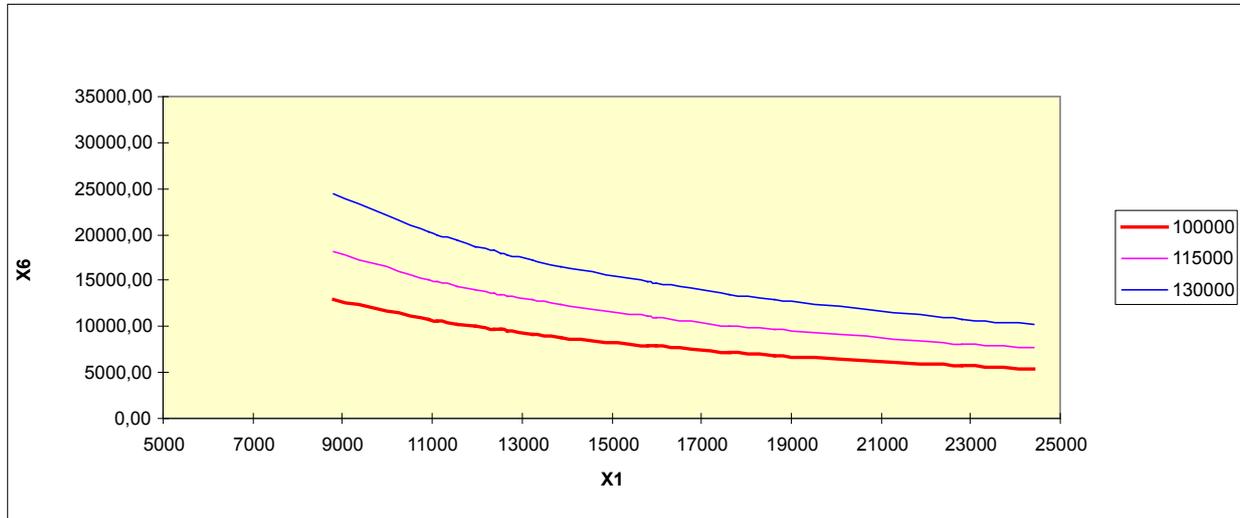

Fig. 1 The dependence modeling of agriculture, forestry, fisheries and trade in the GRP of the Poltava region

The dependence modeling of agriculture, forestry and fisheries and supplying electricity, gas, steam, air conditioning, water supply, sewage, waste management is presented in the following way and is graphically depicted in fig. 1:

$$y = 243,90894 \times x_1^{0,3591} \times x_4^{0,3286},$$ (2)

where x_4 – supply of electricity, gas, steam, air conditioning, water supply, sewage, waste management in the GRP.

Model verification: $R^2 = 0,42101$; $F_p = 4,726 \rangle F_{кр} = 3,806$.

Isoquant has a tendency to decrease and indicates the priority of agricultural development. The increase in the amount of agriculture, fish and forestry in the GRP causes a decrease in the supply of electricity, gas, steam, air conditioning, water supply, sewage, waste management in the GRP. The conducted simulation will allow to determine the optimal level of the data of the TEA, which will allow to plan the development of agriculture, which is a strategic reference point for the spatial development of the Poltava region.

The proceeded modeling will allow to determine the optimal level of the TEA data, which will allow to plan the development of agriculture, which is a strategic reference point for the spatial development of the Poltava region.
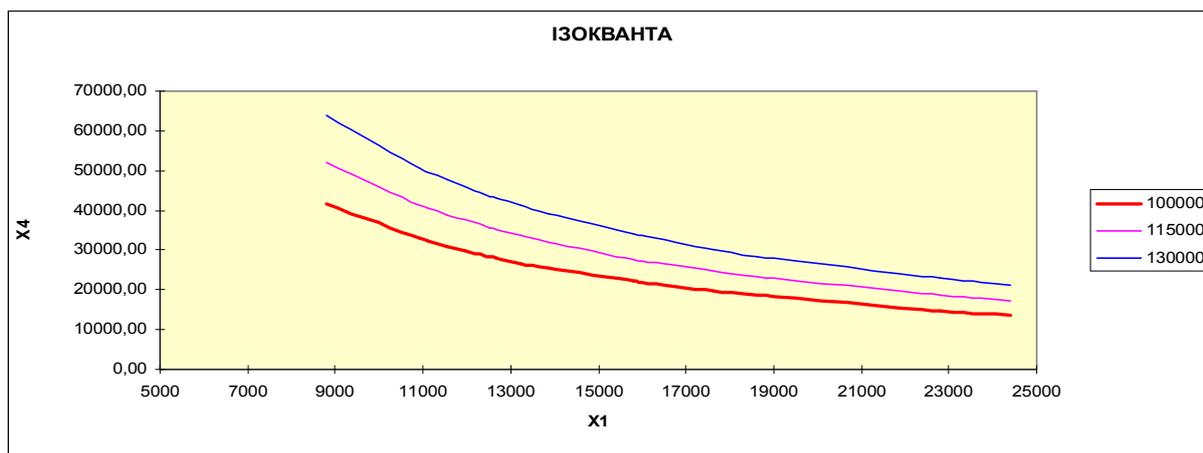
Fig. 2 The dependence modeling of agriculture, forestry and fisheries and supply of electricity, gas, steam, air conditioning, water supply, sewage, waste management in the GRP of the Poltava region

The dependence modeling of agriculture, forestry and fisheries and transport, warehousing, postal and courier delivery is presented in the following way and is graphically depicted in fig. 3:

$$y = 6{,}5403117 \times x_1^{0,5258} \times x_7^{0,5093} , \qquad (3)$$

where x_7 – transport, warehousing, postal and courier delivery in GRP.

Model verification: $R^2 = 0{,}65669$; $F_p = 12{,}433 \rangle F_{\text{кр}} = 3{,}806$.

Isoquant dependence of agriculture, forestry, fisheries and transport, warehousing, postal and courier delivery is declining and suggests that with an increase in agriculture, fisheries and forestry, the GRP will reduce transport in the GRP.

Although the availability of transport infrastructure, that is, the availability of high-quality roads, railways and river transport, is very important for this TEA.
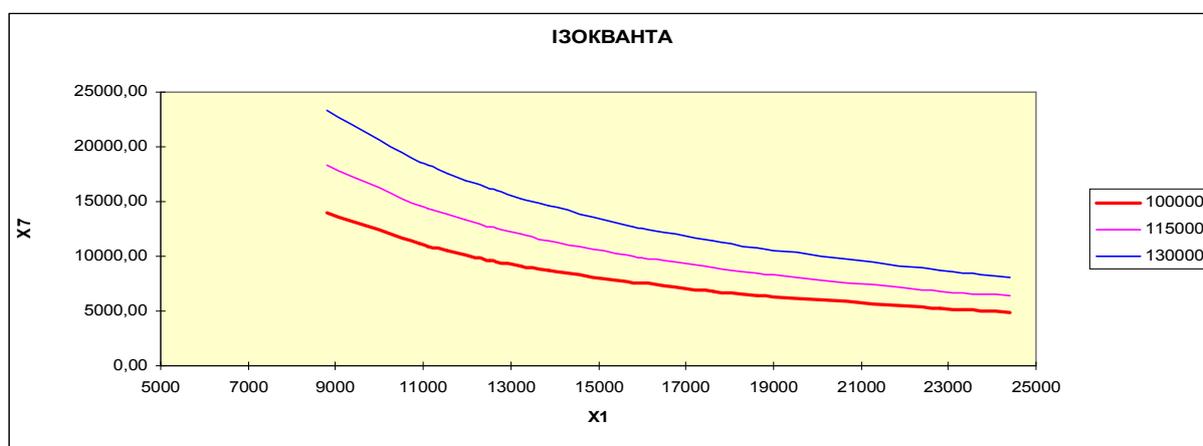

Fig. 3 The dependence modeling of agriculture, forestry, fisheries, transport, warehousing, postal and courier delivery to the GRP of the Poltava region

The dependence modeling of agriculture, forestry, fisheries, financial and insurance activities in the GRP is presented in the following way and is graphically depicted in fig. 4:

$$y = 263,04002 \times x_1^{0,3945} \times x_8^{0,2774}, \tag{4}$$

where x_8 – financial and insurance activities in the GRP.

Model verification: $R^2 = 0,82788$; $F_p = 31,264 \rangle F_{кр} = 3,806$

Isoquant dependence of agriculture, forestry, fisheries, financial, insurance activities is declining and suggests that with an increase in agriculture, forestry, fisheries, the GRP will reduce financial and insurance activities in the GRP of the Poltava region. Although for this TEA it is extremely important to receive loans and credits during the period of the sowing company, especially for small farms.
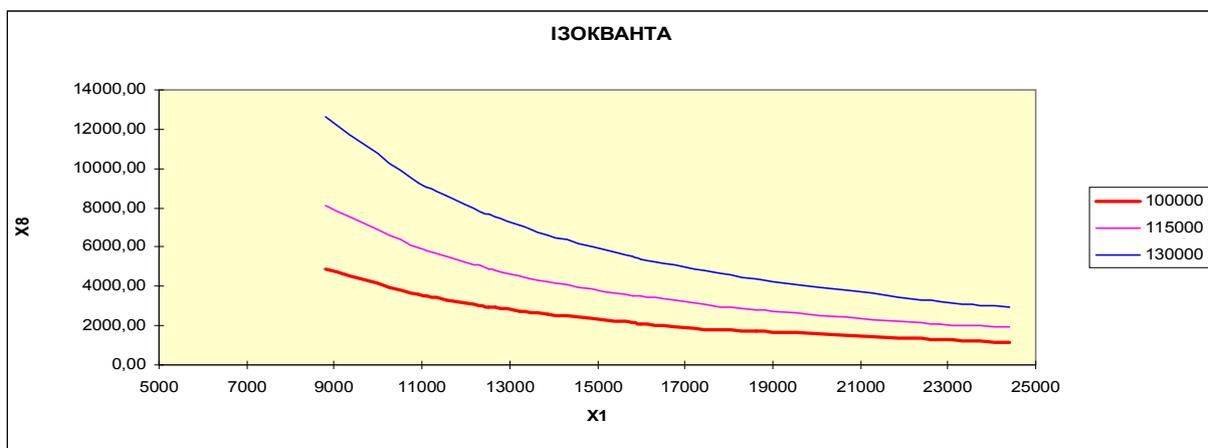

Fig. 4 The dependence modeling of agriculture, forestry, fisheries, financial and insurance activities in the GRP Poltava region

The dependence modeling of agriculture, forestry and fisheries and real estate activities in the GRP is presented in the following way and is graphically depicted in Fig. 5:

$$y = 950,54379 \times x_1^{0,0379} \times x_9^{0,5122}, \tag{5}$$

where x_9 – real estate activities in the GRP.

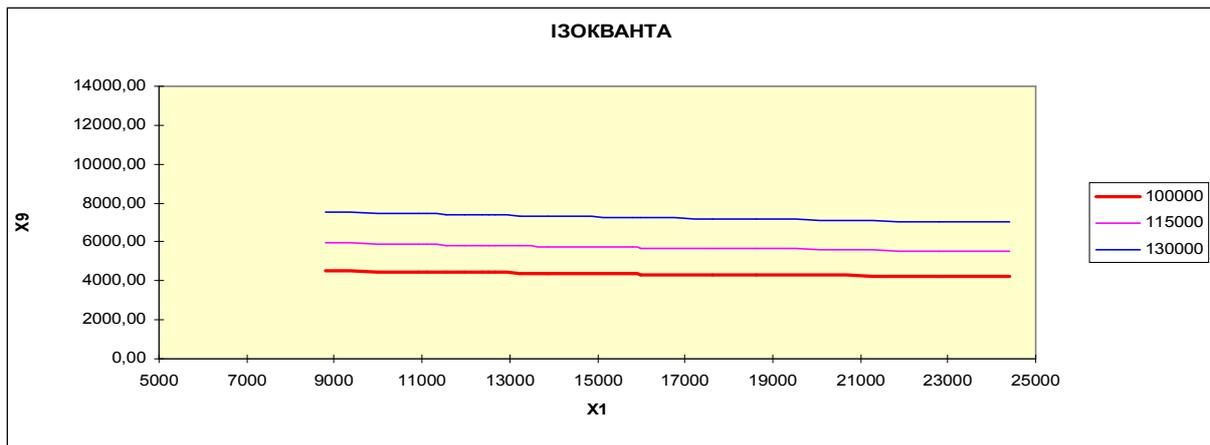Model verification: $R^2 = 0,77722$; $F_p = 22,677 \rangle F_{кр} = 3,806$.

Fig. 5 The dependence modeling of the agricultural, forestry, fishery and real estate activities in the GRP of the Poltava region

Isoquant dependence of the agricultural, fishery, forestry and real estate operations is almost unchanged and suggests that with an increase in the agricultural, fishery, forestry in the GRP, the volume of real estate operations will be a constant value in the GRP of the Poltava region, that is, this TEA does not effect on agriculture development. Nevertheless, this model allows to predict the impact of agricultural growth on the planned gross regional product.

Modeling dependence extractive and processing industry in the GRP presented as follows and shown graphically in Fig. 6:

$$y = 34,143359 \times x_2^{0,3919} \times x_3^{0,4121}, \tag{6}$$

where x_2 – extractive industry in the GRP;

x_3 –processing industry in the GRP.

Model verification: $R^2 = 0,95340$; $F_p = 132,976 \rangle F_{\kappa p} = 3,806$.
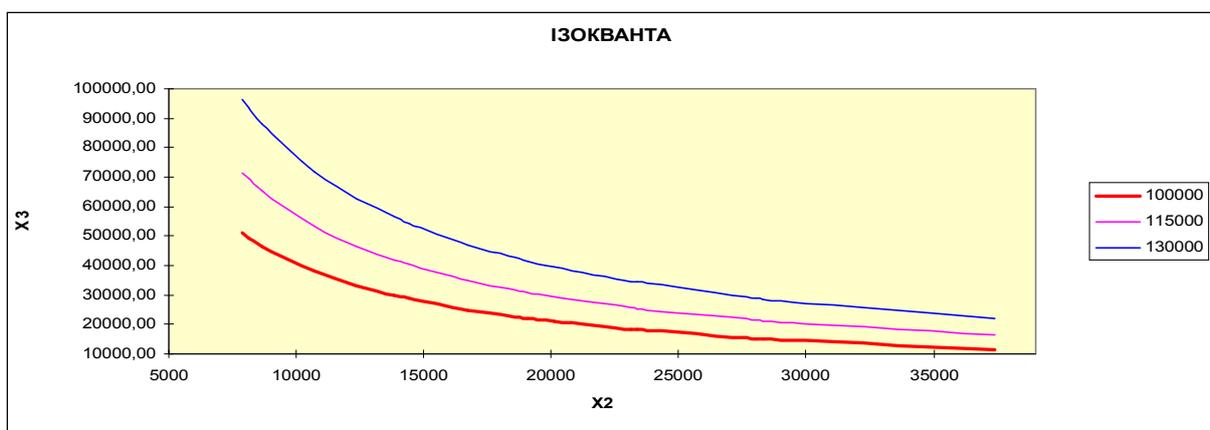

Fig. 6 The dependence modeling of extractive and processing industry in the GRP of the Poltava region

Isoquant dependence of extractive and processing industries in the Poltava region's GRP is declining and suggests that with the increase of extractive industry in the GRP, the value of the processing industry in the GRP will decrease. Extractive industry is the structure-generating gross regional product of the Poltava region and the main strategic priority, especially in the context of the formation of the gas market, a sharp rise in energy prices.

The dependence modeling of extractive industry and construction in the GRP is presented in the following way and is graphically depicted in fig. 7:

$$y = 27,12393 \times x_2^{0,5352} \times x_5^{0,3788}, \tag{7}$$

where x_5 – construction in the GRP.

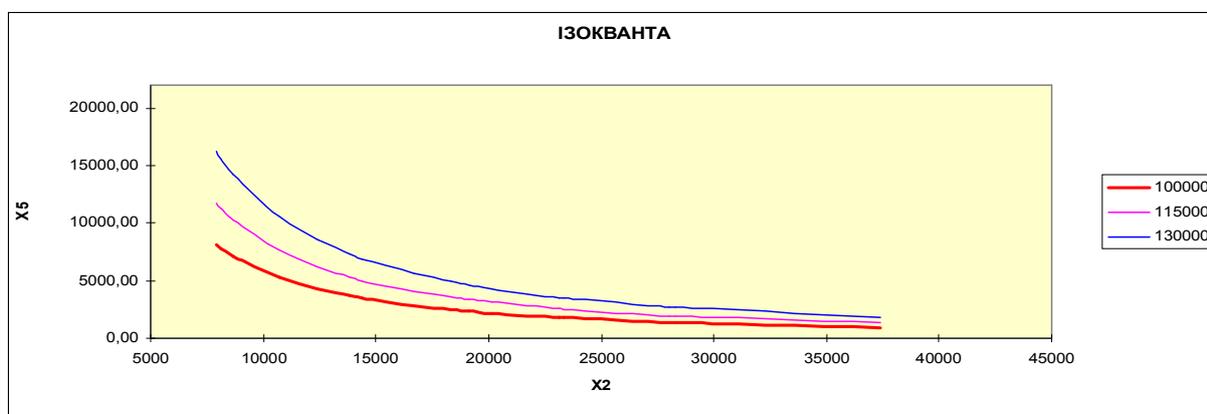Model verification: $R^2 = 0,85753$; $F_p = 39,123 \rangle F_{\kappa p} = 3,806$

Fig. 7 The dependence modeling of extractive industry and construction in the GRP Poltava region

Isoquant dependence of extractive industry and construction in the GRP Poltava region is declining and suggests that with the increase of extractive industry in the GRP, the volume of construction will be reduced. Although in the development of mining industry, the volume of construction of engineering facilities will also increase, which is due to the development of new deposits.

The dependence modeling of the mining industry, wholesale and retail trade in the GRP is presented in the following way and is graphically depicted in fig. 8:

$$y = 557,18405 \times x_2^{0,25995} \times x_6^{0,2933} \tag{8}$$

Model verification: $R^2 = 0,90287$; $F_p = 60,422 \rangle F_{\kappa p} = 3,806$
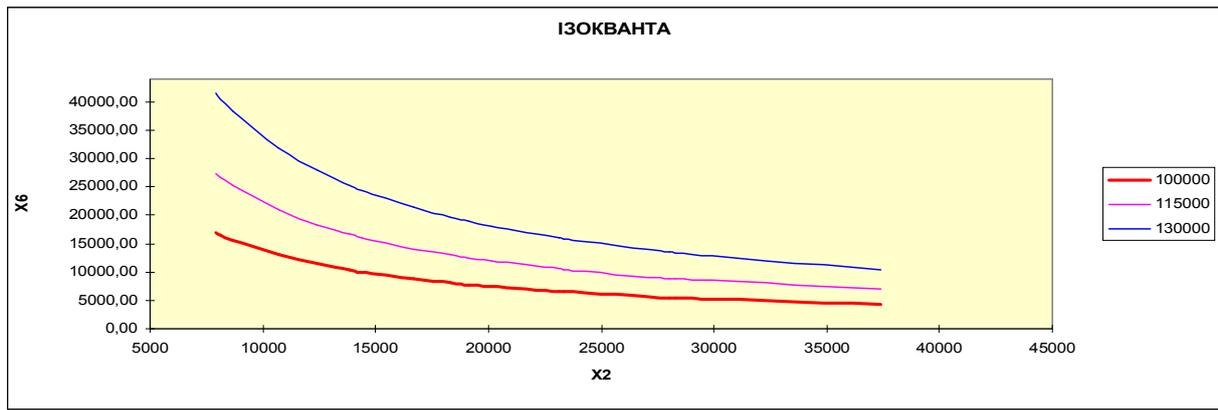
Fig. 8 The dependence modeling of the mining industry, wholesale and retail trade in the GRP of the Poltava region

Isoquant dependence of mining industry, wholesale and retail trade in the GRP of the Poltava region is declining and reflects the tendency to reduce trade while the extractive industry's volumes is increasing. This is explained by the fact that most of the trade is retail, and its consumers are mainly citizens and small commodity producers. In addition, there is a resale of goods between dealers. At that time, extractive industry is characterized by an increase in production volumes, and the main consumers of such products are large enterprises [1].

The dependence modeling of extractive industry and transport, warehousing, postal and courier delivery in the GRP is presented as follows and graphically depicted in fig. 9:

$$y = 167,37124 \times x_2^{0,5258} \times x_7^{0,5093} \tag{9}$$

Model verification: $R^2 = 0,84172$; $F_p = 34,567 \rangle F_{\kappa p} = 3,806$

Isoquant dependence of extractive industry, transport, warehousing, postal and courier delivery to the territorial unit of the Poltava region is declining and suggests that with the increase of the extractive industry in the GRP, transport will decrease. Although in the development of extractive industries, transport infrastructure is very important in the development of new fields and the extraction of resources.
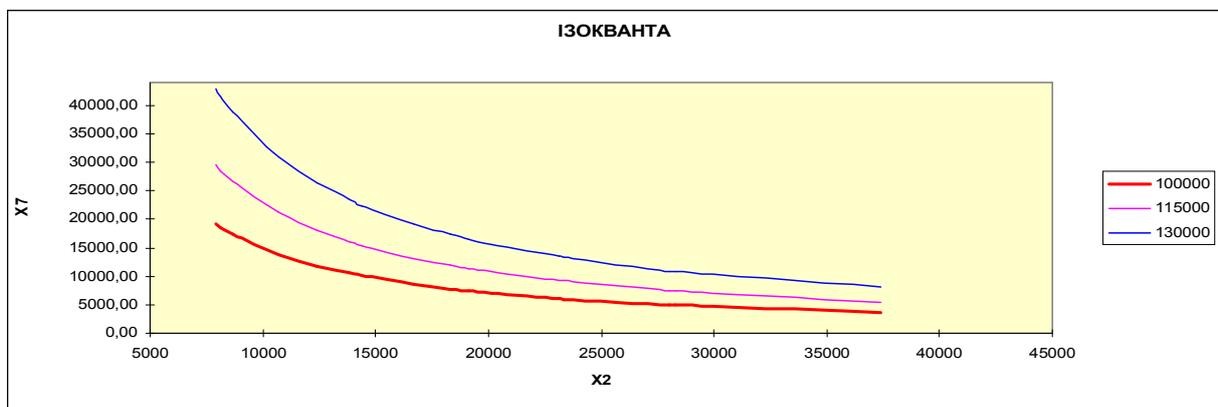
Fig. 9 The dependence modeling of mining industry, transport, warehousing, postal and courier delivery in the GRP of the Poltava region

The dependence modeling of mining industry, financial and insurance activities in the GRP is presented in the following way and is graphically depicted in fig. 10:

The dependence modeling of mining industry, financial and insurance activities in the GRP is presented in the following way and is graphically depicted in fig. 10:

$$y = 1479,2664 \times x_2^{0,28} \times x_8^{0,1903} \qquad (10)$$

Model verification: $R^2 = 0,89952$; $F_p = 58,191 \rangle F_{\kappa p} = 3,806$

Isoquant dependence of extractive industry, financial and insurance activities in the GRP of the Poltava region is declining and suggests that with the increase of extractive industry in the GRP, financial and insurance activities will decrease. These calculations indicate that the extractive industry does not require additional funding. Although for the development of new fields, it is expedient to modernize the equipment, apply fundamentally new, energy-efficient technologies. Such measures require additional financial support for innovation and investment projects, the implementation of which will reduce the energy dependence of Ukraine from Russia.
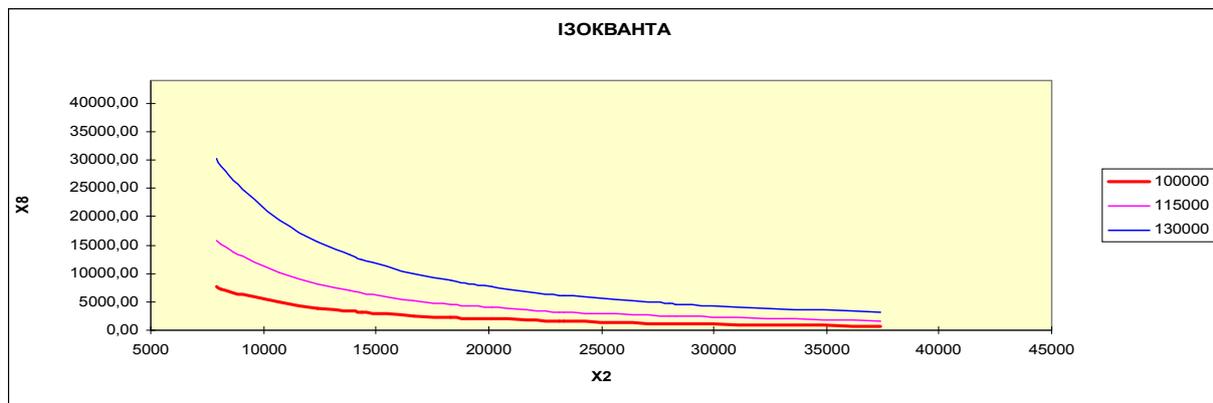

Fig. 10 The dependence modeling of extractive industry, financial and insurance activity in the GRP of the Poltava region

The dependence modeling of extractive industry and operations with real estate in the GRP is presented as follows and graphically depicted in fig. 11:

$$y = 1209,3569 \times x_2^{0,1433} \times x_9^{0,35996} \qquad (11)$$

Model verification: $R^2 = 0,80665$; $F_p = 27,117 \rangle F_{\kappa p} = 3,806$

Isoquant dependence of mining industry and real estate operations in the GRP of the Poltava region is declining and suggests that with the increase of extractive industry in the GRP, the volume of real estate operations is decreasing slightly. These calculations show that extractive industry is a priority type of economic activity not only for the Poltava region, but also for whole Ukraine. The

development of this type of economic activity allows both to increase the gross regional product and the size of the average wage in the region, and, consequently, the purchasing power of the population. Such tendency will effect on increase in real estate operations.
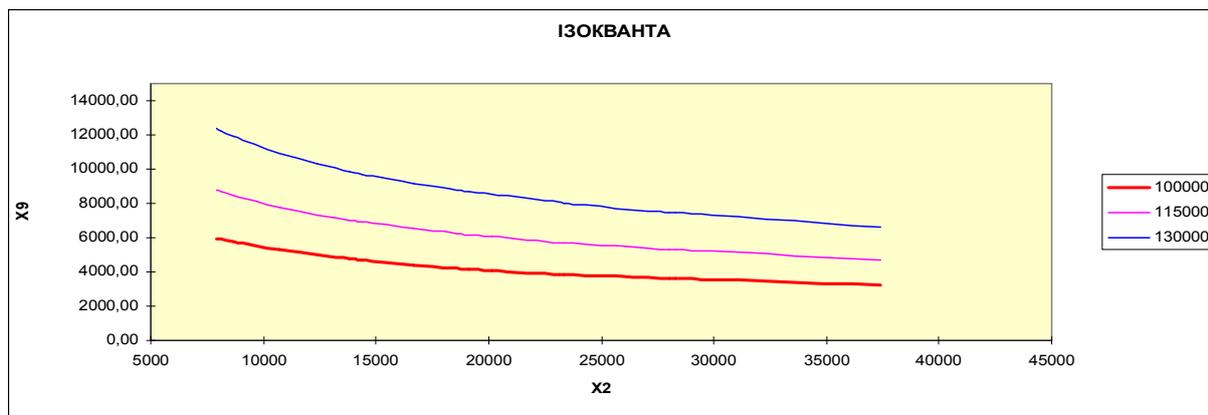

Fig. 11 The dependence modeling of extractive industry and real estate operations in the GRP of the Poltava region

The dependence modeling of the processing industry and the supply of electricity, gas, steam, air conditioning, water supply, sewage, waste management is presented in the following way and is graphically depicted in fig. 12:

$$y = 11,197908 \times x_3^{0,3985} \times x_4^{0,6476} \tag{12}$$

Model verification: $R^2 = 0,43258$; $F_p = 4,955 \rangle F_{\kappa p} = 3,806$

Isoquant dependence of the processing industry and the supply of electricity, gas, steam, air conditioning, water supply, sewage, waste management in the territorial unit of the Poltava region is decreasing and shows that with the increase of the processing industry in the GRP, the volume of electricity, gas, steam, air conditioning, water supply, sewage, waste management is reduced slightly. These calculations indicate that the processing industry depends on its supply of energy resources, as in the Poltava region the processing industry is represented by large, structuring enterprises of mechanical engineering, food processing, oil refining, metallurgy, woodworking, and pharmaceutical industries.
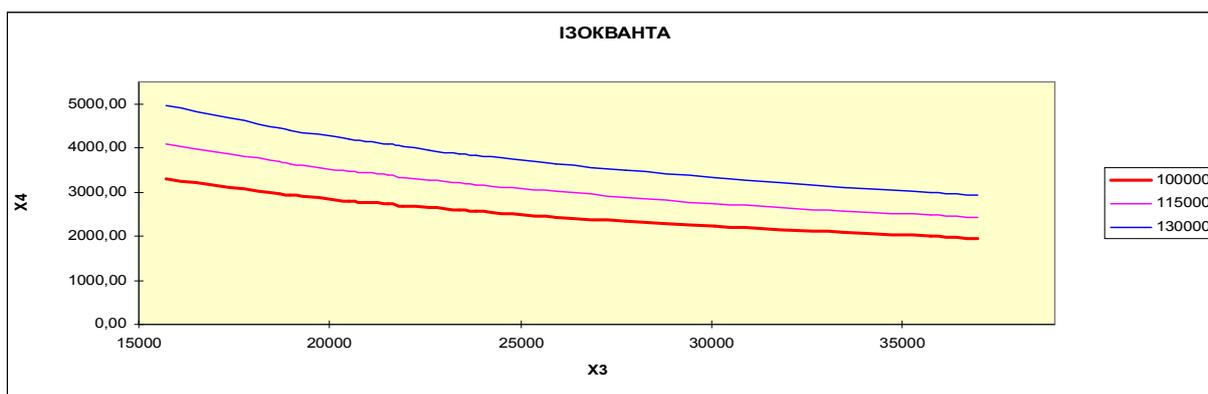
Fig. 12 The dependence modeling of the processing industry and supply of electricity, gas, steam, air conditioning, water supply, sewage, waste management at the GRP of the Poltava region

The dependence modeling of the processing industry and operations with real estate in the GRP is presented as follows and graphically depicted in fig. 13:

$$y = 78,075196 \times x_3^{0,2732} \times x_9^{0,5245} \qquad (13)$$

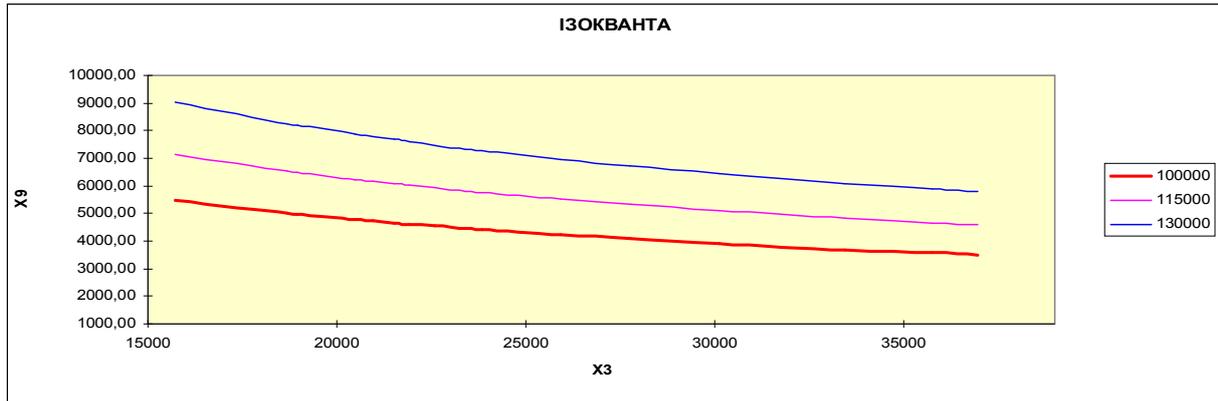Model verification: $R^2 = 0,88551; Fp = 50,272 \rangle F_{\kappa p} = 3,806$

Fig. 13 The dependence modeling of the processing industry and real estate operations in the GRP of the Poltava region

Isoquant dependence of the processing industry and real estate operations in the GRP of the Poltava region is declining and suggests that with the increase of the processing industry in the GRP, the volume of transactions with real estate is reduced slightly. The processing industry is a priority type of economic activity and the increase in the contribution to the gross regional product depends to a certain extent on the volume of real estate operations. For the interior design of residential and non-residential premises, the products of woodworking enterprises, textile industry, etc. are used.

The dependence modeling of electricity supply, gas, steam, air conditioning, water supply, sewage, waste management, wholesale and retail trade is presented in the following way and is graphically depicted in fig. 14:

$$y = 735,82321 \times x_4^{0,1299} \times x_6^{0,4296} \qquad (14)$$

Model verification: $R^2 = 0,62479; Fp = 10,824 \rangle F_{\kappa p} = 3,806$
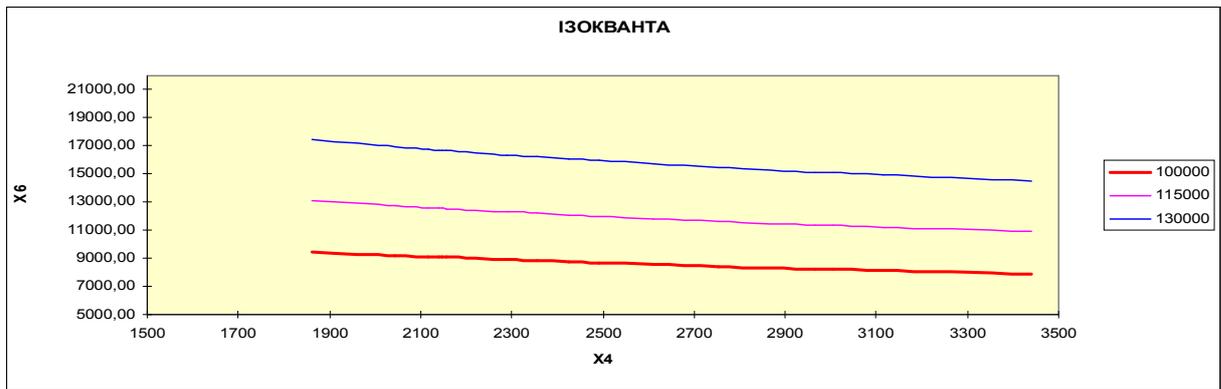
Fig. 14 the dependence modeling of electricity supply, gas, steam, air-conditioning, water supply, sewage, waste management, wholesale and retail trade in the GRP of the Poltava region

Isoquant dependence of the electricity supply, gas, steam, air conditioning, water supply, sewage, waste management, wholesale and retail trade in the GRP of the Poltava region is slightly decreasing and indicates that with increasing electricity, gas supply to the GRP, wholesale and retail trade remains almost unchanged. Because energy resources are consumed, mainly by the processing industry.

The dependence modeling of electricity, gas, steam, air conditioning, water supply, sewage, waste management, financial and insurance activities is presented in the following way and is graphically depicted in fig. 15:

$$y = 2447,4925 \times x_4^{0,2114} \times x_8^{0,2629} \qquad (15)$$

Model verification: $R^2 = 0,56532$; $Fp = 8,454 \rangle F_{кр} = 3,806$
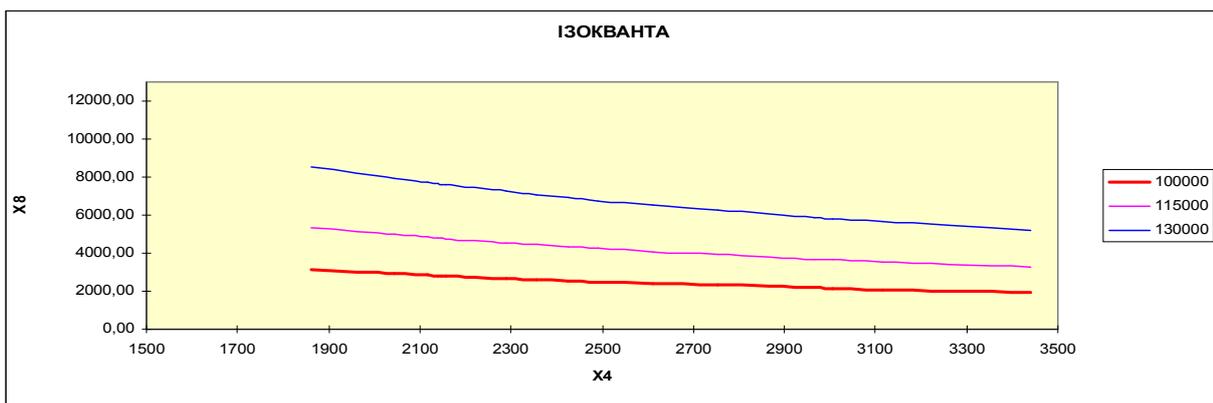

Fig.

15 The dependence modeling of electricity supply, gas, steam, air conditioning, water supply, sewage, waste management, financial and insurance activities in the GRP of the Poltava region

Isoquant dependence of the electricity supply, gas, steam, air conditioning, water supply, sewage, waste management, financial and insurance activities in the GRP of the Poltava region is also decreasing slightly and suggests that with increasing electricity and gas supply to the GRP,

financial and insurance activities remain almost unchanged. Because industry is a priority type of economic activity and has rather own financial resources for development, but still needs additional funds for reorganization, equipment modernization, energy efficiency improvement of production. The dependence modeling of financial and insurance activities, real estate operations is presented in the following way and is graphically depicted in fig. 16:

$$y = 1258,5324 \times x_8^{0,0979} \times x_9^{0,4309} \qquad (16)$$

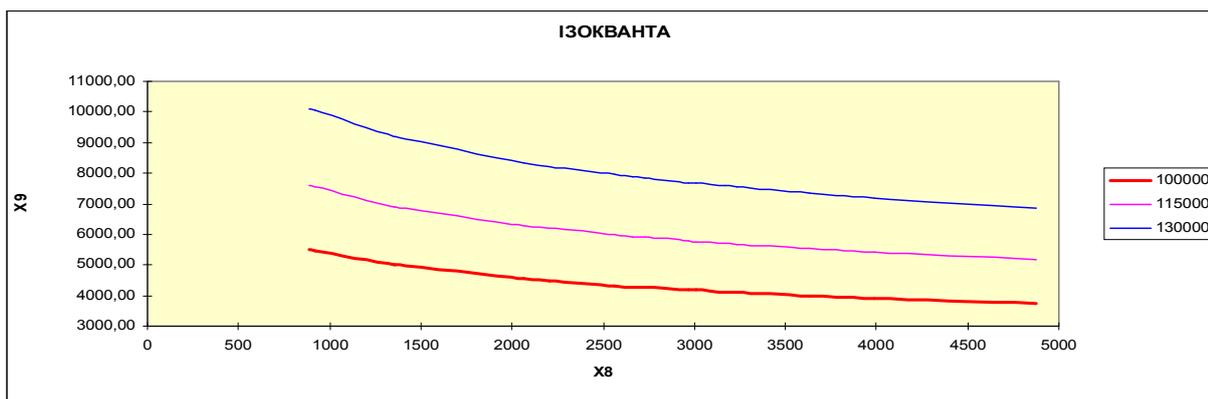Model verification: $R^2 = 0,80732$; $Fp = 27,235 \rangle F_{\kappa p} = 3,806$

Fig. 16 The dependence modeling of financial and insurance activities, real estate operations in the GRP of the Poltava region

Isoquant dependence of financial and insurance activities, real estate operations in the GRP of the Poltava region is declining and suggests that the financial sector needs to grow in order to secure the volume of real estate operations. The development of the financial and insurance activities of the Poltava region will facilitate the revival of the real estate market.

The dependence modeling of transport, warehouse, postal and courier delivery in the GRP of the Poltava region and operations with real estate is presented in the following way and is graphically depicted in Fig. 17:

$$y = 876,2004 \times x_7^{0,0414} \times x_9^{0,5205}, \qquad (17)$$

where x_7 – transport, warehouse, postal and courier delivery in the GRP;

x_9 – operations with real estate in the GRP.

Model verification: $R^2 = 0,77739$; $Fp = 22,700 \rangle F_{\kappa p} = 3,806$
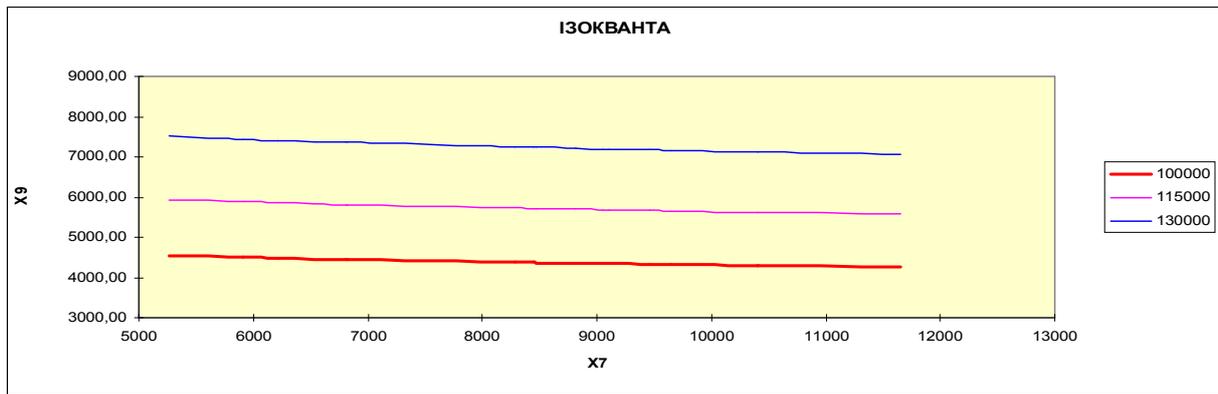
Fig. 17 The dependence modeling of transport, warehousing, postal and courier delivery, real estate operations in the GRP of the Poltava region

Isoquant dependence of transport, warehousing, postal and courier delivery, real estate operations in the GRP of the Poltava region is almost straightforward and suggests that qualitative infrastructure support is important for increasing the volume of real estate operations.

The dependence modeling of construction in the GRP of the Poltava region and operations with real estate is presented in the following way and is graphically depicted in fig. 18:

$$y = 425{,}47 \times x_5^{0,0855} \times x_9^{0,5706}, \tag{18}$$

where x_5 – construction in the GRP.

Model verification: $R^2 = 0{,}78769$; $Fp = 24{,}115 \rangle F_{\kappa p} = 3{,}806$

Isoquant dependence of construction and real estate operations in the GRP of the Poltava region is almost straight and suggests that the development of construction is interconnected with the increase in the volume of transactions with real estate. In general, the increase in the volume of construction products is an indicator of the improvement of the economy of a whole region.
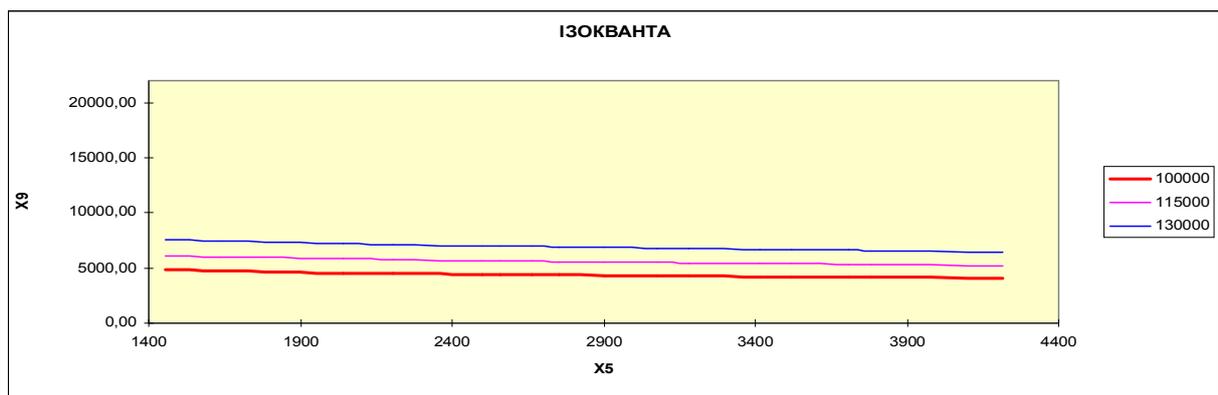

Fig. 18 The dependence modeling of construction and real estate operations in the GRP of the Poltava region

The dependence modeling of wholesale and retail trade in the GRP of the Poltava region and operations with real estate is presented in the following way and is graphically depicted in fig. 19:

$$y = 681,81399 \times x_6^{0,1841} \times x_9^{0,3962} \qquad (19)$$

Model verification: $R^2 = 0,82317$; $Fp = 30,259 \rangle F_{\kappa p} = 3,806$.

Isoquant dependence of wholesale and retail trade, real estate operations on the gross regional product of the Poltava region is declining and suggests that with the growth of trade turnover, the volume of real estate transactions will decrease slightly.

In general, the development of the real estate market is interconnected with the state of the trading space provision. During creation of spatial development strategies related to the aforementioned types of economic activities, it is necessary to take into account the comfort of living for the population inhabitants, infrastructure and social security.
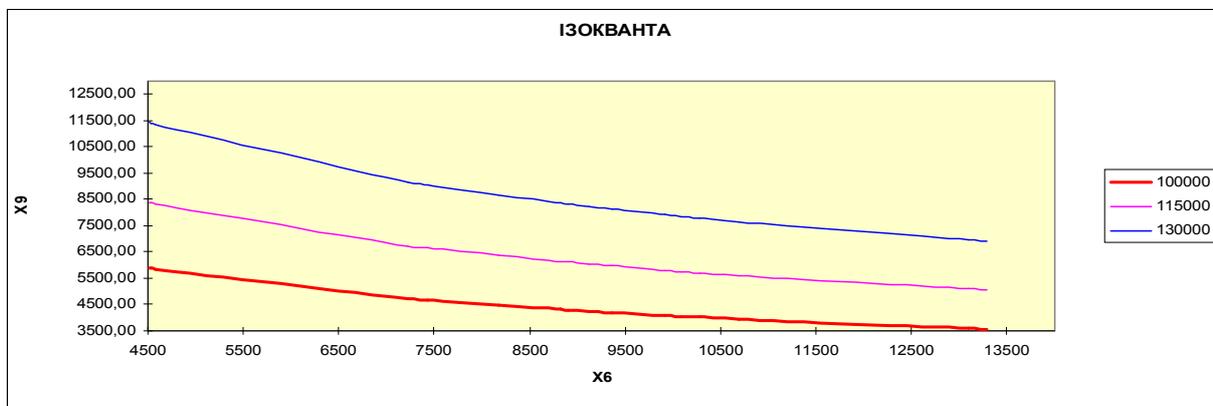

Fig. 19 The dependence modeling of wholesale and retail trade, real estate operations in the GRP of the Poltava region

The dependence modeling of wholesale and retail trade in the GRP of the Poltava region, financial and insurance activities is presented in the following way and is graphically depicted in fig. 20:

$$y = 1988,4137 \times x_6^{0,3771} \times x_8^{0,0637} \qquad (20)$$

Model verification: $R^2 = 0,62003$; $Fp = 10,607 \rangle F_{\kappa p} = 3,806$.
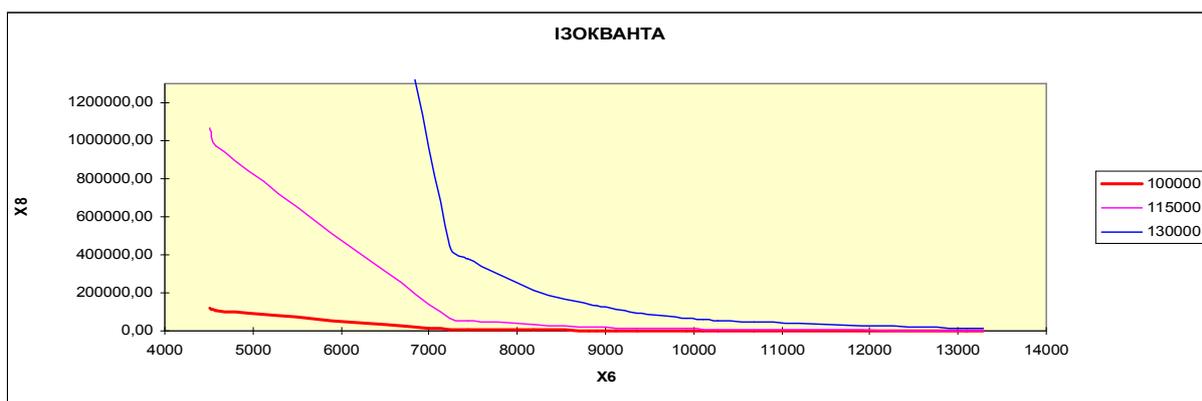
Fig. 20 The dependence modeling of wholesale and retail trade, financial and insurance activities in the GRP of the Poltava region

Isoquant dependence of wholesale and retail trade, financial and insurance activities in the gross regional product of the Poltava region is sharply declining and ambiguous. This model shows that trade development will provide adequate financial resources. Particularly for small businesses, support from the state, region, international organizations, and the availability of preferential lending is very important. Such measures will reduce the unemployment rate, increase incomes, improve the spatial characteristics of the region.

Developed models of spatial development of the Poltava region based on certain interconnections of economic activity allowed to determine the priority of development of agriculture, extractive and processing industry, wholesale and retail trade, transport equipment, real estate operations, financial and insurance activities, construction.

The modeling allowed to determine the significant impact on the development of the material sphere of financial and insurance activities and operations with real estate. Therefore, it is very important in the strategic plan of spatial development of key economic activities to provide development of investment support lines taking into account European experience, that is, the use of traditional sources of financing (budget funds) and funds that should be controlled by territorial communities: State Fund for Regional Development, private and international funds.

It should be noted that the developed models of economic activity type's interconnections do not take into account the investment component for achieving the growth of the gross regional product.

Based on the use of the Cobb-Douglas and Lagrange production function method, it is appropriate to redistribute and determine the optimal amount of investments that will ensure the economic growth of the Poltava region. These calculations are the basis for developing a strategic plan for spatial development of priority economic activities in the Poltava region.

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