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# 6Forecasting Production Performance

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***Abstract:***

*This article considers the application of econometric calculations by the method of statistical dependence equations to analyze the relationships between various factors and the performance indicator.*

*It is noted that the use of econometric calculations should be based on knowledge and understanding of the essence of economic processes and phenomena, the specifics of economic interrelations and the laws of their development.*

*The study presents the methodology by using statistical dependence equations and calculating the factor stability coefficients based on the actual development indicators of the livestock sector in the Akmola region over several years.*

***Keywords:*** *Statistical information, econometric calculations, multiple regression equation, method of statistical dependence equations, trend equation, factor comparison coefficients.*

***JEL Classification:*** *C53, E17, E3.*

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## 1. Introduction

Many economic phenomena and processes are not subject to an accurate evaluation, which results in a significant degree of uncertainty that can change the situation and direction of production development, often contrary to common sense and economic plans. In addition, not all information makes it possible to calculate indicators that are necessary to substantiate the prospects for the development of economic processes. On the other hand, it is important to apply the methods of information evaluation correctly since the use of the same method with the same information may draw completely different conclusions. In addition, numerous methods and means of information evaluation in econometric calculations can be applied with varying degrees of effectiveness. Therefore, using statistical and economic information characterizing economic performance, one should evaluate the links between various factors and performance indicators, identify their trends and develop economic forecasts.

## 2. Materials and Methods

In statistical literature, various statistical and mathematical methods are given that help to make concrete econometric calculations for a comprehensive description of economic processes, the identification of advantages and disadvantages as well as the determination of measures to eliminate undesirable tendencies (Afanasyev, 2005; Dubrov *et al.*, 2010; Eliseyeva, 2011). The use of the methods of statistical dependence equations is because they allow for a more reliable evaluation of the relationship between performance indicators and different factors of economic activities as well as a forecast of production development on their basis.

However, not all statistical methods can be applied to evaluate the interrelation of performance indicators with various factors. Without negating the advantages of such well-known statistical methods as grouping, dispersion analysis, index method, etc., (Kremer, 2011; Aivazyan and Mkhitaryan, 2012; Eliseyeva and Yuzbashev, 2012), as well as mathematical methods for studying dependencies, we will focus on the application of regression and correlation analysis and statistical dependence equations for the evaluation of interrelations. At the same time, we used the so-called Kulinich method as the basis of calculations, described in detail by Kulinich in his book "Econometrics" (Kulinich, 2012).

Many authors note that the application of certain methods allows to eliminate the influence of factors in econometric calculations, evaluating their influence through appropriate calculations as well as giving a more accurate forecast of economic performance (Berezhnaya and Berezhnoy, 2001; Afanasyev and Yuzbashev, 2005).

When setting the goal of the study, we proceeded from the fact that, since the regression analysis characterizes the quantitative relationship between factors and indicators, its outcomes help to establish how much the performance attribute will change when the factor attribute changes by unity, while all other factors remain unchanged. However, our goal, along with this, is to answer the following question: At what levels of factor changes will a given forecasted level of the performance indicator be achieved?

## 3. Results and Discussion

To start with, we would like to note that the main criterion and the necessary condition for the application of econometric calculations is, in our opinion, to know and understand the essence of economic processes and phenomena, the specifics of economic interrelations and the laws of their development. Only within this approach one can use different statistical methods.

One of these methods, which is used for the analysis, planning and forecasting of production, is a multifactorial production function, since the change in any economic indicator depends on the influence of many factors. If one neglects the influence of other factors affecting the object of investigation, a good result can be obtained by using the pair regression equation. However, since practically all performance indicators depend on many factors, the application of the multiple regression equation is more appropriate.

The multiple regression equation makes it possible to reveal the analytical form of the relationship between the dependent (performance) indicator and several independent (factor) variables. The main goal is to build a model with a variety of factors, while determining the influence of each of them separately as well as their combined effect on the performance indicator. The multiple regression model is an equation that reflects the correlation between the performance result and several factors. In other words, each of the factors included in the equation has a correlation relationship with the performance indicator.

The described dependence will be considered based on a example, using the actual development indicators of the livestock sector in the Akmola region for a number of years (see Appendix A). Based on these data, using the method of statistical dependence equations, we will compose equations and calculate the coefficients of meat production stability for each factor. The following factors were considered: $x_1$ the number of cattle, $x_2$ the number of cows, $x_3$ the number of sheep and goats, $x_4$ the number of pigs, and $x_5$ the number of horses. However, in the process of calculating the coefficients of dependencies, the factor $x_2$ was not included in the number of factors due to an insufficient level of relationship.

The method of statistical dependence equations first requires the determination of the parameters of single-factor dependence equations and the relationship stability coefficients. The methods for calculating the size of deviations of the single-factor comparison coefficients make it possible to separate the factors into those that influence the development of the performance indicator either positively or negatively, while the relationship stability coefficients help determine the sufficiency of its level to ensure the reliability of econometric calculations. Table 1 presents the results of calculating the coefficient of stability of the relationship between meat production (y) and the number of cattle ($x_1$).

***Table 1.*** *Initial and calculated data of the direct relationship equation parameters*

| No. | Year | Meat, thousand tons, y | Number of cattle, thousand head, $x_1$ | Deviation of factor comparison coefficients | | | Theoretical value $y_x$, thousand tons |
|---|---|---|---|---|---|---|---|
| | | | | dy | $dx_1$ | $b \cdot dx_1$ | |
| 1 | 1998 | 45,4 | 302,2 | 0 | 0 | 0 | 41,0 |
| 2 | 1999 | 47,3 | 333,4 | 0,4531 | 0,1032 | 1,6715 | 45,0 |
| 3 | 2000 | 47,9 | 346,3 | 0,6771 | 0,1459 | 2,3626 | 46,6 |
| 4 | 2001 | 48,5 | 360,2 | 0,9532 | 0,1919 | 3,1073 | 48,4 |
| 5 | 2002 | 49,8 | 371,3 | 1,1581 | 0,2287 | 3,7019 | 49,8 |
| 6 | 2003 | 50,1 | 388,6 | 1,3474 | 0,2859 | 4,6287 | 52,1 |
| 7 | 2004 | 51,8 | 397,4 | 1,7383 | 0,315 | 5,1002 | 53,2 |
| 8 | 2005 | 53,3 | 394,1 | 2,1675 | 0,3041 | 4,9234 | 52,8 |
| 9 | 2006 | 53,1 | 389,3 | 2,5243 | 0,2882 | 4,6662 | 52,2 |
| 10 | 2007 | 54,8 | 396,4 | 2,8440 | 0,3117 | 5,0466 | 53,1 |
| 11 | 2008 | 54,3 | 402,4 | 3,7001 | 0,3316 | 5,368 | 53,8 |
| 12 | 2009 | 53,7 | 398,9 | 4,6977 | 0,32 | 5,1805 | 53,4 |
| 13 | 2010 | 51,6 | 383 | 4,6641 | 0,2674 | 4,3287 | 51,3 |
| 14 | 2011 | 41,0 | 308 | 4,7923 | 0,0192 | 0,3107 | 41,7 |
| 15 | 2012 | 41,8 | 334,8 | 5,0635 | 0,1079 | 1,7465 | 45,2 |
| 16 | 2013 | 44,1 | 357,5 | 5,6718 | 0,183 | 2,9626 | 48,1 |
| 17 | 2014 | 46,1 | 374,7 | 6,9596 | 0,2399 | 3,8841 | 50,0 |
| 18 | 2015 | 51,7 | 383,6 | 8,6999 | 0,2694 | 4,3609 | 51,6 |
| 19 | 2016 | 56,4 | 398,9 | 10,4191 | 0,32 | 5,1805 | 53,4 |
| Total | | 942,7 | 7020,5 | 68,53099 | 4,231 | 68,531 | 942,7 |

The value of the correlation coefficient $r_{yx}$=0.85 calculated from the data presented in Table 1 indicates that there is a very close relationship between meat production and the number of cattle, while the value of the relationship stability coefficient K=0.98 shows its high level, sufficient to ensure the reliability of calculations. The theoretical value of meat production from the calculated dependence equation ($dx_1$ column) means that due to the influence of the investigated factor, i.e. the number of cattle, the performance indicator is increasing. The obtained adequate single-factor linear equation has the following form:

$$y=41,0*(1+17,1641*dx_1) \quad (1)$$

According to the above methodology, similar calculations were made for the dependence of meat production on other factors. As a result of these calculations, we obtained single-factor dependence equations for all four factors (Table 2).

***Table 2.*** *Single-factor dependence equations and stability coefficients*

| Factor | Equation | Stability coefficient |
|---|---|---|
| Number of cattle | $y=41,0*(1+17,1641*dx_1)$ | 0,98 |
| Number of sheep and goats | $y=41,0*(1+0,1836*dx_3)$ | 0,78 |
| Number of pigs | $y=41,0*(1+0,4227*dx_4)$ | 0,58 |
| Number of horses | $y=41,0*(1+0,4346*dx_5)$ | 0,69 |
| Note. Calculations were made by the authors by the method of statistical dependence equations | | |

As can be seen from the data in Table 2, the presented single-factor dependence equations of meat production in all categories of households in the Akmola region with each of the factors listed and the stability coefficients calculated by the method of statistical equations indicate a close relationship between them.

Among these four factors, the least dependence is observed between meat production and the number of pigs, which can be explained by the tendency to reduce the number of pigs in recent years. Thus, the number of pigs in all categories of households has decreased by 15.5% in 2016 compared with 1998 (Appendix A).

Regarding the dependence on the number of horses, there is both an insignificant rate of growth in the number of horses, and an inadequate accounting for their slaughter population. Therefore, the rate of growth in the number of horses did not exceed an average of 3-4% per year until 2011, and for the last six years (from 2011 to 2016) an average of 9% per year. In general, the low growth rates of meat production compared to the growth rate of livestock are due to the low productivity of livestock (Appendix A). Nevertheless, we decided to include all four factors in the multifactorial equation, since it is necessary to reveal the trend changes of all factor and performance characteristics.

Table 3 shows the calculations of the multifactorial equation parameters. The calculation of the parameter b by deviations of the comparison coefficients from unity is made by the following equation:

$$b = \frac{\sum dy}{\sum dx_1 + \sum dx_2 + \sum dx_3 + \ldots\ldots\ldots\ldots + \sum dx_n}, \text{ or } b = \frac{\sum\left(\frac{y_i}{y_{min}} - 1\right)}{\sum\left(\frac{x_i}{x_{min}} - 1\right)} \quad (2)$$

Using the corresponding values from Table 3 in this equation, we calculate the value of the parameter b, which is equal to 0.68, i.e. b=0.68. The value of the parameter b in this equation indicates that a change in the sizes of deviations of the comparison coefficients of each factor attribute (xi) by unity leads to a change in the magnitude of the performance attribute by 0.68 times.

***Table 3.*** *Multifactorial dependence equation parameters*

| Year | Meat, thousand tons, y | Deviation of factor comparison coefficients | | | | | | Theoretical value $y_x$, thousand tons |
|---|---|---|---|---|---|---|---|---|
| | | dy | $dx_1$ | $dx_3$ | $dx_4$ | $dx_5$ | $\Sigma dx_{1-4}$ | |
| 1998 | 45.4 | 0.107 | 0 | 0 | 0.237 | 0 | 0.237 | 41.0 |
| 1999 | 47.3 | 0.154 | 0.103 | 0.142 | 0.388 | 0.071 | 0.704 | 45.0 |
| 2000 | 47.9 | 0.168 | 0.146 | 0.234 | 0.503 | 0.103 | 0.986 | 46.6 |
| 2001 | 48.5 | 0.183 | 0.192 | 0.363 | 0.612 | 0.145 | 1.312 | 48.4 |
| 2002 | 49.8 | 0.215 | 0.229 | 0.454 | 0.744 | 0.186 | 1.612 | 49.8 |
| 2003 | 50.1 | 0.222 | 0.286 | 0.630 | 0.987 | 0.223 | 2.126 | 52.1 |
| 2004 | 51.8 | 0.263 | 0.315 | 0.836 | 0.853 | 0.280 | 2.285 | 53.2 |
| 2005 | 53.3 | 0.300 | 0.304 | 0.946 | 0.743 | 0.265 | 2.257 | 52.8 |
| 2006 | 53.1 | 0.295 | 0.288 | 1.187 | 0.796 | 0.295 | 2.567 | 52.2 |
| 2007 | 54.8 | 0.337 | 0.312 | 1.190 | 0.710 | 0.327 | 2.539 | 53.1 |
| 2008 | 54.3 | 0.324 | 0.332 | 1.242 | 0.738 | 0.379 | 2.691 | 53.8 |
| 2009 | 53.7 | 0.310 | 0.320 | 1.310 | 0.755 | 0.450 | 2.835 | 53.4 |
| 2010 | 51.6 | 0.259 | 0.267 | 1.587 | 0.634 | 0.536 | 3.024 | 51.3 |
| 2011 | 41,0 | 0.000 | 0.019 | 1.709 | 0.290 | 0.706 | 2.724 | 41.7 |
| 2012 | 41.8 | 0.020 | 0.108 | 1.797 | 0.325 | 0.814 | 3.044 | 45.2 |
| 2013 | 44.1 | 0.076 | 0.183 | 1.892 | 0.063 | 0.948 | 3.086 | 48.1 |
| 2014 | 46.1 | 0.124 | 0.233 | 1.936 | 0.024 | 0.959 | 3.152 | 50.0 |
| 2015 | 51.7 | 0.261 | 0.275 | 2.056 | 0.000 | 1.142 | 3.474 | 51.6 |
| 2016 | 56.4 | 0.376 | 0.320 | 2.231 | 0.045 | 1.356 | 3.952 | 53.4 |
| Total | 942.7 | 3.993 | 4.231 | 21.742 | 9.446 | 9.188 | 44.607 | 942.7 |

It should be noted that the theoretical calculations of the values of the performance attribute show that the sum of its empirical and theoretical values coincides, i.e. $\Sigma y = \Sigma y_x = 942.7$, which indicates the correctness and reliability of the calculations performed (Table 3). By applying the statistical method, we write the multifactorial dependence equation as follows:

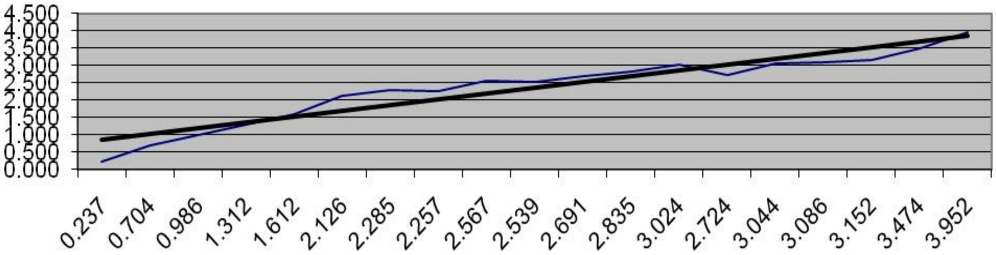
$$y = 41{,}0 * [1 + 0{,}0895(dx_1 + dx_2 + dx_3 + dx_4)] \quad (3)$$

Using the corresponding values from Table 3 in the equation (3), we obtain the characteristic of the changes in the multifactorial dependence, which is shown in Figure 1. Thus, the calculation of the multifactorial equation parameters determined the existence of a relationship, which will allow us to calculate the forecasted values of meat production by a time series, depending on the change in each factor, using the following trend equation:

$$y_t = y_{min}(1 + bdt) \quad (4)$$

where $y_t$ is the trend equation;
$y_{min}$ is the minimum attribute value.

***Figure 1.*** *Dependence factors reflecting meat production in the multifactorial equation.*




The trend parameter b shows that a change in the time series by unity leads to a change in the size of deviations of the performance comparison coefficients and is determined as follows:

$$b = \frac{\sum dx_i}{\sum dt} \tag{5}$$

where dt is the deviation of the comparison coefficients.

The confidence criterion of the forecast is the stability coefficient (K) of the trend, determined by the following formula:

$$K = 1 - \frac{\sum |dx - bdt|}{\sum dx} > 0.7 \tag{6}$$

The calculated level of the stability coefficient in forecasting helps draw a sample by the calculated parameters of the trend equation.

Knowing the values of the four dependence factors, reflecting meat production in the multiple regression equation, we will determine the forecasted values of each of these factors, and then calculate the forecasted volume of meat production. We will proceed from the fact that the value of t always begins with 1 and $t_{min}=1$, and if the factor $x_1$ increases, the trend equation will be written as follows:

$$x_{1t} = x_{1min}(1+bdt) \tag{7}$$

The calculation results for the first factor ($x_1$ – the number of cattle) are presented in Table 4.

***Table 4.*** *Calculations by the factor $x_1$ for determining the trend equation parameters*

| Year | Year sequence number | Factor influence, dt | Number of cattle, thousand head, $x_1$ | Deviation of factor comparison coefficients | | | Theoretical value $y_x$, thousand head |
|---|---|---|---|---|---|---|---|
| | | | | $dx_1$ | b*dt | $dt \cdot dx_1$ | |
| 1998 | 1 | 0 | 302.2 | 0.000 | 0 | 0 | 302.2 |
| 1999 | 2 | 1 | 333.4 | 0.103 | 0.025 | 0.103 | 309.7 |
| 2000 | 3 | 2 | 346.3 | 0.146 | 0.049 | 0.292 | 317.2 |
| 2001 | 4 | 3 | 360.2 | 0.192 | 0.074 | 0.576 | 324.6 |
| 2002 | 5 | 4 | 371.3 | 0.229 | 0.099 | 0.915 | 332.1 |
| 2003 | 6 | 5 | 388.6 | 0.286 | 0.124 | 1.430 | 339.6 |
| 2004 | 7 | 6 | 397.4 | 0.315 | 0.148 | 1.890 | 347.1 |
| 2005 | 8 | 7 | 394.1 | 0.304 | 0.173 | 2.129 | 354.5 |
| 2006 | 9 | 8 | 389.3 | 0.288 | 0.198 | 2.306 | 362.0 |
| 2007 | 10 | 9 | 396.4 | 0.312 | 0.223 | 2.805 | 369.5 |
| 2008 | 11 | 10 | 402.4 | 0.332 | 0.247 | 3.316 | 377.0 |
| 2009 | 12 | 11 | 398.9 | 0.320 | 0.272 | 3.520 | 384.5 |
| 2010 | 13 | 12 | 383.0 | 0.267 | 0.297 | 3.208 | 391.9 |
| 2011 | 14 | 13 | 308.0 | 0.019 | 0.322 | 0.250 | 399.4 |
| 2012 | 15 | 14 | 334.8 | 0.108 | 0.346 | 1.510 | 406.9 |
| 2013 | 16 | 15 | 357.5 | 0.183 | 0.371 | 2.745 | 414.4 |
| 2014 | 17 | 16 | 372.6 | 0.233 | 0.396 | 3.727 | 421.8 |
| 2015 | 18 | 17 | 385.2 | 0.275 | 0.421 | 4.669 | 429.3 |
| 2016 | 19 | 18 | 398.9 | 0.320 | 0.445 | 5.760 | 436.8 |
| Total | 190 | 171 | 7020.5 | 4.232 | 4.232 | 41.150 | 7020.5 |

The value of the parameter b of the trend equation, equal to 0.025 (4.232/171), means that the size of deviations of the performance comparison coefficients, i.e. the number of cattle, is increased by 0.025 with an increase in the size of deviations of the time (period) comparison coefficients by unity. Hence, we can write down the trend equation from the data of Table 4 for the factor $x_1$, which will have the following form:

$$x_{1t}=302,2(1+0,025dt) \quad (8)$$

The forecasted factor levels are calculated as follows: first, calculate the difference in the comparison coefficient of the projected number of cattle from unity. For example, to determine the forecasted value for 2017, take the sequence number t=18, the comparison coefficient and the trend equation parameter, i.e.:

$$dt = \frac{19}{1} - 1 = 18 \qquad b \cdot dt = 0.025 \cdot 18 = 0.446$$

Using the formula (8) and the calculated value of the coefficient $b \cdot dt$, we calculate the forecasted value of the factor $x_1$ for 2017:

$X_{12017}$=302,2(1+0,446) = 436,8

Correspondingly calculate the forecasted values of this factor $x_1$ for 2018, 2019, 2020 and 2021:

$X_{12018}$=302,2(1+0,470) =444,3

$X_{12019}$=302,2(1+0,495) = 451,8

$X_{12020}$=302,2(1+0,519) =459,2

$X_{12021}$=302,2(1+0,544) =466,7

Consequently, in 2017, the forecasted number of cattle compared with the actual number of cattle in 2016 is increased by 37.9 thousand heads and will reach 466.7 thousand heads by 2021, i.e. be increased by more than 67 thousand heads compared with 2016 (by 16%). Then, in accordance with the above methodology, determine the forecasted values of the remaining factors included in the multiple regression equation. After identifying the forecasted changes for all four factors and taking into account their values, calculate the forecasted volume of meat production (Table 5).

***Table 5.*** *Calculation of the trend equation parameters.*

| Year | Year sequence number | Factor influence, dt | Actual meat production, thousand tons, y | Factor comparison factors | | | Theoretical value, $y_x$, thousand tons |
|---|---|---|---|---|---|---|---|
| | | | | dy | b*dt | dt·dy | |
| 1998 | 1 | 0 | 45,4 | 0,107 | 0 | 0 | 41,0 |
| 1999 | 2 | 1 | 47,3 | 0,153 | 0,023 | 0,154 | 42,0 |
| 2000 | 3 | 2 | 47,9 | 0,168 | 0,047 | 0,337 | 42,9 |
| 2001 | 4 | 3 | 48,5 | 0,182 | 0,070 | 0,549 | 43,9 |
| 2002 | 5 | 4 | 49,8 | 0,214 | 0,093 | 0,859 | 44,8 |
| 2003 | 6 | 5 | 50,1 | 0,222 | 0,117 | 1,110 | 45,8 |
| 2004 | 7 | 6 | 51,8 | 0,263 | 0,140 | 1,580 | 46,7 |
| 2005 | 8 | 7 | 53,3 | 0,300 | 0,163 | 2,100 | 47,7 |
| 2006 | 9 | 8 | 53,1 | 0,295 | 0,187 | 2,361 | 48,7 |
| 2007 | 10 | 9 | 54,8 | 0,336 | 0,210 | 3,029 | 49,6 |
| 2008 | 11 | 10 | 54,3 | 0,324 | 0,233 | 3,244 | 50,6 |
| 2009 | 12 | 11 | 53,7 | 0,309 | 0,257 | 3,407 | 51,5 |
| 2010 | 13 | 12 | 51,6 | 0,258 | 0,280 | 3,102 | 52,5 |
| 2011 | 14 | 13 | 41,0 | 0 | 0,304 | 0 | 53,4 |
| 2012 | 15 | 14 | 41,8 | 0,019 | 0,327 | 0,273 | 54,4 |
| 2013 | 16 | 15 | 44,1 | 0,075 | 0,350 | 1,134 | 55,4 |
| 2014 | 17 | 16 | 46,1 | 0,124 | 0,374 | 1,990 | 56,3 |
| 2015 | 18 | 17 | 51,7 | 0,261 | 0,397 | 4,437 | 57,3 |
| 2016 | 19 | 18 | 56,4 | 0,375 | 0,420 | 6,761 | 58,2 |
| Total | 190 | 171 | 942,7 | 3,993 | 3,993 | 36,427 | 942,7 |

The value of the parameter b of the trend equation is 0.0234 (3.993/171), which means that the size of deviations of the performance comparison coefficients (meat production) is increased by 0.0234 times when the size of deviations of the time (period) comparison coefficients is increased by unity. The value of the correlation coefficient (0.84) confirms the conclusion about the correctness of the equation type for characterizing the relationship between the time factor and meat production. The trend stability coefficient is 0.98, which means that, in accordance with the scale of dependencies, the stability of the relationship is very high, and this level ensures the reliability of the dependence equation as well as the correctness and reliability of the calculations performed.

The methodology for forecasting the volume of meat production in the forthcoming 2017-2021 based on the four-factor dependence equation consists in the implementation of the following econometric calculations. Using the dependence equation and the previously calculated forecasted values of all four factors, the forecasted volume of meat production in the forthcoming period is determined by the following formula:

$$y = y_{\min}\left\{1 + B\left[\left(\frac{x_1}{x_{1\min}} - 1\right) + \left(\frac{x_3}{x_{2\min}} - 1\right) + \left(\frac{x_4}{x_{3\min}} - 1\right) + \left(\frac{x_5}{x_{4\min}} - 1\right)\right]\right\} \quad (9)$$

where $x_i$ are the forecasted values of the factors.

Hence, to determine the forecasted volume of meat production in 2017, inserting the corresponding values from Table 5 in the formula (9), we obtain:

$Y_{2017}$ = 41,0*(1+0,419) = 58,2 thousand tons

$Y_{2018}$ = 41,0*(1+0,444) = 59,2 thousand tons

$Y_{2019}$ = 41,0*(1+0,466) = 60,1 thousand tons

$Y_{2020}$ = 41,0*(1+0,490) = 61,1 thousand tons

$Y_{2021}$ = 41,0*(1+0,515) = 62,1 thousand tons

The calculated data on the trend equation and the multifactorial dependence equation are correct, and the significance of the forecast is reliable, since all the criteria for the methods of statistical dependence equations are satisfied, i.e. the sum of theoretical and calculated values coincides in all parameters and the stability coefficient is greater than 0.7 (K>0.7). The obtained forecasted values of the performance indicator, meat production, included in the factor equation, as well as the rate of their changes in comparison with the actual data of 2016 are presented in Table 6.

***Table 6.*** *Theoretical model of the factor levels and meat production.*

| Forecast period | Number of cattle, thousand head | Number of sheep and goats, thousand head | Number of pigs, thousand head | Number of horses, thousand head | Meat, thousand tons |
|---|---|---|---|---|---|
| 2017 | 436,8 | 495,5 | 227,1 | 132,1 | 58,2 |
| 2018 | 444,3 | 514,8 | 233,6 | 135,8 | 59,2 |
| 2019 | 451,8 | 534,2 | 239,9 | 139,5 | 60,1 |
| 2020 | 459,2 | 553,6 | 246,3 | 143,1 | 61,1 |
| 2021 | 466,7 | 572,9 | 252,8 | 146,8 | 62,1 |
| On average (total) | 451,8 | 534,2 | 239,9 | 139,5 | 300,7 |

The forecasted factor levels and the performance indicator as well as the rates of their changes, given in Table 6, indicate the need for intensive use of each factor, since their influence is uniform over the years. In addition, a uniform change in the forecasted indicators identifies a functional relationship between the factors and meat production. This can also be judged from the previously calculated aggregate parameter of the multifactorial combination dependence, which indicates that a change in the size of deviations of the factor comparison coefficients by unity leads to a change in meat production by 0.0895 times (see formula 3).

The use of deviations of the factor comparison coefficients in the theoretical forecast model makes it possible to determine the influence of each factor on the performance indicator (Table 7).

***Table 7.*** *The influence of each factor on the performance indicator.*

| Factor | Deviation of factor comparison coefficients, $dx_i$ | Factor influence on the performance attribute, $x_i$% | Factor rating |
|---|---|---|---|
| Number of cattle, thousand head | 4,231 | 9,5 | 4 |
| Number of sheep and goats, thousand head | 21,742 | 48,7 | 1 |
| Number of pigs, thousand head | 9,446 | 21,2 | 2 |
| Number of horses, thousand head | 9,188 | 20,6 | 3 |
| Total | 44,607 | 100 | - |

According to Table 7, which shows the deviation of the comparison coefficients for each factor, the main factor affecting meat production is the number of sheep and goats (48.7%), followed by the number of pigs (21.2%), the number of horses

(20.6%) and, finally, the number of cattle (9.5%). Such a factor rating has developed because of the forecasted growth rates of livestock. Thus, the average annual growth rate of the number of sheep and goats in the next five years is projected to be about 6%, which is slightly higher than the number of other livestock species: pigs and horses – about 4%, cattle – 2% (Table 6).

Based on the calculations with the help of the above methodology for constructing a functional theoretical model, it is possible to determine how much the factor level indicators should be increased to achieve the forecasted volume of production. It follows that the calculations of the factor levels and the performance indicator can be the basis for forecasting indicators, drawing up models for the development of agricultural production, and used to justify production plans.

## 4. Conclusion

To evaluate economic information in terms of justifying the prospects for production development, there is a need to study the relationship between various factors and performance indicators, identify their trends and develop economic forecasts based on econometric calculations.

The use of econometric calculations should be based on knowledge and understanding of the essence of economic processes and phenomena, the specifics of economic interrelations and the laws of their development inherent in a branch of production.

The construction of multiple regression equations using the correlation regression method is because there is no close linear relationship and dependence between the factors included in this equation. This is because in the multiple regression equation with an invariable level of other factors, the performance attribute changes only by the amount by which the factor attribute has changed.

The methodology for calculating the deviation of the comparison coefficients of the factor and performance attributes, constructing a functional theoretical model and its application, set forth in this study, is universal in nature and can be used to determine the forecasted factor level and the volume of production.

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**Appendix A:** Main indicators of the livestock sector of Akmola region

| Year | Gross livestock production, million tenge | Livestock, thousand head | | | | | Meat production, thousand tons |
|---|---|---|---|---|---|---|---|
| | | Cattle | Cow | Sheep and goat | Pig | Horse | |
| | | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $y$ |
| 1998 | 9205,7 | 302,2 | 154,7 | 147,0 | 138,4 | 66,0 | 45,4 |
| 1999 | 13376,6 | 333,4 | 165,9 | 167,9 | 155,3 | 70,7 | 47,3 |
| 2000 | 15438,6 | 346,3 | 172,5 | 181,4 | 168,2 | 72,8 | 47,9 |
| 2001 | 17980,6 | 360,2 | 177,8 | 200,3 | 180,4 | 75,6 | 48,5 |
| 2002 | 19867,0 | 371,3 | 182,4 | 213,7 | 195,1 | 78,3 | 49,8 |
| 2003 | 21609,8 | 388,6 | 187,6 | 239,6 | 222,4 | 80,7 | 50,1 |
| 2004 | 25207,8 | 397,4 | 188,7 | 269,9 | 207,4 | 84,5 | 51,8 |
| 2005 | 29159,4 | 394,1 | 181,8 | 286,0 | 195,0 | 83,5 | 53,3 |
| 2006 | 32443,2 | 389,3 | 181,0 | 321,5 | 201,0 | 85,5 | 53,1 |
| 2007 | 35386,3 | 396,4 | 184,7 | 322,0 | 191,3 | 87,6 | 54,8 |
| 2008 | 43267,7 | 402,4 | 189,1 | 329,6 | 194,5 | 91,0 | 54,3 |
| 2009 | 52451,3 | 398,9 | 189,1 | 339,5 | 196,4 | 95,7 | 53,7 |
| 2010 | 52142,3 | 383,0 | 178,4 | 380,3 | 182,8 | 101,4 | 51,6 |
| 2011 | 53322,1 | 308,0 | 137,4 | 413,6 | 144,3 | 112,6 | 41,0 |
| 2012 | 55818,9 | 334,8 | 154,3 | 434,2 | 148,3 | 119,7 | 41,8 |
| 2013 | 61418,3 | 357,5 | 169,1 | 460,6 | 118,9 | 128,6 | 44,1 |
| 2014 | 73273,4 | 374,7 | 181,7 | 491,5 | 114,6 | 142,4 | 46,1 |
| 2015 | 89294,4 | 383,6 | 175,2 | 509,6 | 111,9 | 152,2 | 51,7 |
| 2016 | 105120,6 | 398,9 | 148,8 | 515,6 | 116,9 | 155,5 | 56,4 |
| ***Note.*** *Compiled by the authors based on official data from stat.qov.kz* | | | | | | | |