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ECONOMIC FACTORS INVESTIGATION INFLUENCE
ON
COMMUNICATION SERVICE DEMAND

Methodical instructions for laboratory works

For technical elite groups

Odessa 2011

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The methodical instructions consists exercises for implementation the cycle of laboratory works in tasks, which can be appeared to managers at strategic, operation planning and marketing decision-making on telecoms operator department, internet provider or telecommunication agency.

The methodical instructions are recommended for students, which are study in trend of “Telecommunications”. Also the methodical instructions can be useful for students, which study in trend of other ways, and for telecoms specialists at strategic, operation planning and marketing decision-making.

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1. BASIC THEORETICAL FACTS ABOUT FORECASTING

A *forecast* is a prediction of what will occur in the future. Meteorologists forecast the weather, sportscasters predict the winners of football games, and managers of business firms attempt to predict how much of their product will be demanded in the future. In fact, managers are constantly trying to predict the future, making decisions in the present that will ensure the continued success of their firms. Often a manager will use judgment, opinion, or past experiences to forecast what will occur in the future. However, a number of mathematical methods are also available to aid managers in making decisions. In this chapter, we present two of the traditional forecasting methods: time series analysis and regression. Although no technique will result in a totally accurate forecast (i.e., it is impossible to predict the future exactly), these forecasting methods can provide reliable guidelines for decision making.

A variety of forecasting methods exist, and their applicability is dependent on the time frame of the forecast (i.e., how far in the future we are forecasting), the existence of patterns in the forecast (i.e., seasonal trends, peak periods), and the number of variables to which the forecast is related. We will discuss each of these factors separately.

In general, forecasts can be classified according to three time frames: short range, medium range, and long range. **Short-range forecasts** typically encompass the immediate future and are concerned with the daily operations of a business firm, such as daily demand or resource requirements. A short-range forecast rarely goes beyond a couple months into the future. A **medium-range forecast** typically encompasses anywhere from 1 or 2 months to 1 year. A forecast of this length is generally more closely related to a yearly production plan and will reflect such items as peaks and valleys in demand and the necessity to secure additional resources for the upcoming year. A **long-range forecast** typically encompasses a period longer than 1 or 2 years. Long-range forecasts are related to management's attempt to plan new products for changing markets, build new facilities, or secure long-term financing. In general, the further into the future one seeks to predict, the more difficult forecasting becomes.

These classifications should be viewed as generalizations. The line of demarcation between medium- and long-range forecasts is often quite arbitrary and not always distinct. For some firms a medium-range forecast could be several years, and for other firms a long-range forecast could be in terms of months.

A trend is a gradual, long-term, up-or-down movement of demand.

Forecasts often exhibit patterns, or trends. A **trend** is a long-term movement of the item being forecast. For example, the demand for personal computers has shown an upward trend during the past decade, without any long downward movement in the market. Trends are the easiest patterns of demand behavior to detect and are often the starting point for developing a forecast. Figure 1(a) illustrates a demand trend in which there is a general upward movement or increase. Notice that Figure 1(a) also includes several random movements up and down. **Random variations** are movements that are not predictable and follow no pattern (and thus are virtually unpredictable).

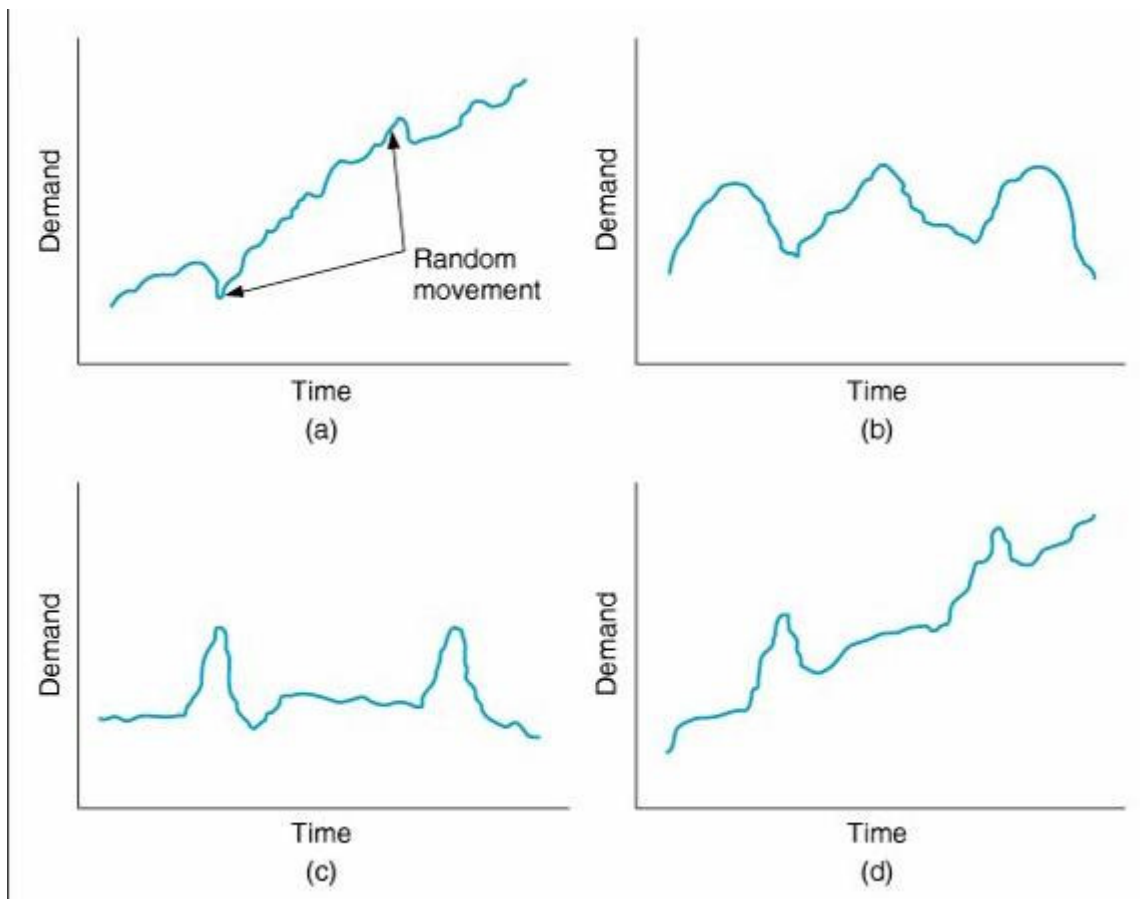


Figure 1.1 – Forms of forecast movement: (a) trend, (b) cycle, (c) seasonal pattern, and (d) trend with seasonal pattern

A **cycle** is an undulating movement in demand, up and down, that repeats itself over a lengthy time span (i.e., more than 1 year). For example, new housing starts and thus construction-related products tend to follow cycles in the economy. Automobile sales tend to follow cycles in the same fashion. The demand for winter sports equipment increases every 4 years, before and after the Winter Olympics. Figure 1(b) shows the general behavior of a demand cycle.

A cycle is an up-and-down repetitive movement in demand.

A seasonal pattern is an up-and-down, repetitive movement within a trend occurring periodically.

A **seasonal pattern** is an oscillating movement in demand that occurs periodically (in the short run) and is repetitive. Seasonality is often weather related. For example, every winter the demand for snowblowers and skis increases dramatically, and retail sales in general increase during the Christmas season. However, a seasonal pattern can occur on a daily or weekly basis. For example, some restaurants are busier at lunch than at dinner, and shopping mall stores and theaters tend to have higher demand on weekends. Figure 1(c) illustrates a seasonal pattern in which the same demand behavior is repeated each period at the same time.

Of course, demand behavior will frequently display several of these characteristics simultaneously. Although housing starts display cyclical behavior, there has been an upward trend in new house construction over the years. As we noted, demand for skis is seasonal; however, there has been a general upward trend in the demand for winter sports equipment during the past 2 decades. Figure 1(d) displays the combination of two demand patterns, a trend with a seasonal pattern.

There are instances in which demand behavior exhibits no pattern. These are referred to as irregular movements, or variations. For example, a local flood might cause a momentary increase in carpet demand, or negative publicity resulting from a lawsuit might cause product demand to drop for a period of time. Although this behavior is causal, and thus not totally random, it still does not follow a pattern that can be reflected in a forecast.

Forecasting Methods

The factors discussed previously determine to a certain extent the type of forecasting method that can or should be used. In this chapter we discuss the basic types of forecasting: time series, regression methods, and qualitative methods. Time series is a category of statistical techniques that uses historical data to predict future behavior. **Regression** (or causal) methods attempt to develop a mathematical relationship (in the form of a regression model) between the item being forecast and factors that cause it to behave the way it does. Most of the remainder of this chapter is about time series and regression forecasting methods. In this section we focus our discussion on qualitative forecasting.

Types of forecasting methods are time series, regression, and qualitative.

Qualitative methods use management judgment, expertise, and opinion to make forecasts. Often called "the jury of executive opinion," they are the most common type of forecasting method for the long-term strategic planning process. There are normally individuals or groups within an organization whose judgments and opinions regarding the future are as valid or more valid than those of outside experts or other structured approaches. Top managers are the key group involved in the development of forecasts for strategic plans. They are generally most familiar with their firms' own capabilities and resources and the markets for their products.

The sales force is a direct point of contact with the consumer. This contact provides an awareness of consumer expectations in the future that others may not possess. Engineering personnel have an innate understanding of the technological aspects of the type of products that might be feasible and likely in the future.

Consumer, or market, research is an organized approach that uses surveys and other research techniques to determine what products and services customers want and will purchase, and to identify new markets and sources of customers. Consumer and market research is normally conducted by the marketing department within an organization, by industry organizations and groups, and by private marketing or consulting firms. Although market research can provide accurate and useful forecasts of product demand, it must be skillfully and correctly conducted, and it can be expensive.

The **Delphi method** is a procedure for acquiring informed judgments and opinions from knowledgeable individuals, using a series of questionnaires to develop

a consensus forecast about what will occur in the future. It was developed at the RAND Corporation shortly after World War II to forecast the impact of a hypothetical nuclear attack on the United States. Although the Delphi method has been used for a variety of applications, forecasting has been one of its primary uses. It has been especially useful for forecasting technological change and advances.

Technological forecasting has become increasingly crucial for successful competition in today's global business environment. New enhanced computer technology, new production methods, and advanced machinery and equipment are constantly being made available to companies. These advances enable them to introduce more new products into the marketplace faster than ever before. The companies that succeed do so by getting a technological jump on their competitors through accurate prediction of future technology and its capabilities. What new products and services will be technologically feasible, when they can be introduced, and what their demand will be are questions about the future for which answers cannot be predicted from historical data. Instead, the informed opinion and judgment of experts are necessary to make these types of single, long-term forecasts.

Regression Methods

The simplest form of regression is linear regression, which you will recall we used previously to develop a linear trend line for forecasting. In the following section we will show how to develop a regression model for variables related to items other than time.

Linear Regression

Simple **linear regression** relates one dependent variable to one independent variable in the form of a linear equation:

$$y = a + bx$$

Linear regression relates demand (dependent variable) to an independent variable.

To develop the linear equation, the slope, b , and the intercept, a , must first be computed by using the following least squares formulas:

$$a = \bar{y} - b\bar{x}$$

$$b = \frac{\sum xy - n\bar{x}\bar{y}}{\sum x^2 - n\bar{x}^2}$$

where

$$\bar{x} = \frac{\sum x}{n} = \text{mean of the } x \text{ data}$$

$$\bar{y} = \frac{\sum y}{n} = \text{mean of the } y \text{ data}$$

We will consider regression within the context of an example. The University athletic department wants to develop its budget for the coming year, using a forecast for football attendance. Football attendance accounts for the largest portion of its revenues, and the athletic director believes attendance is directly related to the number of wins by the team. The business manager has accumulated total annual attendance figures for the past 8 years:

| Wins | Attendance |
|-------------|-------------------|
| 4 | 36,300 |
| 6 | 40,100 |
| 6 | 41,200 |
| 8 | 53,000 |
| 6 | 44,000 |
| 7 | 45,600 |
| 5 | 39,000 |
| 7 | 47,500 |

Given the number of returning starters and the strength of the schedule, the athletic director believes the team will win at least seven games next year. He wants to develop a simple regression equation for these data to forecast attendance for this level of success.

The computations necessary to compute a and b, using the least squares formulas, are summarized in Table 15.10. (Note that the magnitude of y has been reduced to make manual computation easier.)

Table 1.1 – Least squares computations

| x (wins) | y (attendance, 1,000s) | xy | x² |
|-----------------|-------------------------------|-----------|----------------------|
| 4 | 36.3 | 145.2 | 16 |
| 6 | 40.1 | 240.6 | 36 |
| 6 | 41.2 | 247.2 | 36 |
| 8 | 53.0 | 424.0 | 64 |

Table 1.1 – Least squares computations

| x (wins) | y (attendance, 1,000s) | xy | x ² |
|----------|------------------------|---------|----------------|
| 6 | 44.0 | 264.0 | 36 |
| 7 | 45.6 | 319.2 | 49 |
| 5 | 39.0 | 195.0 | 25 |
| 7 | 47.5 | 332.5 | 49 |
| 49 | 346.7 | 2,167.7 | 311 |

$$\bar{x} = \frac{49}{8} = 6.125$$

$$\bar{y} = \frac{346.9}{8} = 43.34$$

$$b = \frac{\sum xy - n\bar{x}\bar{y}}{\sum x^2 - n\bar{x}^2}$$
$$= \frac{(2,167.7) - (8)(6.125)(43.34)}{(311) - (8)(6.125)^2} = 4.06$$

$$a = \bar{y} - b\bar{x} = 43.34 - (4.06)(6.125) = 18.46$$

Substituting these values for a and b into the linear equation line, we have

$$y = 18.46 + 4.06x$$

Thus, for x = 7 (wins), the forecast for attendance is

$$y = 18.46 + 4.06(7) = 46.88 \text{ or } 46,880$$

The data points with the regression line are shown in Figure 2. Observing the regression line relative to the data points, it would appear that the data follow a distinct upward linear trend, which would indicate that the forecast should be relatively accurate. In fact, the MAD value for this forecasting model is 1.41, which suggests an accurate forecast.

Correlation

Correlation in a linear regression equation is a measure of the strength of the relationship between the independent and dependent variables. The formula for the correlation coefficient is

Correlation is a measure of the strength of the relationship between independent and dependent variables.

$$r = \frac{n \sum xy - \sum x \sum y}{\sqrt{[n \sum x^2 - (\sum x)^2][n \sum y^2 - (\sum y)^2]}}$$

The value of r varies between -1.00 and +1.00, with a value of ± 1.00 indicating a strong linear relationship between the variables. If $r = 1.00$, then an increase in the independent variable will result in a corresponding linear increase in the dependent variable. If $r = -1.00$, an increase in the independent variable will result in a linear decrease in the dependent variable. A value of r near zero implies that there is little or no linear relationship between variables

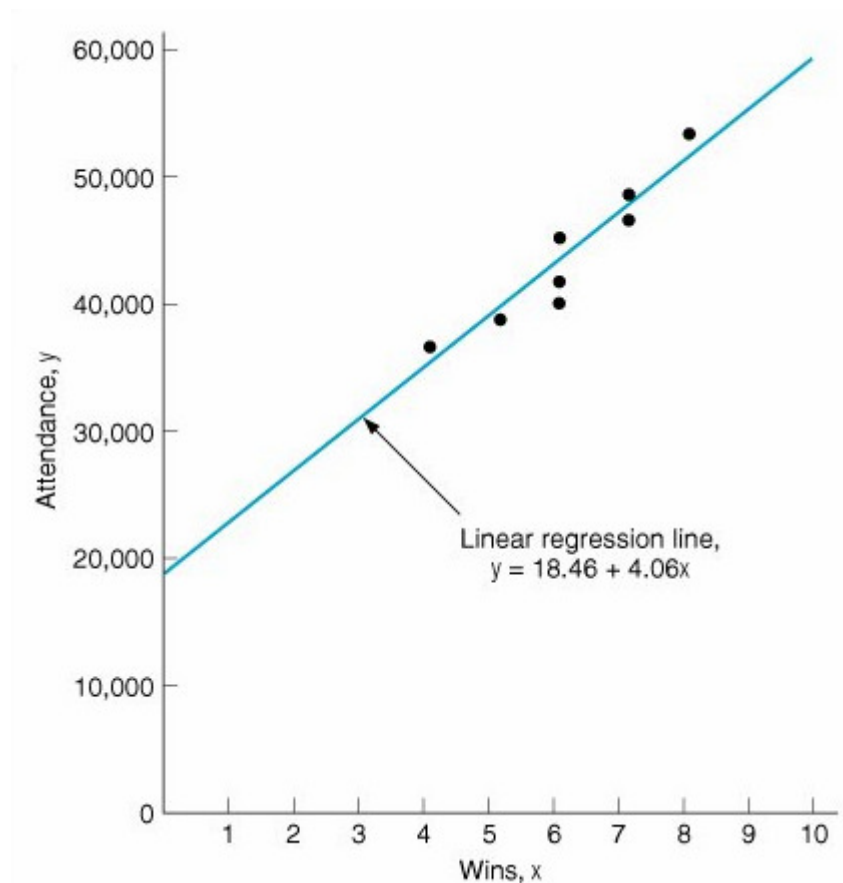


Figure 1.2 – Linear regression line

We can determine the correlation coefficient for the linear regression equation determined in our State University example by substituting most of the terms calculated for the least squares formula (except for $\sum y^2$) into the formula for r :

$$r = \frac{(8)(2,167.7) - (49)(346.7)}{\sqrt{[(8)(311) - (49)^2][(8)(15,224.7) - (346.7)^2]}}$$

$$= .948$$

This value for the correlation coefficient is very close to one, indicating a strong linear relationship between the number of wins and home attendance.

Another measure of the strength of the relationship between the variables in a linear regression equation is the **coefficient of determination**. It is computed by simply squaring the value of r . It indicates the percentage of the variation in the

dependent variable that is a result of the behavior of the independent variable. For our example, $r = .948$; thus, the coefficient of determination is

The coefficient of determination is the percentage of the variation in the dependent variable that results from the independent variable.

$$\begin{aligned} r^2 &= (.948)^2 \\ &= .899 \end{aligned}$$

This value for the coefficient of determination means that 89.9% of the amount of variation in attendance can be attributed to the number of wins by the team (with the remaining 10.1% due to other unexplained factors, such as weather, a good or poor start, publicity, etc.). A value of one (or 100%) would indicate that attendance totally depends on wins. However, because 10.1% of the variation is a result of other factors, some amount of forecast error can be expected.

2. METODICAL INSTRUCTIONS FOR LABORATORY WORK IMPLEMENTATION

Laboratory work № 1

on subject : **“Selection and analyze of factors, which influence on quantitative change of selling service capacity”**

1. Work object

1. To increase and to fix the theoretical knowledge of “Telecommunication agency management” course.
2. To get knowledge of gather and analyze factors, which influence on service sale volume.
3. To take a priori analysis of chosen factors, which can be include in forecast models of service sale volume.

2. Key provisions

Terms and notions

- service;
- service life circle;
- demand;
- market service analyze;
- market segmentation;
- service sale volume;
- internal and external factors;
- sale volume forecasting;
- sale curve.

3 Implementation methodic

So, let review a task, in which telecommunication agency, that don't have a special forecasting department, needs to make forecast of something sale service volume. At this there are no any manufactures-monopolists, which conduct could be dictate market situation. There are many different small and medium manufactures. It's need to forecast service sale volume of specific manufacture for sale service planning, and also make a price for a making decision risk. To show on the graphic value of given services build on given and forecasted values (with taking into account a risk). To make conclusion build on results.

Forecast – is the grounding thoughts of probable character about possible instance study state in a future. Forecasting – is the process of forecasts forming.

The market is present itself very difficult cybernetic model with different internal and external factors. Forecasting of confidently market situation factor (for example: the value of given services of specific manufacture, communication statement) is not possible building on only trend factor as himself. It obvious, that on given service value of communication statement (as individual indicator) can de

influence of competitors sales, of segment trend capacity and their values of sales and many others factors. And that influence depend not only the factors of service sale volume, but any in-house indicators too. But such forecast is necessary at marketing research.

We are starting the forecast from factors selection, which defined quantitative change of service sale volume. Notably, we are making a hypothesis, which influence on sales curve behaviour. Factors are carrying out of expert way: the expert of proper market allows the next possible parameters:

- that, who influence on sales flow;
- that, on dynamics whose, are expressed mathematical, which are known on a same space as sale volume (this is a quantitative or qualitative parameter, which can be progressed up to quantitative characteristic);
- that, who are refer to as an external (external environment factors of market), and as to an internal market environment (internal environment factors of market).

In the event of difficulty to do factor choice, is recommended to choice macro factors of external and internal environment for specifically manufacture. There are examples some of them:

External environment factors of marketing:

- exchange rate;
- capacity of consumer sector;
- Sector total sales;
- Quantity competitor dynamics;
- Market sector goods (services) satisfaction;

Internal environment factors of marketing:

- purveyance goods availability;
- Manufacture personnel operating efficiency;
- advertising expenses or advertising type message;
- change the way of goods (services) positioning.

On the first stage it is come to do priori analyze and there are not any special restriction on factors, which includes in preliminary model composition. There are not any limits on quantity of chosen factors. As much as them will be on the first stage, then it will be better. It gives more exact result. We chose 3 factors x_1 , x_2 , x_3 in given example.

Table 2.1 – Factors selection (x_1, x_2, x_3), which probably influence on a quantitatively change of service sale volume (Q)

| Term (i) | $Q(y)$, thousand pc. | x_1 | x_2 | x_3 |
|--------------|--------------------------|-------|-------|-------|
| 2009 | | | | |
| I quarter | 23 | 28 | 50 | 12 |
| II quarter | 34 | 45 | 55 | 15 |
| III quarter | 55 | 56 | 44 | 15 |
| IV quarter | 34 | 46 | 53 | 13 |
| 2010 | | | | |
| I quarter | 22 | 57 | 49 | 11 |
| II quarter | 34 | 56 | 68 | 14 |
| III quarter | 44 | 34 | 59 | 17 |
| IV quarter | 45 | 45 | 75 | 18 |
| 2011 | | | | |
| I quarter | 56 | 68 | 70 | 24 |
| II quarter | 54 | 67 | 73 | 20 |

To make an analyze of sale service volume dynamic rows and influence factors. To detect it's graphical trend changes.

3. Key questions

1. What do you understand under the notion “market of communication service“, “demand of communication service“, “offer of communication service”?
2. On what kind of ways of field complex investigation, the communication service is taken?-
3. Give the main ways of demand market research on communication services?
4. What is the main target to learn market research on communication services?
5. What kind of raw information gather methods at market research do you know?

4. Mission of laboratory work

1. To prepare outgoing data for factors priori analyze, which influence on a quantitatively change of service sale volume.
2. To finalize outgoing data at protocol and on PC in a view as at table 2.1
3. To draw outgoing data (result indication factors).

5. Protocol Content

The laboratory protocol must have:

1. The terms and notions definitions, which were brought at key provisions.
2. Content and numerical values of outgoing information in according with individual task, which brought into addition A.

3. Priori analysis resume of chosen factors, which can be include to service sale volume forecasting model.

Laboratory work № 2

on subject: **“Factors choosing, which probably define the quantitatively change of service sale volume”**

1. Work object

1. To increase and to fix the theoretical knowledge of “Telecommunication agency management” course.
2. To get knowledge of gather and analyze factors, which influence on service sale volume.
3. To take a priori analysis of chosen factors, which can be include in forecast models of service sale volume.

2. Key provisions

Terms and notions

- service;
- service life circle;
- demand;
- market service analyze;
- market segmentation;
- service sale volume;
- internal and external factors;
- sale volume forecasting;
- sale curve.

3 Implementation methodic

On the second stage, is the compare estimation and lagging of some factors do. For doing this, it necessary to determinate how essential factors (x_1, x_2, \dots, x_n) influence on results (y) and it need to specify that there are no any of them that closely associated with each other. This can be reach by couple factors and correlation indexes analyses and also to estimate theirs relevance. For doing this is need to be build the pair factors correlation matrix, which measure the density of connections each factors with result factor and connections of each other (table 2.2). Attention, all elements of main diagonal matrix ($r_{yy}, r_{x_1x_1}, r_{x_2x_2}, \dots, r_{x_nx_n}$) are equals 1, because the connection of even factors is only functional, a $r_{yx1} = r_{x1y}, r_{yx2} = r_{x2y}$ i T.D., because there are a symmetrical elements of matrix ($r_{ij} = r_{ji}$).

Table 2.2 – The pare factors correlation matrix of multiple regression model

| Definitions | y | x_1 | x_2 | ... | x_j | ... | x_n |
|-------------|-----------|------------|------------|-----|------------|-----|------------|
| y | 1 | r_{yx1} | r_{yx2} | ... | r_{yxj} | ... | r_{yxn} |
| x_1 | r_{x1y} | 1 | r_{x1x2} | ... | r_{x1xj} | ... | r_{x1xn} |
| x_2 | r_{x2y} | r_{x2x1} | 1 | ... | r_{x2xj} | ... | r_{x2xn} |
| ... | ... | ... | ... | 1 | ... | ... | ... |
| x_i | r_{xiy} | r_{xix1} | r_{xix2} | ... | 1 | ... | r_{xixn} |
| ... | ... | ... | ... | ... | ... | 1 | ... |
| x_n | r_{xny} | r_{xnx1} | r_{xnx2} | ... | r_{xnxj} | ... | 1 |

The pare correlation factor is calculates by the next formula:

$$r = \frac{\sum xy - \frac{\sum x \sum y}{n}}{\sqrt{\left[\sum x^2 - \frac{(\sum x)^2}{n} \right] \left[\sum y^2 - \frac{(\sum y)^2}{n} \right]}}$$

were x – factor sense definition;

y – result definition sense;

n – quantity of observation.

On foundation of this matrix (table. 2.2) can be done conclusion about factors connection density with the result indication and with each other. Although these figures are even to pair connections, but the matrix can be used for preliminary selection of factors included in the regression equation.

In the first action, it necessary to compare a definition correlation coefficients (y) with all factors (x_1, x_2, \dots, x_n). If factors hamy a relativity small result definition, than they can be removed from further analysis.

Then detected by matrix factors, which are among themselves in the functional or correlation relationship with a high degree of connection ($r_{ij} \geq 0,7...0,8$), which are called collinear. At availability of multicollinearity it necessary to except from collinear definitions those definitions which have a smaller result.

After disengagement from factors, which are weakly connect to result definition, and also from duplicate collinear factors, it necessary to leave most important factors. The circle of factors, which are remained, must be reasonable, minimal, but it must be enough for task solution.

By establishment of definition kit, it necessary to considerate, that the analyses of main factors quantity squeeze too sizeable work. For example, transferring from 3 to 4 factors increase labour-output ratio almost in 10 times.

Let's do the analyze of the table 2.3 on the next example.

Table 2.3 – The pair factor correlation matrix of multiple regression model.

| | y | x_1 | x_2 | x_3 |
|-------|-----|-------|-------|-------|
| y | 1 | 0,533 | 0,448 | 0,838 |
| x_1 | - | 1 | 0,376 | 0,511 |
| x_2 | - | - | 1 | 0,713 |
| x_3 | - | - | - | 1 |

Comparing of pair correlation factors by absolutely value of results definition with all factors, we need to exclude those factors, where connections with the result definition of which, are not big. This can be done by using a Cheddock scale:

| Closeness connection factors | 0,1 – 0,3 | 0,3 – 0,5 | 0,5 – 0,7 | 0,7- 0,9 | 0,9 – 0,99 |
|------------------------------|-----------|-----------|-----------|----------|------------|
| Connection force description | weak | medium | tangible | high | ultrahigh |

The functional connection marked as 1, and absence of connection marked as 0.

So, it need to except from review the x_2 factor.

To build the pair factor correlation matrix for given variant, and choose two factors for further forecast.

3. Key questions

1. To give the definition of correlation-regression analyses and sense of it's doing.
2. To give the definition of straight and reverse connection.
3. What kind of connections between factors are called a collinear?
4. What is the correlation factor is? How is it can be calculated?
5. How to build the pair factor correlation matrix?
6. How can be released the factor selection for including them in regression lever using the pair factor matrix?

4. Mission of laboratory work

1. To calculate the pair factor matrix with 3 digit after comma.
2. To execute the analyses on the basis of calculated pair factor correlation matrix.
3. To make the decision about factors including in regression equation.

5. Protocol content

The laboratory protocol must have:

1. The terms and notions definitions, which were brought at key provisions.
2. The results of pare factor correlation calculating.

3. The resume about analyses of pare factors correlation matrix.

Laboratory work № 3
on subject: “ Drafting a model of communication or multiple regression equation ”

1. Work object

1. To increase and to fix the theoretical knowledge of and “Telecommunication agency management” course.
2. To learn how to build linear regression factor models.
3. To learn, using the least squares method how to find regression parameters.
4. To get knowledge in making connections models or regression equation.
5. To get knowledge in forecast making, using the factors models.

1. Key provisions

Terms and notions

- One factor regression model;
- Dependent (efficient) and independent (factor) definitions;
- Kinds of connections between effective and factor definitions.
- One factor model type;
- One factor model parameters;
- least squares method;
- Forecast using the one factor model.

2. Implementation methodic

The next phase of correlation analysis is the developing of communication models or regression equation. It is necessary to investigate the structure of connections among definitions, to give factors in mathematical symbols, to establish a list of permissible operations over them, to make a set of variables, to take into record assumptions and conditions in a mathematical solution communications. It should assume that if the model is forming, then it should be very simple and intuitive.

The essential in preparing one factor regression is the choice of function type. The model must have a mathematical solve, and for this it necessary to submit as form one of the known functions.

Studying the relationship between two interrelated features is named as pair regression model or one factor regression model. The pair regression describing the relationship between two parameters: effective (dependent) and factor (independent). Analytical relationship between them can be written by equations:

- direct – $y(x) = a_0 + a_1 * x$;
- hyperbole – $y(x) = a_0 + a_1 / x$
- parabola – $y(x) = a_0 + a_1 * x + a_2 x$;

and other functions of the two approximations given features.

It's possible to determinate the equation type by two ways: to explore graphically or territorial statistical series. However, there are more general methods to detect connection equation without resorting to graphics. If the efficient and factor definitions are grown similarly, so it shows that connection between them is the linear, and when is the feedback -- hyperbolic. The definition is increase in an arithmetic progression if the model is efficient, and much faster is the factor, then it is need to use the parabolic or degree regression. Parameter regressions equations estimation (a 0, and 1 and a 2 - to second-order equation of the parabola) is the method of least squares, which is based on the observations independence assumption of the study population. The simplest linear correlation equation depends on productive traits y one factor (x) can be record as follows:

$$\hat{y} = a_0 + a_1 x .$$

Define evaluation a_0, a_1 parameters for least squares method. The essence of the least squares method is a found in the model parameters (a_0, a_1) , which minimizes the squared deviations sum of the empirical (actual) values of result definition from theoretical, which obtained for the chosen regression equation:

$$S = \sum_{i=1}^n (y_i - \hat{y}_i)^2 \rightarrow \min .$$

The system of normal equations for calculating the parameters of linear regression least squares method pair is:

$$\begin{cases} na_0 + a_1 \sum_{i=1}^n x_i = \sum_{i=1}^n y_i; \\ a_0 \sum_{i=1}^n x_i + a_1 \sum_{i=1}^n x_i^2 = \sum_{i=1}^n x_i y_i, \end{cases}$$

were n – the volume of the study population (number of observations).

Therefore, this problem must find functions depends "factors of influence" (x_1 та x_3) and from the trend (time factor t), ie the function $x_i = f(t)$.

In our case, you must find the coefficients for these models:

$$y(t) = a_0 + a_1 t; \quad x_1 = a_0 + a_1 t \quad \text{та} \quad x_3 = a_0 + a_1 t.$$

Carry out calculations with two signs after coma.

Example of defining the regression equation parameters for the first factor listed in Table 2.4.

Table 2.4 – Definition of regression parameters

| Period (t) | t | x_1 | t^2 | $t x_1$ |
|--------------|-----------|------------|------------|-------------|
| 2009 | | | | |
| I quarter | 1 | 28 | 1 | 28 |
| II quarter | 2 | 45 | 4 | 90 |
| III quarter | 3 | 56 | 9 | 168 |
| IV quarter | 4 | 46 | 16 | 184 |
| 2010 | | | | |
| I quarter | 5 | 57 | 25 | 285 |
| II quarter | 6 | 56 | 36 | 336 |
| III quarter | 7 | 34 | 49 | 238 |
| IV quarter | 8 | 45 | 64 | 360 |
| 2011 | | | | |
| I quarter | 9 | 68 | 81 | 612 |
| II quarter | 10 | 67 | 100 | 670 |
| Total | 55 | 502 | 385 | 2971 |

The system of normal equations for this example is:

$$\begin{cases} 10a_0 + 55a_1 = 502; \\ 55a_0 + 385a_1 = 2971; \end{cases}$$

Hence: $a_0 = 36,2$; $a_1 = 2,55$; $x_1 = 36,2 + 2,55t$.

Similarly find the regression equation parameters for the third factor and the Q(y) sales volume

x_3 : $a_0 = 10,4$; $a_1 = 1,01$; $x_3 = 10,4 + 1,01t$.

Q(y): $a_0 = 17,1$; $a_1 = 2,58$; $y = 17,1 + 2,58t$.

For a quick search of the coefficients of the linear regression equation can be used embedded feature Excel .

3. Key questions

1. In which case use one factor regression, and in which many factors regression?
2. Give the definition of linear and nonlinear nature of the relationship between factors and effective basis?
3. What is the essence of the least squares method?
4. What signs should be taken for efficient factor (independent), and which - for converting (dependent)?
5. How to calculate the coefficients of linear and nonlinear one factor regression models?

4. Mission of laboratory work

1. To calculate linear regression coefficients for selected factors using the least squares method (with two decimal places).
2. To give economic interpretation of regression equations parameters.

5. Protocol content

The laboratory protocol must have:

1. To get definitions and concepts that are in key provisions.
2. Intermediate and final results of the regression equation defining parameters for each factor of influence and sales services.
3. To bring models (linear equation) for the sales volume and services in selected factors influence x_2 , x_3 .
4. Resume about regression equations and their economic interpretation.

Laboratory work № 4
on subject: “ Linear prediction factors of influence”

1. Work subject

1. To increase and to fix the theoretical knowledge of “Telecommunication agency management” course.
2. To learn how to make models of communication or regression.
3. Learning by linear regression to found factors to predict the time and sales over time.

2 Key provisions

Terms and notions

- time factor;
- dynamic factors of influence;
- prognosis factors of influence;

3 Implementation methodic

Based on the influence factors dynamics and sales using regression equations for each factor, it is necessary to make a forecast for the time of 4 periods

There were linear forecasted values by factors of influence for the example in table 2.5.

Table 2.5 – Linear prediction of impact factors (predicted linear trend for factors x_1 and x_3 presented a half fat italics)

| Період | y | x_1 | x_3 |
|----------------|--------------|--------------|--------------|
| 2009 | | | |
| I кв. | 23 | 28 | 12 |
| II кв. | 34 | 45 | 15 |
| III кв. | 55 | 56 | 15 |
| IV кв. | 34 | 46 | 13 |
| 2010 | | | |
| I кв. | 22 | 57 | 11 |
| II кв. | 34 | 56 | 14 |
| III кв. | 44 | 34 | 17 |
| IV кв. | 45 | 45 | 18 |
| 2011 | | | |
| I кв. | 56 | 68 | 24 |
| II кв. | 54 | 67 | 20 |
| III кв. | 45,38 | 64,25 | 21,51 |
| IV кв. | 47,96 | 66,8 | 22,52 |
| 2012 | | | |
| I кв. | 50,54 | 69,35 | 23,53 |

| | | | |
|---------------|--------------|-------------|--------------|
| II кв. | 53,12 | 71,9 | 24,54 |
|---------------|--------------|-------------|--------------|

4 Key questions

1. In which cases is need to use trend argument (time factor) for factor forecast?
2. How is found the influence forecast factors using the regression equation?

4. Mission of laboratory work

- 1 To calculate manually or on PC forecast factors influence.
- 2 To show graphically forecasted values factors of influence and sales services.

5. Protocol content

The laboratory protocol must have:

1. Definitions and concepts that are in key positions.
2. The forecast results of each factor and sales must be drawn in a view as at table 2.5 and graphically.
3. Findings on factors influencing the values predicted by linear regression.

Laboratory work № 5
on subject: “ Forecasting sales using the forecast factors influence ”

1. Work object

1. To increase and to fix the theoretical knowledge of “Telecommunication agency management” course.
2. To learn how to do sales volume forecast using the linear regression equation.

2 Key provisions

Terms and notions

- demand model;
- forecast sales;

3. Implementation methodic

Demand Model - a certain functionality, which reflects the forecast object and the factors that contribute to it and linked in ways that reflect the basic structures and patterns of consumer development demand for specific types of services.

The general form of mathematical model of demand can be supplied in the next form:

$$y_i = f_i(x_1, x_2, \dots, x_n),$$

where y_i – service demand of i species;

f_i – mathematical function that links the independent variables;

x_1, x_2, \dots, x_n - factors that determine demand for the i -th species.

Obviously, we can not to do the forecast sales, using only the sales trend over the time, and the same would have been treated as a factor for forecast factor. But we have an existing trend influence factor, that essentially determines the behaviour sale tendencies (this follows from our calculated correlation coefficient). And this is predictable trend allows us to predict sales in accordance with the values of each factor.

It is necessary to calculate one factor sales model depends on the chosen factors. For our example, these models look like:

$$y = a_0 + a_1 x_1 \quad \text{ma} \quad y = a_0 + a_1 x_3.$$

With normal equations for each equation we find the coefficients a_0 and a_1 .

$$\begin{cases} na_0 + a_1 \sum_{i=1}^n x_i = \sum_{i=1}^n y_i; \\ a_0 \sum_{i=1}^n x_i + a_1 \sum_{i=1}^n x_i^2 = \sum_{i=1}^n x_i y_i, \end{cases}$$

For determining the parameters of regression equation for the first factor is need build the supporting table.

Table 2.6 - Definition of regression parameters

| Period (t) | y | x_1 | x_1^2 | yx_1 |
|--------------|------------|------------|--------------|--------------|
| 2009 | | | | |
| I KB. | 23 | 28 | 784 | 644 |
| II KB. | 34 | 45 | 2025 | 1530 |
| III KB. | 55 | 56 | 3136 | 3080 |
| IV KB. | 34 | 46 | 2126 | 1564 |
| 2010 | | | | |
| I KB. | 22 | 57 | 3249 | 1254 |
| II KB. | 34 | 56 | 3136 | 1904 |
| III KB. | 44 | 34 | 1158 | 1496 |
| IV KB. | 45 | 45 | 2025 | 2025 |
| 2011 | | | | |
| I KB. | 56 | 68 | 4624 | 3808 |
| II KB. | 54 | 67 | 4489 | 3618 |
| Total | 401 | 502 | 26740 | 20923 |

$$\begin{cases} 10a_0 + 502a_1 = 401 \\ 502a_0 + 26740a_1 = 20923 \end{cases}$$

$$a_1 = 0,51; a_0 = 14,25$$

Demand model of factor x_1 will be:

$$y_1 = 14,25 + 0,51x_1$$

Similarly find the regression equation parameters for the third factor. Demand model of factor x_3 will be:

$$y_3 = -2,45 + 2,68x_3$$

Realization algorithm for forecasting sales volume of trends influence factors listed in Table 2.7

Table 2.7 - Forecast sales forecast for the impact factors

| Period | x_1 | y_1 | x_3 | y_3 | Q_i |
|---------------|--------------|--------------|--------------|--------------|--------------|
| 2009 I кв. | 28 | 23 | 12 | 23 | |
| ... | ... | | ... | | |
| 2011 I кв. | 68 | 56 | 24 | 56 | |
| II кв. | 67 | 54 | 20 | 54 | |
| III кв. | 64,25 | 47,02 | 21,51 | 55,2 | 51,11 |
| IV кв. | 66,8 | 48,32 | 22,52 | 57,9 | 53,11 |
| 2012 I кв. | 69,35 | 49,62 | 23,53 | 60,61 | 55,12 |
| II кв. | 71,9 | 50,92 | 24,54 | 63,32 | 57,12 |

Note that the forecast sales value determined as an average value of the amount forecasted under each of the factors impact in forecast.

$$Q_i = \frac{\sum_{j=1}^m y_j}{m},$$

where Q_i – forecast value sales (demand) in the i-th period;

y_j – forecasted sales value of j-m factor;

m – number of selected factors.

4 Key questions

1. What is the forecast demand for individual services at a certain time period in the future?
2. What is a demand model and how to present a general mathematical demand model?
3. What are the main stages of the development demand model?

5 Mission of laboratory work

1. To calculate parameters of one factor sales volume models of selected factors (using the least squares method).
2. To give the economic interpretation of the found regression equations parameters.
3. To calculate the forecast sales volume services using the regression equation.
4. Draw a graph of forecasted sales volume value services.

6. Protocol content

The laboratory protocol must have:

1. Definitions and concepts that are in key positions.
2. The forecast sales results must be drawn in a view as at table 2.7 and graphically.

3. Conclusions concerning forecasted sales volume value services for linear regression.

Laboratory work № 6
on subject: “Evaluation of risk prediction ”

1. Work object

1. To increase and to fix the theoretical knowledge of “Telecommunication agency management” course.
2. To learn how to evaluate the forecasting sales services.

2 Key provisions

Terms and notions

- forecasting accuracy;
- risk prediction;

3 Implementation methodic

Please note that forecasting is done to suggest that they could significantly affect our forecast:

- our study can’t get a factor that affects sales;
- using linear forecast, and the tendency may be much more powerful;
- perform the forecasted values calculation as the arithmetic mean of the forecasted values by factors not including in the factor correlation level.

Certainly, these factors bring down the forecasting accuracy affect. Moreover, note that forecasting future periods is conducted not only on the basis of the time values and also on the values which were forecasted mathematically. That is, if we try to make forecast to the longer period, that will be more mistakes in the forecast value.

These restrictions do not take affect to the usage of this method (and a fortiori, it does not cancel) and it is only indicate to us necessity for calculation the risk forecast (var) tab. 2.10. This error can be estimated from the ratio between the predicted value of sales trends and projected sales values of each factor of influence:

$$\text{var}_i = \frac{\sum_{j=1}^m |Q_i - y_{ij}|}{Q_i} 100 \% .$$

The mean of approximation error, which is determined by the formula should not exceed 12-15%.

$$\text{var} = \left(\frac{|51,11 - 47,02| + |51,11 - 55,2|}{2} \right) / 51,11 * 100\% = 3,9\%$$

Table 2.8 - Implementation of calculations of risk prediction (var)

| Period | x_1 | y_1 | x_3 | y_3 | Q_i | $\text{var}_i, \%$ | $Q_{\text{пл } i}$ |
|--------|-------|-------|-------|-------|-------|--------------------|--------------------|
|--------|-------|-------|-------|-------|-------|--------------------|--------------------|

| | | | | | | | |
|----------------|--------------|--------------|--------------|--------------|--------------|-------|--------------|
| 2011 | | | | | | | |
| I кв. | 68 | 56 | 24 | 56 | | | |
| II кв. | 67 | 54 | 20 | 54 | | | |
| III кв. | 64,25 | 47,02 | 21,51 | 55,2 | 51,11 | 8,0 | 47,02 |
| IV кв. | 66,8 | 48,32 | 22,52 | 57,9 | 53,11 | 9,02 | 48,33 |
| 2012 | | | | | | | |
| I кв. | 69,35 | 49,62 | 23,53 | 60,61 | 55,12 | 9,97 | 49,66 |
| II кв. | 71,9 | 50,92 | 24,54 | 63,32 | 57,12 | 10,85 | 50,84 |

Analyzing the table 2.8, it should be noted that with increasing prediction period increases the risk prediction.

The forecasted risk may be taken into account in the service amount as a direct value of sales percent. So in our example, it is recommended to schedule II Apt. 2002, the services provided:

$$Q_{\text{пл } i} = Q_i (1 - \text{var} / 100) = 51,11 (1 - 0,08) = 47,02$$

The calculated value reduces the risk of our planned services volume.

4. Key questions

1. Why the forecast risk can be in the case, while the sales volume are forecasting?
2. From what is the accuracy of forecast depend?
3. How to calculate risk forecast?
4. How can reduce the risk forecast?

5 Mission of laboratory work

1. To calculate the forecast risk
2. To portray graphically projected sales value of services including risk forecast.

5. Protocol content

The laboratory protocol must have:

1. Terms and concepts definitions that are in key provisions.
2. Fill the form same as in a table 2.8 and graphically forecasted sales of services, including the forecast risk.
3. Conclusions on expectations sales services including risk forecast.

Initial data for the laboratory work

| Variant 1 | | | | | | |
|-----------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 21 | 53 | 27 | 13 | 50 | 12 | 7 |
| 22 | 76 | 29 | 15 | 55 | 15 | 8 |
| 25 | 59 | 35 | 19 | 44 | 15 | 6 |
| 22 | 66 | 36 | 10 | 53 | 13 | 8 |
| 24 | 82 | 42 | 15 | 49 | 11 | 9 |
| 27 | 81 | 36 | 20 | 68 | 14 | 11 |
| 31 | 66 | 49 | 19 | 59 | 17 | 14 |
| 28 | 76 | 40 | 24 | 75 | 18 | 15 |
| 35 | 88 | 55 | 25 | 70 | 24 | 10 |
| 40 | 70 | 60 | 28 | 73 | 20 | 13 |

| Variant 2 | | | | | | |
|-----------|----|----|----|-----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 25 | 34 | 13 | 7 | 66 | 7 | 14 |
| 24 | 38 | 13 | 8 | 72 | 6 | 18 |
| 28 | 31 | 12 | 11 | 74 | 6 | 16 |
| 33 | 37 | 13 | 12 | 91 | 5 | 18 |
| 34 | 39 | 15 | 13 | 75 | 8 | 20 |
| 35 | 35 | 16 | 14 | 89 | 6 | 17 |
| 33 | 43 | 15 | 11 | 93 | 1 | 18 |
| 38 | 49 | 16 | 10 | 99 | 9 | 22 |
| 35 | 41 | 19 | 15 | 110 | 9 | 21 |
| 40 | 40 | 18 | 14 | 105 | 8 | 20 |

| Variant 3 | | | | | | |
|-----------|-----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 15 | 54 | 4 | 12 | 27 | 9 | 11 |
| 18 | 49 | 4 | 11 | 29 | 13 | 14 |
| 20 | 52 | 5 | 15 | 35 | 12 | 12 |
| 25 | 73 | 7 | 11 | 36 | 13 | 13 |
| 26 | 67 | 6 | 17 | 42 | 12 | 15 |
| 26 | 64 | 7 | 16 | 36 | 11 | 14 |
| 30 | 80 | 9 | 18 | 49 | 15 | 16 |
| 34 | 93 | 11 | 16 | 40 | 13 | 14 |
| 32 | 95 | 14 | 19 | 55 | 17 | 13 |
| 30 | 100 | 15 | 18 | 50 | 16 | 12 |

| Variant 4 | | | | | | |
|-----------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 12 | 45 | 13 | 5 | 74 | 4 | 8 |
| 10 | 48 | 12 | 3 | 69 | 4 | 7 |
| 13 | 52 | 14 | 4 | 81 | 6 | 8 |
| 15 | 51 | 13 | 6 | 87 | 5 | 5 |
| 16 | 47 | 11 | 6 | 76 | 8 | 4 |
| 19 | 60 | 15 | 5 | 89 | 7 | 6 |
| 25 | 44 | 13 | 7 | 90 | 5 | 7 |
| 30 | 55 | 10 | 6 | 75 | 7 | 8 |
| 26 | 53 | 16 | 8 | 83 | 10 | 7 |
| 28 | 45 | 15 | 5 | 85 | 13 | 9 |

| Variant 5 | | | | | | |
|-----------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 11 | 44 | 6 | 14 | 53 | 8 | 15 |
| 13 | 41 | 7 | 11 | 49 | 10 | 17 |
| 12 | 46 | 6 | 14 | 62 | 9 | 14 |
| 15 | 57 | 7 | 17 | 54 | 10 | 17 |
| 13 | 48 | 9 | 16 | 67 | 11 | 18 |
| 16 | 60 | 8 | 18 | 65 | 12 | 17 |
| 16 | 57 | 10 | 22 | 67 | 13 | 20 |
| 17 | 69 | 9 | 21 | 79 | 11 | 21 |
| 20 | 78 | 8 | 23 | 90 | 15 | 25 |
| 17 | 80 | 10 | 20 | 85 | 17 | 22 |

| Variant 6 | | | | | | |
|-----------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 20 | 53 | 8 | 15 | 53 | 4 | 13 |
| 22 | 49 | 10 | 17 | 76 | 4 | 15 |
| 20 | 62 | 9 | 14 | 59 | 5 | 19 |
| 20 | 54 | 10 | 17 | 66 | 6 | 10 |
| 21 | 67 | 11 | 18 | 82 | 7 | 15 |
| 22 | 65 | 12 | 17 | 81 | 6 | 20 |
| 20 | 67 | 13 | 20 | 66 | 7 | 19 |
| 23 | 79 | 11 | 21 | 76 | 7 | 24 |
| 24 | 90 | 15 | 25 | 88 | 9 | 25 |
| 28 | 80 | 17 | 30 | 90 | 8 | 30 |

| Variant 7 | | | | | | |
|-----------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 5 | 74 | 4 | 8 | 34 | 13 | 7 |
| 7 | 69 | 4 | 7 | 38 | 13 | 8 |
| 8 | 81 | 6 | 8 | 31 | 12 | 11 |
| 9 | 87 | 5 | 5 | 37 | 13 | 12 |
| 9 | 76 | 8 | 4 | 39 | 15 | 13 |
| 10 | 89 | 7 | 6 | 35 | 16 | 14 |
| 12 | 90 | 5 | 7 | 43 | 15 | 11 |
| 13 | 75 | 7 | 8 | 49 | 16 | 10 |
| 15 | 83 | 10 | 7 | 41 | 19 | 15 |
| 18 | 80 | 8 | 6 | 50 | 20 | 17 |

| Variant 8 | | | | | | |
|-----------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 24 | 27 | 9 | 11 | 54 | 4 | 12 |
| 28 | 29 | 13 | 14 | 49 | 4 | 11 |
| 33 | 35 | 12 | 12 | 52 | 5 | 15 |
| 34 | 36 | 13 | 13 | 73 | 7 | 11 |
| 35 | 42 | 12 | 15 | 67 | 6 | 17 |
| 33 | 36 | 11 | 14 | 64 | 7 | 16 |
| 38 | 49 | 15 | 16 | 80 | 9 | 18 |
| 32 | 40 | 13 | 14 | 93 | 11 | 16 |
| 35 | 55 | 17 | 13 | 95 | 14 | 19 |
| 33 | 60 | 15 | 15 | 90 | 18 | 18 |

| Variant 9 | | | | | | |
|-----------|-----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 29 | 66 | 7 | 14 | 45 | 13 | 5 |
| 35 | 72 | 6 | 18 | 48 | 12 | 3 |
| 36 | 74 | 6 | 16 | 52 | 14 | 4 |
| 42 | 91 | 5 | 18 | 51 | 13 | 6 |
| 36 | 75 | 8 | 20 | 47 | 11 | 6 |
| 49 | 89 | 6 | 17 | 60 | 15 | 5 |
| 40 | 93 | 1 | 18 | 44 | 13 | 7 |
| 43 | 99 | 9 | 22 | 55 | 10 | 6 |
| 55 | 110 | 9 | 21 | 53 | 16 | 8 |
| 52 | 95 | 13 | 20 | 50 | 15 | 7 |

| Variant 10 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 28 | 50 | 12 | 7 | 44 | 6 | 14 |
| 30 | 55 | 15 | 8 | 41 | 7 | 11 |
| 27 | 44 | 15 | 6 | 46 | 6 | 14 |
| 26 | 53 | 13 | 8 | 57 | 7 | 17 |
| 30 | 49 | 11 | 9 | 48 | 9 | 16 |
| 34 | 68 | 14 | 11 | 60 | 8 | 18 |
| 38 | 59 | 17 | 14 | 57 | 10 | 22 |
| 40 | 75 | 18 | 15 | 69 | 9 | 21 |
| 44 | 70 | 24 | 10 | 78 | 8 | 23 |
| 45 | 71 | 20 | 11 | 80 | 10 | 20 |

| Variant 11 | | | | | | |
|------------|----|----|----|-----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 29 | 33 | 11 | 8 | 62 | 5 | 15 |
| 28 | 35 | 13 | 7 | 72 | 6 | 17 |
| 25 | 32 | 12 | 11 | 73 | 6 | 16 |
| 27 | 36 | 13 | 12 | 81 | 5 | 18 |
| 30 | 37 | 17 | 13 | 90 | 8 | 19 |
| 32 | 38 | 16 | 14 | 89 | 6 | 17 |
| 34 | 40 | 15 | 12 | 93 | 2 | 21 |
| 38 | 42 | 16 | 10 | 95 | 8 | 22 |
| 36 | 43 | 19 | 15 | 110 | 9 | 21 |
| 39 | 40 | 18 | 14 | 107 | 10 | 24 |

| Variant 12 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 18 | 69 | 14 | 16 | 34 | 20 | 18 |
| 19 | 66 | 11 | 12 | 39 | 22 | 17 |
| 20 | 78 | 12 | 13 | 32 | 21 | 20 |
| 21 | 84 | 13 | 10 | 38 | 22 | 21 |
| 21 | 73 | 15 | 9 | 0 | 24 | 22 |
| 22 | 86 | 14 | 11 | 36 | 25 | 23 |
| 24 | 87 | 12 | 12 | -1 | 24 | 20 |
| 25 | 72 | 15 | 13 | 50 | 25 | 19 |
| 27 | 80 | 17 | 12 | 2 | 28 | 24 |
| 29 | 76 | 16 | 14 | 50 | 31 | 28 |

| Variant 13 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 16 | 68 | 11 | 15 | 35 | 18 | 13 |
| 17 | 65 | 8 | 12 | 40 | 20 | 12 |
| 18 | 77 | 10 | 11 | 33 | 19 | 15 |
| 19 | 83 | 9 | 8 | 39 | 20 | 16 |
| 19 | 72 | 12 | 7 | 41 | 22 | 17 |
| 20 | 85 | 11 | 9 | 37 | 23 | 18 |
| 22 | 86 | 9 | 10 | 45 | 22 | 15 |
| 23 | 71 | 11 | 11 | 51 | 24 | 14 |
| 25 | 77 | 14 | 10 | 43 | 26 | 19 |
| 27 | 75 | 13 | 12 | 51 | 29 | 23 |

| Variant 14 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 11 | 69 | 9 | 13 | 33 | 15 | 9 |
| 12 | 66 | 10 | 11 | 38 | 17 | 8 |
| 13 | 78 | 8 | 15 | 31 | 16 | 11 |
| 15 | 84 | 7 | 9 | 37 | 19 | 12 |
| 14 | 73 | 11 | 7 | 39 | 17 | 13 |
| 16 | 88 | 9 | 8 | 35 | 20 | 14 |
| 17 | 87 | 7 | 9 | 43 | 19 | 11 |
| 18 | 72 | 9 | 10 | 9 | 21 | 10 |
| 20 | 80 | 12 | 9 | 41 | 23 | 15 |
| 22 | 76 | 15 | 11 | 47 | 26 | 19 |

| Variant 15 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 7 | 72 | 8 | 12 | 34 | 12 | 10 |
| 8 | 70 | 9 | 11 | 32 | 14 | 9 |
| 9 | 69 | 7 | 8 | 30 | 13 | 12 |
| 12 | 68 | 6 | 9 | 38 | 14 | 13 |
| 10 | 77 | 8 | 7 | 40 | 17 | 14 |
| 11 | 88 | 9 | 9 | 36 | 18 | 15 |
| 1 | 91 | 6 | 12 | 44 | 19 | 12 |
| 18 | 76 | 10 | 8 | 50 | 17 | 11 |
| 16 | 84 | 12 | 11 | 42 | 20 | 16 |
| 19 | 81 | 10 | 14 | 50 | 23 | 20 |

| Variant 16 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 6 | 72 | 7 | 11 | 33 | 11 | 9 |
| 7 | 69 | 4 | 7 | 38 | 13 | 8 |
| 8 | 81 | 6 | 8 | 31 | 12 | 11 |
| 9 | 87 | 5 | 5 | 37 | 13 | 12 |
| 9 | 76 | 8 | 4 | 39 | 15 | 13 |
| 10 | 89 | 7 | 6 | 35 | 16 | 14 |
| 12 | 90 | 5 | 7 | 43 | 15 | 11 |
| 13 | 75 | 7 | 8 | 49 | 16 | 10 |
| 15 | 83 | 10 | 7 | 41 | 19 | 15 |
| 17 | 79 | 9 | 9 | 49 | 22 | 19 |

| Variant 17 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 27 | 28 | 12 | 13 | 48 | 3 | 10 |
| 28 | 29 | 13 | 14 | 49 | 4 | 11 |
| 30 | 31 | 15 | 16 | 51 | 6 | 13 |
| 34 | 36 | 13 | 13 | 73 | 7 | 11 |
| 37 | 39 | 16 | 17 | 76 | 10 | 14 |
| 33 | 36 | 11 | 14 | 64 | 7 | 16 |
| 38 | 49 | 15 | 16 | 80 | 9 | 18 |
| 32 | 40 | 13 | 14 | 93 | 11 | 16 |
| 33 | 41 | 14 | 15 | 94 | 12 | 17 |
| 37 | 45 | 18 | 19 | 98 | 16 | 21 |

| Variant 18 | | | | | | |
|------------|-----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 29 | 66 | 0 | 12 | 42 | 6 | 7 |
| 35 | 72 | 6 | 18 | 48 | 12 | 3 |
| 37 | 74 | 8 | 20 | 50 | 14 | 5 |
| 42 | 91 | 5 | 18 | 51 | 13 | 6 |
| 36 | 85 | 8 | 12 | 45 | 9 | 7 |
| 49 | 89 | 6 | 17 | 60 | 15 | 5 |
| 40 | 93 | 1 | 18 | 44 | 13 | 7 |
| 43 | 99 | 9 | 22 | 55 | 10 | 6 |
| 55 | 110 | 9 | 21 | 53 | 16 | 8 |
| 53 | 108 | 7 | 19 | 51 | 14 | 6 |

| Variant 19 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 28 | 45 | 16 | 7 | 47 | 7 | 15 |
| 30 | 55 | 15 | 8 | 41 | 7 | 11 |
| 27 | 44 | 15 | 6 | 46 | 6 | 14 |
| 26 | 53 | 13 | 8 | 57 | 7 | 17 |
| 29 | 56 | 16 | 11 | 60 | 10 | 20 |
| 34 | 68 | 14 | 11 | 60 | 8 | 18 |
| 38 | 59 | 17 | 14 | 57 | 10 | 22 |
| 40 | 75 | 18 | 15 | 69 | 9 | 21 |
| 44 | 70 | 24 | 10 | 78 | 8 | 23 |
| 42 | 68 | 26 | 11 | 74 | 10 | 24 |

| Variant 20 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 30 | 57 | 17 | 12 | 61 | 11 | 21 |
| 29 | 56 | 16 | 11 | 60 | 10 | 20 |
| 27 | 44 | 15 | 6 | 46 | 6 | 14 |
| 26 | 53 | 13 | 8 | 57 | 7 | 17 |
| 30 | 49 | 11 | 9 | 48 | 9 | 16 |
| 32 | 51 | 13 | 11 | 50 | 11 | 18 |
| 38 | 59 | 17 | 14 | 57 | 10 | 22 |
| 37 | 58 | 16 | 13 | 56 | 9 | 21 |
| 46 | 69 | 24 | 10 | 78 | 8 | 23 |
| 45 | 71 | 20 | 11 | 80 | 10 | 20 |

| Variant 21 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 27 | 55 | 26 | 14 | 52 | 11 | 9 |
| 22 | 76 | 29 | 15 | 55 | 15 | 8 |
| 25 | 59 | 35 | 19 | 44 | 15 | 6 |
| 24 | 67 | 36 | 10 | 53 | 13 | 8 |
| 26 | 82 | 42 | 15 | 49 | 11 | 9 |
| 27 | 80 | 36 | 20 | 68 | 14 | 11 |
| 31 | 66 | 49 | 19 | 59 | 17 | 14 |
| 28 | 76 | 44 | 24 | 75 | 18 | 15 |
| 35 | 88 | 55 | 25 | 70 | 24 | 10 |
| 41 | 73 | 62 | 28 | 73 | 20 | 13 |

| Variant 22 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 18 | 51 | 4 | 14 | 34 | 11 | 11 |
| 17 | 49 | 4 | 11 | 29 | 13 | 14 |
| 19 | 52 | 5 | 15 | 35 | 12 | 12 |
| 24 | 73 | 7 | 11 | 36 | 13 | 13 |
| 23 | 67 | 6 | 17 | 42 | 12 | 15 |
| 27 | 64 | 7 | 16 | 36 | 11 | 14 |
| 32 | 80 | 9 | 18 | 49 | 15 | 16 |
| 33 | 81 | 10 | 19 | 50 | 16 | 17 |
| 31 | 95 | 14 | 19 | 55 | 17 | 13 |
| 33 | 97 | 16 | 21 | 57 | 19 | 15 |

| Variant 23 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 28 | 50 | 12 | 7 | 44 | 6 | 14 |
| 30 | 55 | 15 | 8 | 41 | 7 | 11 |
| 27 | 44 | 15 | 6 | 46 | 6 | 14 |
| 26 | 53 | 13 | 8 | 57 | 7 | 17 |
| 30 | 49 | 11 | 9 | 48 | 9 | 16 |
| 34 | 68 | 14 | 11 | 60 | 8 | 18 |
| 38 | 59 | 17 | 14 | 57 | 10 | 22 |
| 40 | 75 | 18 | 15 | 69 | 9 | 21 |
| 44 | 70 | 24 | 10 | 78 | 8 | 23 |
| 45 | 71 | 20 | 11 | 80 | 10 | 20 |

| Variant 24 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 24 | 27 | 9 | 11 | 54 | 4 | 12 |
| 28 | 29 | 13 | 14 | 49 | 4 | 11 |
| 33 | 35 | 12 | 12 | 52 | 5 | 15 |
| 34 | 36 | 13 | 13 | 73 | 7 | 11 |
| 35 | 42 | 12 | 15 | 67 | 6 | 17 |
| 33 | 36 | 11 | 14 | 64 | 7 | 16 |
| 38 | 49 | 15 | 16 | 80 | 9 | 18 |
| 32 | 40 | 13 | 14 | 93 | 11 | 16 |
| 35 | 55 | 17 | 13 | 95 | 14 | 19 |
| 33 | 60 | 15 | 15 | 90 | 18 | 18 |

| Variant 25 | | | | | | |
|------------|-----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 29 | 66 | 7 | 14 | 45 | 13 | 5 |
| 35 | 72 | 6 | 18 | 48 | 12 | 3 |
| 36 | 74 | 6 | 16 | 52 | 14 | 4 |
| 42 | 91 | 5 | 18 | 51 | 13 | 6 |
| 36 | 75 | 8 | 20 | 47 | 11 | 6 |
| 49 | 89 | 6 | 17 | 60 | 15 | 5 |
| 40 | 93 | 1 | 18 | 44 | 13 | 7 |
| 43 | 99 | 9 | 22 | 55 | 10 | 6 |
| 55 | 110 | 9 | 21 | 53 | 16 | 8 |
| 52 | 95 | 13 | 20 | 50 | 15 | 7 |

| Variant 26 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 7 | 72 | 8 | 12 | 34 | 12 | 10 |
| 8 | 70 | 9 | 11 | 32 | 14 | 9 |
| 9 | 69 | 7 | 8 | 30 | 13 | 12 |
| 12 | 68 | 6 | 9 | 38 | 14 | 13 |
| 10 | 77 | 8 | 7 | 40 | 17 | 14 |
| 11 | 88 | 9 | 9 | 36 | 18 | 15 |
| 1 | 91 | 6 | 12 | 44 | 19 | 12 |
| 18 | 76 | 10 | 8 | 50 | 17 | 11 |
| 16 | 84 | 12 | 11 | 42 | 20 | 16 |
| 19 | 81 | 10 | 14 | 50 | 23 | 20 |

| Variant 27 | | | | | | |
|------------|----|----|----|-----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 29 | 33 | 11 | 8 | 62 | 5 | 15 |
| 28 | 35 | 13 | 7 | 72 | 6 | 17 |
| 25 | 32 | 12 | 11 | 73 | 6 | 16 |
| 27 | 36 | 13 | 12 | 81 | 5 | 18 |
| 30 | 37 | 17 | 13 | 90 | 8 | 19 |
| 32 | 38 | 16 | 14 | 89 | 6 | 17 |
| 34 | 40 | 15 | 12 | 93 | 9 | 21 |
| 38 | 42 | 16 | 10 | 95 | 8 | 22 |
| 36 | 43 | 19 | 15 | 110 | 9 | 21 |
| 39 | 40 | 18 | 14 | 107 | 10 | 24 |

| Variant 28 | | | | | | |
|------------|----|----|----|----|----|----|
| y | x1 | x2 | x3 | x4 | x5 | x6 |
| 27 | 23 | 14 | 10 | 52 | 7 | 18 |
| 26 | 25 | 13 | 9 | 56 | 8 | 17 |
| 25 | 22 | 11 | 11 | 63 | 6 | 16 |
| 27 | 26 | 12 | 12 | 68 | 8 | 18 |
| 31 | 27 | 15 | 13 | 70 | 10 | 19 |
| 30 | 28 | 16 | 12 | 79 | 11 | 18 |
| 34 | 30 | 17 | 14 | 73 | 9 | 21 |
| 36 | 32 | 16 | 13 | 75 | 8 | 22 |
| 35 | 33 | 19 | 16 | 80 | 11 | 23 |
| 38 | 30 | 17 | 14 | 87 | 10 | 24 |

y – sales of services;

x_1 – average quarterly gross domestic product, millions UAH;

x_2 – average quarterly nominal of salary for national economy workers, thousand UAH;

x_3 – average revenue tax, UAH;

x_4 – money income, thousand, UAH;

x_5 – capital investment, millions UAH;

x_6 – unemployment rate, %.

All outgoing data is conditional.

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