Financial and Management Tools to Identify Realistic Factors Affecting Production Output

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Abstract. Correlation and regression analysis can be used to establish casual relationships between variables. In practice, these tools help to find out the variable value and determine its impact on the change of the dependent variable.

The purpose of the article is to study the factors affecting the change in the production output, in particular, stock inventories, their turnover as well as contractors and buyers of finished products. Even if the values are expressed in different units of measurement, i.e. the production output and inventories - in rubles and inventory turnover - in turns, contractors - in the number of men, the economic and mathematical models presented enable us to make a comparison. Therefore, the article demonstrates a practical approach to find the dependency between specific and above factors (variables) and their cause-and-effect associations.

In practice, it is necessary to find out the values of the variable and determine its impact on the change of the dependent variable. In this particular case, the production output is taken as a dependent value. Its value is influenced by variables (stocks of raw materials and supplies, their turnover, number of consumers formed for a certain type of finished product of a given production), and therefore they change proportionally. The calculation of values for one variable on the basis of another one will be shown using regression equation with known initial numbers. Consequently, a practical approach presented demonstrates how correlation analysis, mathematical function, regression equation and trend line can be applied allowing practitioners to identify not only cause-and-effect but also regression relationships between variables. The proposed regression analysis allows to identify changes in the microeconomic production policy and to trace their impact on the economic activity of the entity over time.

1. Introduction
Economic and mathematical methods of analysis provide practitioners with an opportunity to identify causal relationships between variables and explain their regression relationships.

2. Problem statement
In practice, the analytics do not use economic and mathematical methods of research as they fear they will be unable to accomplish it and will fail to see the result of hard work allowing to establish a link between casual relations and factors affecting the financial results of economic activity.
3. Research questions
Determine the strength and direction of the relationship between selected variables using correlation and regression analysis and embedded Microsoft Excel functions.

4. Purpose of the study
Assess the dependence factors explaining the change in production output and financial results of economic activity with the help of regression equation.

5. Research method
Economic and mathematical modeling, correlation and regression analysis, calculation of regression equation, generation of a trend line, embedded functions of MS Excel.

6. Main section
The economic entity under study belongs to the production sphere. Its main part of the assets is represented by raw materials and supplies as a required condition for ensuring the continuity of production process. Their inventory should be sufficient to ensure uninterrupted production of a wide range of finished products.

For the purposes of selecting parameters for the economic and mathematical model, it should be noted that the range of finished products and their sales, the availability of raw materials and their turnover at the production process actually affect the enterprise volume of activity [6,8].

To present a realistic view of close link between the factors and activity volume, the source data provided in Table 1 (average cost of inventory and contractors-buyers of the given finished products in the economic supply chain of the enterprise) are logged in the embedded function of MS Excel, which allows to establish a relationship between the selected factors (values) [1,3] by means of correlation and regression analysis for the causal relationship between the variables.

| Finished product No. | Production output for 2018, RUB | Inventory cost (raw materials and supplies) | Contractors, men |
|---------------------|-------------------------------|--------------------------------------------|-----------------|
| No. 1               | 9359000                       | 420915                                     | 968             |
| No. 2               | 4860900                       | 695840                                     | 1563            |
| No. 3               | 3303700                       | 246261                                     | 334             |
| No. 4               | 13763900                      | 1664891                                    | 765             |
| No. 5               | 3216400                       | 450732                                     | 291             |
| No. 6               | 4400500                       | 621486                                     | 309             |
| No. 7               | 1677000                       | 161024                                     | 105             |
| No. 8               | 5174600                       | 692684                                     | 299             |
| No. 9               | 5043500                       | 787734                                     | 478             |
| No. 10              | 2973000                       | 376916                                     | 219             |
| No. 11              | 1752400                       | 138245                                     | 119             |
| No. 12              | 2020700                       | 369579                                     | 175             |
| No. 13              | 2602200                       | 444016                                     | 721             |
| No. 14              | 2135300                       | 225653                                     | 301             |
| No. 15              | 3063800                       | 397611                                     | 271             |
| No. 16              | 4367500                       | 621102                                     | 782             |
| No. 17              | 2923800                       | 687766                                     | 367             |
| No. 18              | 5449100                       | 518341                                     | 429             |
| No. 19              | 2052500                       | 261568                                     | 366             |
| No. 20              | 675700                        | 123462                                     | 243             |
| No. 21              | 5177200                       | 591126                                     | 307             |
The tabular correlation data determined the strength and direction of the relationship between the sample variables as provided in Table 2.

**Table 2.** The obtained data of correlation between the factors.

| First Section       | First Section | First Section | First Section |
|---------------------|---------------|---------------|---------------|
| Production output   | 1             | 0.791233      | 0.271435      |
| Inventory cost      | 0.791233      | 1             | -0.0349181    |
| Contractors-buyers  | 0.271435      | -0.0349181    | 1             |

The analysis package (regression string) and linear regression equation $\hat{y} = \alpha + \beta x$ in MS Excel allowed to obtain the results reflected in Figure 1 and Table 3.

**Figure 1.** The relationship between the production output and availability of raw materials and supplies at the enterprise (inventory).

The results obtained (Fig. 1) make it possible to note a direct and close correlation between the production output (effective) and inventory (factor), which is confirmed by the multiple $R$ coefficient ($R = 0.791233 \approx 0.8$). The multiple $R$ coefficient, showing the dependency between production output and the number of contractors-buyers, is low since it has a small actual value ($R = 0.271435 \approx 0.3$), but the causal relationship between the inventory cost and the population is not small at all, since the correlation coefficient has developed a negative value ($R = -0.0349181$).
Table 3. Linear regression parameters as obtained using the analysis package and linear regression equation.

| Finished product No. | Production output for 2018, RUB | Inventory cost | Contractors-buyers | Average production output $\bar{T}_3$ | Effective use of inventory ratio |
|----------------------|---------------------------------|----------------|-------------------|--------------------------------------|----------------------------------|
| No. 1                | 9752400                         | 999846         | 456               | 8321024                              | 1.17                             |
| No. 2                | 9359000                         | 420915         | 968               | 3965126                              | 2.36                             |
| No. 3                | 4860900                         | 695840         | 1563              | 6033672                              | 0.81                             |
| No. 4                | 3303700                         | 246261         | 334               | 2651023                              | 1.25                             |
| No. 5                | 13762900                        | 1664891        | 765               | 13324847                             | 1.03                             |
| No. 6                | 3216400                         | 450732         | 291               | 4189471                              | 0.77                             |
| No. 7                | 4400500                         | 621486         | 309               | 5474230                              | 0.80                             |
| No. 8                | 1677000                         | 161024         | 105               | 2009697                              | 0.83                             |
| No. 9                | 5174600                         | 692684         | 299               | 6009926                              | 0.86                             |
| No. 10               | 5043500                         | 787734         | 478               | 6725086                              | 0.75                             |
| No. 11               | 2973000                         | 376916         | 219               | 3634076                              | 0.82                             |
| No. 12               | 1752400                         | 138245         | 119               | 1838307                              | 0.95                             |
| No. 13               | 2020700                         | 369579         | 175               | 3578872                              | 0.56                             |
| No. 14               | 2602200                         | 444016         | 721               | 4138939                              | 0.63                             |
| No. 15               | 2135300                         | 225653         | 301               | 2495968                              | 0.86                             |
| No. 16               | 3063800                         | 397611         | 271               | 3789786                              | 0.81                             |
| No. 17               | 4675000                         | 621102         | 782               | 5471341                              | 0.80                             |
| No. 18               | 2923800                         | 687766         | 367               | 5972923                              | 0.49                             |
| No. 19               | 5449100                         | 518341         | 429               | 4698163                              | 1.16                             |
| No. 20               | 2052500                         | 261568         | 366               | 2766194                              | 0.74                             |
| No. 21               | 6757000                         | 123462         | 243               | 1727079                              | 0.39                             |
| No. 22               | 5177200                         | 591126         | 307               | 5245800                              | 0.99                             |
| No. 23               | 1076200                         | 138407         | 185               | 1839526                              | 0.59                             |
| No. 24               | 7531800                         | 651096         | 492               | 5697017                              | 1.32                             |
| No. 25               | 8066300                         | 437120         | 523               | 4087053                              | 1.97                             |
| No. 26               | 1732700                         | 274316         | 608               | 2862110                              | 0.61                             |
| Total                | 114152100                       | 12997737       | 11676             | x                                    | x                                |

At the next stage, the economic and mathematical modeling uses MS Excel function to construct a trend line (a linear trend), showing the equation and the value of the approximation reliability ($R^2$) provided in Figure 2.

The results in Figure 2 show that $a = 7.8184$ and $b = 481958$, so the linear regression equation takes the following form: $\hat{y} = 7.8184x + 481958$. The calculated slope $a = + 7.8184$ means that as the variable $x$ (inventory) increases by one, whereas the average value of the variable $y$ (production output) increases by 7.8184.
Consequently, the growth of inventory leads to an increase in production, namely the calculated shift \( b = +481958 \) (RUB). This value is the average variable \( y \) at \( x = 0 \). It should be taken into account, however, that the shift of the variable \( y \) is beyond the range of the variable \( x \). Therefore, we should be careful when interpreting parameter \( b \) [7].

If we take a close look at the location of points in relation to the trend line (Fig. 2), we can see that some points are in a relatively remote distance from the trend line thus indicating another factor that strongly affects the production output [2].

Once the trend line indicates the availability of another factor, we need to look for another causal relationship of factors affecting both the inventory amount and production output. This causal factor is an economic factor of inventory turnover or stock turnover [4].

Inventory Turnover is a circulation rate of finished products and an indicator of economic activity (Table 4) measured in days or turns (Formula 1, 2) [5].

\[
\text{Volume Turnover Ratio} = \frac{\text{Production Output}}{\text{Average Inventory at Cost}}; \quad (1)
\]

If the volume turnover is to be computed in days, than the following formula is used:

\[
\text{Volume Turnover} = \frac{365}{\text{Volume Turnover Ratio}}; \quad (2)
\]

**Table 4. Causal factor calculation (turnover of raw materials).**

| Finished product No. | Production output for 2018, RUB | Average production output \( \bar{T}_{\text{inv. Rub}} \) | Turnover, days | Effective use of inventory ratio |
|----------------------|---------------------------------|----------------------------------|----------------|-------------------------------|
| No. 1               | 9752400                         | 999846                           | 37             | 1.17                          |
| No. 2               | 9359000                         | 420915                           | 16             | 2.36                          |
| No. 3               | 4860900                         | 695840                           | 52             | 0.81                          |
| No. 4               | 3303700                         | 246261                           | 27             | 1.25                          |
| No. 5               | 13763900                        | 1664891                          | 44             | 1.03                          |
| No. 6               | 3216400                         | 450732                           | 51             | 0.77                          |
| No. 7               | 4400500                         | 621486                           | 52             | 0.80                          |
| No. 8               | 1677000                         | 161024                           | 35             | 0.83                          |
| No. 9               | 5174600                         | 692684                           | 49             | 0.86                          |
| No. 10              | 5043500                         | 787734                           | 57             | 0.75                          |
| No. 11              | 2973000                         | 376916                           | 46             | 0.82                          |
| No. 12              | 1752400                         | 138245                           | 29             | 0.95                          |
| No. 13              | 2020700                         | 369579                           | 67             | 0.56                          |
| No. 14              | 2602200                         | 444016                           | 62             | 0.63                          |
| No. 15              | 2135300                         | 225653                           | 39             | 0.86                          |
| No. 16              | 3063800                         | 397611                           | 47             | 0.81                          |
| No. 17              | 4367500                         | 621102                           | 52             | 0.80                          |
| No. 18              | 2923800                         | 687766                           | 86             | 0.49                          |
For example, the most effective use of stock inventory is observed in the range of finished products No.2 where the turnover ratio is equal to 2.36, whereas the turnover (days) is equal to 16. On the contrary, the most ineffective use of stock inventory is under No. 18 where the turnover is 86 days and the circulation rate is 0.49 times, i.e. a slow turnover is observed.

It means that the faster the inventory turnover rate, the higher the inventory efficiency ratio, and vice versa - the slower the inventory turnover rate, the lower the inventory efficiency ratio [7].

To facilitate management decisions, it is necessary to take appropriate measures to accelerate the inventory turnover (Figure 3) [7].

| No.  | Stock No. | Stock  | Turnover (Ratio) |
|------|-----------|--------|------------------|
| 19   | 5449100   | 518341 | 35               | 1.16 |
| 20   | 2052500   | 261568 | 47               | 0.74 |
| 21   | 675700    | 123462 | 67               | 0.39 |
| 22   | 5177200   | 591126 | 42               | 0.99 |
| 23   | 1076200   | 138407 | 47               | 0.59 |
| 24   | 7531800   | 651096 | 32               | 1.32 |
| 25   | 8066300   | 437120 | 20               | 1.97 |
| 26   | 1732700   | 274316 | 58               | 0.61 |
| Total| 114152100 | 12997737 | 42           | x    |

Measures to promote the efficient use of inventory

- develop effective logistics of supplies, if applicable, in order to limit overstocking which can cause the slowdown in turnover;

- study the needs of the contractor-buyer assigned to this type of finished products in order to implement the effective application for stocks;

- expand purchase of raw materials on preferential terms (making delay payments, making sure that raw materials will be needed in the production process);

- analyze the range of finished products through a survey of contractors-buyers to identify customer interest;

- timely utilize stale industrial stocks, if applicable, since they contribute to slowdown of turnover and bigger payment of the property tax.

Figure 3. Actions contributing to inventory turnover acceleration.

The proposed actions will contribute to production growth and reduction of inventories. The forecast calculation data are presented in Table 5.
Table 5. Efficiency forecast for use of inventories production stocks.

| Year                  | Actual as of 2018 | Forecast 2019 | Forecast 2020 | Forecast 2021 |
|-----------------------|-------------------|---------------|---------------|---------------|
| Production output,    | 114152100         | 119859705     | 125852690     | 132145339     |
| Rub.                  |                   |               |               |               |
| Average cost of inventories, Rub. | 12997737        | 12347850     | 11730457     | 11143934     |
| Turnover, Day         | 42                | 37            | 34            | 30            |

Forecast data makes it possible to emphasize that accelerating the turnover of finished products in days reduces material inventories for manufacturing enterprises in order to prevent overstocking and to achieve an increase in sales, which gives workers the opportunity to reduce labor-intensive work in inventories and business efficiency.

7. References

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