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THE HYBRID MODEL OF MULTIVARIATE INDEX ANALYSIS OF CURRENT ASSETS

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This article discusses the principles and methods of constructing a hybrid model for multivariate index analysis of the circulation of tangible assets on the example of retail trade enterprises. Analysis of the time and circulation velocity of the current assets was carried out with respect to the on-hand inventory for homogeneous positions of the group assortment of a shoe department of an economic entity. The time model and the turnover rate were built separately. At the final stage, applying the so-called index crossing procedure, the author constructed a v|t-model, which contains five independent characteristic factors. Each of the considered characteristic factors corresponds to its standard statistical indicator, according to which the economic analysis is traditionally carried out depending on the formulated goals and tasks, both at enterprises and in special applied studies. The same factors serve as indicators of the financial performance of any economic entity, as comparative characteristics in assessing the subject's competitiveness in the commodity markets and can be used in assessing the market value of a business. The resulting model is verified, reliable calculations have been made for it. The model opens up new horizons for financial and economic analysis of the circulation of the company's tangible assets, allows to comprehensively study the parameters of velocity and time of commodity circulation. The latter is complicated, and sometimes even impossible at all, in econometric multifactor models due to multicollinearity of characteristic factors. This circumstance makes the future hybrid model constructed in the solution of problems of short-term forecasting and operational planning promising.

Keywords: simple index; analytical index; index crossing; mixed-index analysis; hybrid model of factor analysis; primary and secondary feature; working capital; current assets; index model

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ГИБРИДНАЯ МОДЕЛЬ МНОГОФАКТОРНОГО ИНДЕКСНОГО АНАЛИЗА ОБОРОТНЫХ АКТИВОВ

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Рассматриваются принципы и методы построения гибридной модели многофакторного индексного анализа обращения материальных активов на примере запасов розничного торгового предприятия. Анализ времени и скорости движения оборотных средств проведен в отношении товарных запасов текущего хранения по однородным позициям группового ассортимента обувного отдела экономического субъекта. Отдельно построены модели анализа времени и скорости оборачиваемости изучаемых активов. На заключительном этапе с применением процедуры так называемого индексного кроссинга сконструирована v|t-модель, которая содержит пять самостоятельных признаков-факторов. За каждым из учтенных признаков-факторов скрывается свой стандартный

статистический показатель, по которому традиционно осуществляется экономический анализ в зависимости от сформулированных целей и задач как на предприятиях, так и для специальных прикладных исследований. Эти же показатели являются индикаторами финансового состояния любого экономического субъекта, сравнительными характеристиками при оценке конкурентоспособности субъекта на товарных рынках и могут быть использованы при оценках рыночной стоимости бизнеса. Полученная модель верифицирована, по ней проведены достоверные расчеты. Модель открывает новые горизонты проведения финансово-экономического анализа движения материальных активов предприятия, позволяет воедино и комплексно изучать параметры скорости и времени товарного обращения. Последнее осложнено, а подчас бывает и вовсе невозможно в эконометрических многофакторных моделях в связи с явлением мультиколлинеарности признаков-факторов. Отмеченное обстоятельство делает перспективной построенную впервые подобную гибридную модель в решении задач краткосрочного прогнозирования и оперативного планирования.

Ключевые слова: простой индекс; аналитический индекс; индексный кроссинг; индексный микст-анализ; гибридная модель факторного анализа; первичный и вторичный признак; средства обращения; оборотные активы

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«Well, in our country,» said Alice, still panting a little, «you'd generally get to somewhere else – if you run very fast for a long time, as we've been doing.»

«A slow sort of country!» said the Queen. «Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!»

Carroll, Lewis: Through the Looking-Glass and What Alice Found There, Chapter 2

Introduction. Research in the field of industrial production, as well as in wholesale and retail trade touches upon issues of turnover of tangible assets which is a separate and important area of analysis of the financial condition of any economic subject. The effectiveness of such asset management is reflected immediately in terms of solvency and stability of the enterprise. There is considerable domestic and foreign bibliography dedicated to the study of time and the circulation velocity of certain types of tangible assets. This article is related to the construction of a fundamentally new hybrid *v|t*-model of multivariate analysis on the example of the dynamics of asset inventory of a particular trader.

The indicators of the *time and velocity* of circulation of working capital are some of the most important and generalizing economic characteristics of the efficiency of circulation of the commodity mass in the form of raw materials, fuels, finished products, commodity reserves in the market space and of the circulation within production cycles. These indicators generally serve such a special economic concept as *commodity turnover*.

The economic analysis of these characteristics is particularly important in setting conditions of the market mechanism of management of industrial enterprises of the real sector, sales, trading and purchasing of specialized applications and systems, improvement of commercial calculation and the increasing importance of financial leverage in diverse relationships with market partners [1; 2].

Formulation of the problem. Analysis of the time and the velocity of inventory circulation is included in the scheme of analysis of working capital, but it should be carried out taking into account the results directly analyzing the volume and structure of sales production and trade. Let us consider in more detail the measure to which commodity stocks secure the commodity turnover, i.e. The time of circulation of some fixed commodity mass, in order to build a multifactor index model for analyzing the circulation of the economic assets of the economic entity [3].

The indicator in the corresponding provision of *i*-th period is measured in days of turnover, i.e. the time of circulation of the *j*-th asset by the following relationship:

$$t_i^{(j)} = \overline{З_i^{(j)}} \,/\, W(1)_i^{(j)};\ \ i = \overline{1,n};\ \ j = \overline{1,m}, \qquad (1)$$

where $t_i^{(j)}$ – the spending time average stock, for example, normal sales process of goods in the days or time of circulation of goods; $\overline{З_i^{(j)}}$ – the average size of inventory in value during the reporting period, which is calculated as the average dynamic range of the torque on the observations of the state of inventory; $W(1)_i^{(j)}$ – the cost of one-day turnover of the *j*-th asset on the integrated heading, in the relevant currency units in the *i*-th period.

The index of turnover margin of security, or the measure of the time of circulation of goods, indicates the number of days of uniform sales that the actual size of the commodity stocks recorded and evaluated at the end of the reporting period, i.e., at a particular time or date, will be sufficient for. If you interpret the value of this indicator in terms of the circulation time of the goods, it characterizes the length of stay of the goods assortment of varieties in the form of a corresponding commodity stock. We calculate the value $t_i^{(j)}$ from Tab. 1 on the example of the company «Trading House» for the 3rd quarter of 2015, which will continue to be regarded as a period. Preceding all subsequent analytical calculations, it is necessary to estimate the size of the average commodity stock for the 3rd quarter of the reporting period $\overline{З_1^{(ij)}}$:

$$\overline{З_1^{(ij)}} = \frac{0,5 \cdot 15\,600 + 12\,000 + 9\,600 + 0,5 \cdot 15\,900}{3} = 12\,450 \text{ thousand rub.} \quad (2)$$

Given that the turnover of one day in the 3rd quarter of 2015, i.e., the reporting period was 200 thousand rubles, the actual provision of turnover inventory was found to be in days

$$t_1^{(ij)} = \frac{12\,450}{200} = 62.25 \text{ days.}$$

In this case, we can say with a known certainty that its enterprise standards of inventory are not fulfilled, because the time of its circulation of inventory amounted to only 62.25 days with easily defined regulatory circulation time:

$$t_{n_0}^{(ij)} = \frac{\overline{З_{n_0}^{(ij)}}}{W(1)_1^{(ij)}} = \frac{15\,000}{200} = 75.00 \text{ days.} \quad (3)$$

Table 1

Calculation of deviations from the norm of inventory storage current *j*-th type retailer Limited Liability Company «Trading House» for the III quarter of 2015*

Order №	At the beginning of the month reporting year	Credited (planned) turnover for the quarter, ths. Rub.		The actual inventory of the current storage		Deviation from the norm		The actual turnover per month, ths. Rub.
		total	day turnover $ИП_3/n_{pl}$**	cost of, ths. Rub.	turnover in days	cost of, ths. Rub.	turnover in days	
$i = \overline{1,k}$	i	$W_{pl}^{(ij)}$	$W(1)_{pl}^{(ij)}$	$З_1^{(ij)}$	$v_1^{(ij)} = \frac{\overline{З_1^{(ij)}}}{W(1)_{pl}^{(ij)}}$	$\Delta З_{1/n_0}^{(ij)}$	$\Delta t^{(i)}_{1/no}$	$W(1)_1^{(ij)}$
1	2	3	4	5	6	7	8	9
1	01.07.2015	×	×	15 600	78.00	600.00	3.00	5 850.00
2	01.08.2015	×	×	12 000	60.00	−3 000.00	−15.00	5 200.00
3	01.09.2015	×	×	9 600	48.00	−5 400.00	−27.00	6 900.00
4	The specification for the III quarter	18 000	200.00	15 000	75.00	×	×	17 950.00
5	01.10.2015	18 900	210.00	15 900	–	–	–	–

* *Data source*: the official state reporting data operational and technical and managerial accounting;
** *Note*: $n_{pl} = 90$ days.

Most often, in practice, when calculating this parameter, a one-day turnover of the reporting period, month or quarter, is taken as a denominator, and the actual commodity stocks at the end of the reporting period that will ensure the turnover of the upcoming period as a numerator.

So, for example, the security of commodity turnover in days under these conditions of the sales process for August ($i = 2$) turned out to be equal to

$$t_1^{(2j)} = \frac{З_1^{(2j)}}{W(1)_1^{(2j)}} = \frac{12\,000}{200} = 60.00 \text{ days.} \qquad (4)$$

As seen from expression (4), the calculation of this parameter as the denominator is taken as the one-day turnover of the reporting period (month or quarter), as well as the numerator – the actual inventory at the end of the month in the reporting period, which will directly provide trade next month. Naturally, it is a complication that at the time when the index is calculated, the next analyzed one day turnover $W(1)^{(i)}$ is not yet known. Therefore, the actual turnover of preplanning period $W(1)_1^{(ij)}$ is often taken in commercial practice. Index of turnover of inventory availability, in days, is determined by the individual products, product groups and as a whole.

Unequal turnover of tangible assets for selected groups of food and non-food items is primarily due to: the quality of goods, determining the nature of customer demand – daily, periodic, excessive; the complexity of the product portfolio; conditions for storage of inventory determined by the physicochemical properties of the goods; so a variety of food products require special storage conditions, which can be provided only in large enterprises, for example, or urban refrigeration chambers, vaults with special gas fillings, effective in the conditions of refrigerants and the use of modern innovative technologies [4].

Inventories turnover in days for a complex range of products, such as significant depth and breadth / width range, and durable, are generally much higher than for a simple range of goods and *FMCG* (*Fast Moving Consumer Goods*). Thus, food products of the so-called «Basic basket» of consumption (bread, milk, eggs, cheese, etc.), without which the trading network cannot work (required, tie-in), have a transient turnover, in contrast to the products of the premium segment and the goods with a period of prolonged turnover (alcohol, confectionery and tobacco products and so on.).

The magnitude of the time of commodity circulation, both in the direction of acceleration and in the direction of its deceleration, and accordingly, the size of the commodity stock, is influenced by various factors that can be taken into account and, importantly, used in the inventory management system. Among the basic, fairly objective factors contributing to the reduction of the circulation time and, thus, the increase in the efficiency of trade, are such universal factors as the process of commodity distribution as general economic, industrial, trade and marketing.

The factors of general economic order should include political, social, legal and economic stability of the state, development of market structures, having a healthy competition among producers, suppliers and vendors, and as a consequence of the marked points – an increase in market supply of goods in accordance with the positive dynamics of solvent demand of the population as a whole and the individual consumer groups, in particular [5].

Production factors, such as the manufacture of printing book products, include the degree of conformity of print runs of books in the publication to customer demand. In the book market, this factor ultimately emerges as the changing ratio of the size of consumer demand for a specific product offering literature and adjusted the number of so-called «factories», i.e., publication issues within the general circulation.

Research methods. Analysis of the inventory of the current storage for example, by the trade organization, can be illustrated by the example shown in the Tab. 1 (columns 7–8). After analyzing the current inventory storage for the overall economic entity by comparing individual headings range. Research Methodology, used here by the author, is based on the technique of index analysis with the assistance of the First and Second Index systems, the development of which directly involved the works of authors [6–8].

The range of instruments used in the study includes the construction of simple and multivariate analytical indexes, with the release

of a result on the construction of the five-factor model, a hybrid of retail turnover. Author's model contains the analysis of the time factors, material assets turnover rate, size, inventory and analysis of two structural components with respect to the value of one-day sales and stock SKUs current storage company.

We consider the applied methodology. For each *j*-th commodity group it is determined by the size of the actual stock of the current storage at the beginning of the quarter, and in days of turnover. The value of the turnover indicator in days of turnover is obtained by dividing the total stock by the one-day planned, lending turnover of the new quarter for a particular commodity group:

$$t_1^{(ij)} = \frac{\overline{З}_1^{(ij)}}{W(1)_1^{(ij)}}. \quad (5)$$

For July 2015, i.e. for the number $i = 1$ period of time, the stock circulation will be equal to

$$t_1^{(1j)} = 15\,600 / 200 = 78.0 \text{ days}.$$

Then, the value of $t_1^{(1j)}$ is compared with the value of $t_{n_0}^{(ij)}$, i.e. to the agreed norm or reference turnover.

In the event of significant changes in the actual structure of the turnover compared to a planned recalculation of sums standards for product groups, based on the actual size of turnover:

$$\Delta t_{1/n_0}^{(ij)} = t_1^{(ij)} - t_{n_0}^{(ij)}; \quad (6)$$

Let us say, for the points in time – July 2015 ($i = 1$)

$$\Delta t_{1/n_0}^{(1j)} = 78.0 - 75.0 = +3.0 \text{ days}. \quad (7)$$

Thus, the excess of inventory for the month turned out to be three days, and on the cost of the commodity mass excess was the same:

$$\Delta \overline{З_{1/n_0}^{(1j)}} = \Delta t_{1/n_0}^{(1j)} \cdot W(1)_1^{(ij)} = \\ = 3.0 \cdot 200.0 = 600.0 \text{ thousand rub}. \quad (8)$$

These estimates characterizing the excess of the normal level of monthly stocks can already serve in this form as valuable indicators of the inventory, even with very superficially conducted rapid analysis.

Analysis of the Speed circulation of inventory (*v*-model). Analysis of the current inventory storage, one of whose tasks is to identify deviations of the actual stock on a specific date from the commodity standard of this period cannot be complete without examining the rate of turnover of tangible assets, which has independent significance.

Recall that the indicator already considered above for the asset or the time-reversal of inventory – is the term or period of time during which the average inventory is marketed. The faster the commercialized products are sold, the less working capital in the form of tangible assets is required for uninterrupted circulation process in trading systems, and the lower, hence, the distribution costs developing in trade and value chains.

Acceleration asset turnover, in turn, leads to a reduction the duration of the process of handling the material benefits in the form of a complete production and supply cycle, and, accordingly, to increase profitability, strengthen the financial condition of the company, etc. The indicator of inventory turnover security is closely related to the indicator of the *speed of circulation of commodities*, or the turnover of tangible assets having independent analytical value.

The rate of circulation of commodities, or *inventory turnover*, or even *the turnover speed* characterizes the number of revolutions of the mass of commodities, taken in the amount of the average commodity stock, which is calculated every time specifically for the analyzed period. The practical content of this characteristic can be interpreted as follows with the possible comment: how many times renewed commodity stock during the analyzed period, or sales occur during the reporting period in the amount of the average commodity stock.

The rate of turnover in the reporting period $v_1^{(ij)}$ is defined as a relative value by dividing the volume of trade on the average size of inventory for a particular *i*-th period and, preferably, on the integrated *j*-th commodity items with the following well-known relation:

$$v_1^{(ij)} = W_1^{(ij)} / \overline{З_1^{(ij)}}, \quad (9)$$

where $W_1^{(ij)}$ – the value of the actual turnover for the period (quarter); $\overline{З_1^{(ij)}}$ – the average inventory for the same period (quarter).

We perform speed calculation according to the same Tab. 1 for the period with the final counting of the column 9, in which the actual trade is shown in the amount of 17 950.0 thousand rubles. The velocity of the turnover for the quarter was, according to expression (9):

$$v_1^{(ij)} = 17\,950.0/12\,450.0 = 1.44 \text{ turnover.} \quad (10)$$

Thus, the mass of commodities is equal to the average commodity stocks, addressed during the period of about one and a half times. Knowing the speed of commodity circulation $v_1^{(ij)}$, can be determined during the already known circulation $t_1^{(ij)}$. For this purpose let us out a series of necessary identity transformations taking into account the meaning of the expression of formula (6):

$$v_1^{(ij)} = \frac{W_1^{(ij)}}{\overline{З_1^{(ij)}}} = \frac{W(1)_1^{(ij)} \cdot n_1}{\overline{З_1^{(ij)}}} = \frac{n_1}{t_1^{(ij)}}, \quad (11)$$

where n_1 – the number of days of operation of the enterprise in this quarter.

Location is determined by the time the average stock turnover rate through its characteristic

$$t_1^{(ij)} = n_1 / v_1^{(ij)} = 90.00 / 1.44 = 62.25 \text{ days.} \quad (12)$$

Consequently, the weight of tangible assets, equal to the average value of inventory addressed in the quarter of about 62.25 days – i.e. slightly more than the length of two full consecutive months.

In analyzing the dynamics of the rate of circulation of commodities and commodity-supply circulation time the index method is traditionally used which is a simple, clear, reliable and generally efficient comparison tool in conducting analytical calculations in the following areas: analysis of growth in turnover through faster turnover of goods; calculation of volume released (mobilized) or overly involved (immobilized) current assets as a result of the rate of change and the time of turnover of goods [9].

In order to illustrate these aspects of the example analysis of said range of footwear companies, which is listed in Tab. 2, should be to build the index dynamics of the average rate of turnover for the three k-th commodity items ($k = \overline{1,s}$) that are reflected in the table for the reporting and the base period. This measure of the average speed will be the index of variable composition – characteristic of a productive attribute, the so-called First index system (1st IS):

$$\mathfrak{I}_{\bar{v}(\bar{З},v)_{1/0}} = {}_{\bar{З}_1}\overline{v_1^{(k)}} : {}_{\bar{З}_0}\overline{v_0^{(k)}} = \frac{\sum_{k=1}^{s} v_1^{(k)} \overline{З}_1^{(k)}}{\sum_{k=1}^{s} \overline{З}_1^{(k)}} : \frac{\sum_{k=1}^{s} v_0^{(k)} \overline{З}_0^{(k)}}{\sum_{k=1}^{s} \overline{З}_0^{(k)}}, \quad (13)$$

$$\begin{array}{|c|}\hline v^{(k)}{}_0 => v^{(k)}{}_1 \\ \hline З^{(k)}{}_0 => З^{(k)}{}_1 \\ \hline \end{array}$$

where ${}_{\bar{З}_1}\overline{v_1^{(k)}}$ – the average speed of the mass of commodities turnover in the reporting period specified in the Tab. 2 commodity groups of the shoe range, which can be estimated from the ratio of the final counting (FC) of columns 4 and 6 as FC_4/FC_6:

$${}_{\bar{З}_1}\overline{v_1^{(k)}} = \frac{\sum_{k=1}^{s} v_1^{(k)} \overline{З}_1^{(k)}}{\sum_{k=1}^{s} \overline{З}_1^{(k)}} = \frac{72\,570.0}{26\,620.0} = 2.726; \quad (14)$$

value ${}_{\bar{З}_1}\overline{v_0^{(k)}}$ – the average rate of the mass of commodities turnover in the corresponding reference period on the specified table in the same commodity groups of the shoe range, which can be estimated from the FC_3/FC_5 calculation:

$${}_{\bar{З}_0}\overline{v_0^{(k)}} = \frac{\sum_{k=1}^{s} v_0^{(k)} \overline{З}_0^{(k)}}{\sum_{k=1}^{s} \overline{З}_0^{(k)}} = \frac{57\,690.0}{25\,260.0} = 2.284. \quad (15)$$

Finally, the very dynamics of the index of the average turnover rate, according to expression (13), was found to be

$$\mathfrak{I}_{\bar{v}(З,v)_{1/0}} = {}_{З_1}\overline{v_1^{(k)}} : {}_{З_0}\overline{v_0^{(k)}} = 2,726 : 2,284 = 1,1935 \sim 119.35\,\%. \quad (16)$$

$$\begin{array}{|c|}\hline v(j)_0 => v(j)_1 \\ \hline З(j)_0 => З(j)_1 \\ \hline \end{array}$$

Thus, the relative *growth rate of turnover* in the reporting period compared with baseline was 19.35 %. This increase occurred both through the growth of the actual speed rate (circulation of commodities) on all commodity positions range (see: Individual indices rate of commodity circulation in column 13 of Tab. 2), and due to changes in inventory structure for the same commodity items, that is, on the analyzed groups of shoes – leather, combined and sports (respectively, columns 9 and 10 of Tab. 2).

Table 2

The analysis of turnaround time of (*t*-model) and of turnover speed (*v*-model) material current assets in trade for the shoe department of Limited Liability Company «Trading House» for the III quarter of 2014–2015

Order №	Name of product group footwear	Quarterly volume of turnover by period, ths. Rub.		Individual quarterly turnover index	Average inventory on current storage periods, ths. Rub.		Individual index of inventories	Structure of average inventory for the period, %		The speed of turnover by period, time	
		basic	reported		basic	reported		basic	reported	basic	reported
$k = \overline{1,s}$	k	$W^{(k)}{}_0$	$W^{(k)}{}_1$	$i^{(k)}_{W_{1/0}} = \frac{W^{(k)}_1}{W^{(k)}_0}$	$З^{(k)}{}_0$	$З^{(k)}{}_1$	$i^{(k)}_{З_{1/0}} = \frac{З^{(k)}_1}{З^{(k)}_0}$	$d^{(k)}_{З_0} = \frac{З^{(k)}_0}{\sum_{k=1}^{s} З^{(k)}_0}$	$d^{(k)}_{З_1} = \frac{З^{(k)}_1}{\sum_{k=1}^{s} З^{(k)}_1}$	$v^{(k)}{}_0$	$v^{(k)}{}_1$
1	2	3	4	5	6	7	8	9	10	11	12
1	Leather	24 260.00	29 820.00	1.2214	6990.00	6130.00	0.8770	27.67	23.03	3.47	4.86
2	Combined	21 350.00	30 640.00	1.4346	10 100.00	12 340.00	1.2218	39.99	46.36	2.11	2.48
3	Sports	12 080.00	12 110.00	1.0150	8 170.00	8 150.00	0.9976	32.34	30.61	1.48	1.49
–	In total:	57 690.00	72 570.00	1.2579	25 260.00	26 620.00	1.0538	100.00	100.00	2.284	2.726

Continuation of Tab. 2

Individual index of commodity circulation speed	The volume of trade turnover for the one-day period, ths Rub.		Individual commodity mass index of a one-day turnover	The structure of the one-day turnover by period, %		Treatment in time periods, days		Individual index time reversal commodity weight
	basic	reported		basic	reported	basic	reported	
$i^{(k)}_{v_{1/0}} = \frac{v^{(k)}_1}{v^{(k)}_0}$	$W(1)^{(k)}_0$	$W(1)^{(k)}_1$	$i^{(k)}_{W(1)_{1/0}} = \frac{W(1)^{(k)}_1}{W(1)^{(k)}_0}$	$d^{(k)}_{W(1)_0} = \frac{W(1)^{(k)}_0}{\sum_{k=1}^{s} W(1)^{(k)}_0}$	$d^{(k)}_{W(1)_1} = \frac{W(1)^{(k)}_1}{\sum_{k=1}^{s} W(1)^{(k)}_1}$	$t^{(k)}_0$	$t^{(k)}_1$	$i^{(k)}_{t_{1/0}} = \frac{t^{(k)}_1}{t^{(k)}_0}$
13	14	15	16	17	18	19	20	21
1.4006	271.00	331.00	1.2214	42.28	41.07	25.79	18.52	0.7181
1.1754	237.00	340.00	1.4346	36.97	42.18	42.62	36.29	0.8515
1.0068	133.00	135.00	1.0150	20.75	16.75	61.43	60.37	0.9827
1.1935	641.00	806.00	1.2574	100.00	100.00	39.407	33.027	0.8381

In other words, the very average increment rate in the dynamics of expression (16) has taken place due to the simultaneous and combined effects of these two characteristic factors that should be resolved by the analyst into the individual components. Consequently, this increment should be decomposed into the factors noted specifically that will take into account their impact on the isolated change in the average characteristics of the velocity under the 1st *IS*.

The index scheme of factor analysis in this case can be constructed by decomposing an index of variable composition, which in a concrete situation is already essentially constructed and counted in the formulas from expressions (13–16). But for the purposes of further analysis, this simple index of the variable structure is represented in its *modified form* as a record through the structural component – the stock share in columns 9 and 10 of Tab. 2.

$$\Im_{\substack{\bar{v}(\bar{d_З},v)_{1/0} \\ \boxed{\substack{d_{\bar{З}_0} \Rightarrow d_{\bar{З}_1} \\ v_0 \Rightarrow v_1}}}} = \frac{\sum_{k=1}^{s} d^{(k)}_{\bar{З}_1} v^{(k)}_1}{\sum_{k=1}^{s} d^{(k)}_{\bar{З}_0} v^{(k)}_0}. \qquad (17)$$

In the aggregate index (17), all the values of the factors taken into account ($d_З$ и v) change their value during the transition from reporting period to the base period. For this reason, we

should bear in mind that the index is called the index of variable composition of the resultant characteristic. In order not to clutter the calculation formulas, the overline over the analyzed characteristic factor $\overline{З_0^{(k)}}, \overline{З_1^{(k)}}$ serving as the characteristic of statistical averaging of the inventory over the corresponding headings will have to be omitted in the expressions below.

To assess the effect of turnover rate of individual commodity positions on the change in the average circulation velocity for the entire range of goods, it is necessary to build, within the framework of the 1st IS, analytical indices of permanent composition. Actually, this analytical index is built according to the rules for constructing a factor analytic index with weights of the corresponding period, taking into account the statistical nature of the indexed attribute [10]. In the specific case, the index of constant structure is constructed by the weights of the reporting quarter of 2015 with respect to a secondary sign, the circulation velocity of a commodity mass (v)

$$\mathfrak{I}_{\bar{v}(v)1/0} = \overline{{}_{d_{З_1}} v_1^{(k)}} : \overline{{}_{d_{З_1}} v_0^{(k)}} = \frac{\sum_{k=1}^{s} v_1^{(k)} d_{З_1}^{(k)}}{\sum_{k=1}^{s} v_0^{(k)} d_{З_1}^{(k)}} = \left| \begin{array}{|c|}\hline d_{З_1} = \text{const} \\ \hline v_0 \Rightarrow v_1 \\ \hline \end{array} \right| = \frac{2.726}{2.230} = 1.2224 \sim 122.24\,\%. \quad (18)$$

Thus, according to the results of calculations in expression (18), by increasing the velocity of the actual commodity weight for individual commodity groups, the average speed of the mass of commodities turnover increased in the reporting period compared to the base period by 22.24 %.

Next, you should find out how to affect change in the structure of inventory at an average speed of circulation of commodities. To this end, it is recommended to build the index of structural shifts or structure index

$$\mathfrak{I}_{\bar{v}(d_З)1/0} = \overline{{}_{d_{З_1}} v_0^{(k)}} : \overline{{}_{d_{З_0}} v_0^{(k)}} = \frac{\sum_{k=1}^{s} v_0^{(k)} d_{З_1}^{(k)}}{\sum_{k=1}^{s} v_0^{(k)} d_{З_0}^{(k)}} = \left| \begin{array}{|c|}\hline d_{З_0} \Rightarrow d_{З_1} \\ \hline v_0 = \text{const} \\ \hline \end{array} \right| = \frac{2.230}{2.284} = 0.9764 \sim 97.64\,\%. \quad (19)$$

Calculations show that the decrease in the average turnover rate of 2.36 %, reflecting the structure of index changes in expression (19), is due to a reduction in the proportion of the fastest on the winding assets against the share of growth relatively «slow» the winding assets (compare the decrease in the share of leather footwear and the increase in the proportion of shoes combined in rows 1, 2 in column 9). This brings to mind the quote from Carroll, quoted in an epigraph to the article, where there categories *Comparability*, *Relativity* are treated terminologically as extremely informative and very modern.

Of course, all built in (13-19) indexes, both simple and analytical, are algebraically linked together in the so-called First index system as follows

$$\mathfrak{I}_{\bar{v}(d_{\bar{З}},v)1/0} = \mathfrak{I}_{\bar{v}(d_З)1/0} \mathfrak{I}_{\bar{v}(v)1/0} = 1.2224 \cdot 0.9764 = 1.1935 \sim 119.35\,\%. \quad (20)$$

Verification of calculations, of course, gives a numerical link for the built analytical indexes in said system in a relative way.

Built system indices can also be determined in accordance with the above trend analysis of the absolute amount of growth in turnover due to the acceleration of the turnover of individual products. This value is defined as the difference form of the index of constant composition formula of expression (18), presented in the aggregate form familiar for analytical indexes. Hence, the difference form of this index can be presented and calculated as

$$\Delta \sum_{k=1}^{s} W(v^{(k)})_{1/0} = \sum_{k=1}^{s} v_1^{(k)} d_{З_1}^{(k)} - \sum_{k=1}^{s} v_0^{(k)} d_{З_1}^{(k)} = 72\,570.00 - 59\,370.00 = 13\,200.00 \text{ ths. Rub.} \quad (21)$$

The resulting cost estimate of the increase of 13.2 million rubles can be attributed to the the increase in turnover in the footwear group of goods achieved by the retailer in the reporting quarter as compared to the basic one due to the increase in the speed of turnover of tangible assets in the form of commodity stocks. In addition to the 1st *IS*, for the purpose of this analysis, the Second Index System (2nd *IS*), constructed on the direct characteristics of the statistical coupling, and also represented by three indices [11] can be used.

The index of permanent composition from expression (18) $\mathfrak{I}_{\bar{v}(v)1/0}$ can also be found by

simple calculation in the framework of a direct characteristic of the statistical relationship by the following expression

$$\mathfrak{I}_{\bar{v}(v)_{1/0}} = \mathfrak{I}_{W(v,3)_{1/0}} : \mathfrak{I}_{W(3)_{1/0}}, \qquad (22)$$

but as an analytical index of another index system, the 2nd *IS*.

The presented scheme of construction of the 1st and 2nd *IS*, followed by analytical calculations and comments reveal certain possibilities of deepening the detailed economic analysis of the characteristics of the retail turnover of the company investigated. Opening possibilities allow further discussion during case study material to build a more complex multivariate index structure in the form of analytical models involving, in addition to the characteristics of the turnover rate of current tangible assets (v), the characteristic time of their circulation (t).

The above is structurally loose material requires its logical conclusion in the form of a holistic copyright construct, based on the methodology adopted by the multivariate index analysis, which must be backed up by illustrative calculations on the raw data from Tab. 1 and 2, which will be demonstrated in the continuation of the article.

For the construction of the aforesaid models index methods of analyzing the dynamics of inventory homogeneous range were used with the assistance of the First (1st *IS*) and the Second index system (2nd *IS*). And if the first *IS* allows factor analysis with elements of degradation of resultant variable with respect to changes in the structure and composition of the assets, the second *IS* directs the analyst on the study of direct communication characteristics of statistical factors and their components.

In support of the above, let us once again get back to the first index system (1st *IS*), more precisely, to its resultant variable $W^{(k)}$, and apply the known analytical technique *replacing the secondary diagonal elements*. That is, known transformations are made over expression (13), which naturally do not change the essence of this equality itself

$$\mathfrak{I}_{\bar{v}(v,3)_{1/0}} = \frac{\sum_{k=1}^{s} v_1^{(k)} 3_1^{(k)}}{\sum_{k=1}^{s} 3_1^{(k)}} \cdot \frac{\sum_{k=1}^{s} v_0^{(k)} 3_0^{(k)}}{\sum_{k=1}^{s} 3_0^{(k)}} = \frac{\sum_{k=1}^{s} v_1^{(k)} 3_1^{(k)}}{\sum_{k=1}^{s} v_0^{(k)} 3_0^{(k)}} : \frac{\sum_{k=1}^{s} 3_1^{(k)}}{\sum_{k=1}^{s} 3_0^{(k)}} = \mathfrak{I}_{W(v,3)_{1/0}} : \mathfrak{I}_{3_{1/0}}. \qquad (23)$$

$v_0 \Rightarrow v_1$; $3_0 \Rightarrow 3_1$

The index of variable composition from the First index system was reduced, as shown in expression (23), to the ratio of two simple *dynamics indexes* of trade turnover and commodity stocks of current storage. But the thus obtained ratio is useful for the purposes of further deepening the factor analysis, and here it is permissible to use the analytical technique that allows due to differences in the two index systems to carry out a kind of factor complements. Such a technique may well be called *a crossing index*, or *the index of mixed analysis*.

Thus, on one hand, according to expression (20), the variable composition index $\mathfrak{I}_{\bar{v}(v^{(k)},3^{(k)})_{1/0}}$ is equal to the product of two factorial indices

$$\mathfrak{I}_{\bar{v}(d_3,v)_{1/0}} = \mathfrak{I}_{\bar{v}(d_3)_{1/0}} \times \mathfrak{I}_{\bar{v}(v)_{1/0}}, \qquad (24)$$

and, on the other hand, the same index $\mathfrak{I}_{\bar{v}(d_3,v)_{1/0}}$, according to equation (23), coincides with the following expression

$$\mathfrak{I}_{\bar{v}(d_3,v)_{1/0}} = \mathfrak{I}_{W(v,3)_{1/0}} : \mathfrak{I}_{3_{1/0}}. \qquad (25)$$

Considering the last two entries (24) and (25) as a system of two equations with the same left-hand sides, let us solve them with respect to $\mathfrak{I}_{W(v,3)_{1/0}}$ as an unknown quantity index, placing the right side of the multiplier in a strictly meaningful sequence with the purpose of the circular linking of these indices in the shown pattern of expression (26).

Thus, in the course of transformation we obtained a 3-factor model of the volume index of turnover, depending on changes in the average inventory, changing its structure and changes in the average speed (rate) of its commodity circulation. This model can be called the *three-factor model* of trade analysis , depending on the state and dynamics of commodity stocks. In terms of content model must be «streamlined» as indicated in the scheme of logical and quantitative link located directly below expression (27).

$$\mathfrak{I}_{W(v,3)_{1/0}} = \mathfrak{I}_{\bar{v}(v)_{1/0}} \times \mathfrak{I}_{\bar{v}(d_3)_{1/0}} \times \mathfrak{I}_{3_{1/0}}, \qquad (26)$$

1.2579 1.2224 0.9764 1.0538

$\mathfrak{I}_{\bar{v}(v^{(k)},3^{(k)})_{1/0}} = 1.1935$

$\mathfrak{I}_{W(v,3)_{1/0}} = 1.2579$

Analysis of the circulation time (t-model) of tangible assets in the form of stock. Similar to the above analysis of the turnover rate, the circulation of inventory can be analyzed by the 1st *IS* scheme suitable for a homogeneous mix. However, here the pair of factors ($t(k)$, $W(1)(k)$) depending on each other determines as the multiplier the average size of the current storage stock ($З(k)$). Needless to say, the calculations of factor influence are similar to the calculations for the analysis of asset turnover rate.

In particular, the modified index of variable composition from the 1st *IS* has the form that is easy to view and convenient for the purpose of factor analysis

$$\mathfrak{I}_{\bar{t}(t_1^{(k)},t_0^{(k)})_{1/0}} = {}_{W(1)_1}\overline{t_1^{(k)}} : {}_{W(1)_0}\overline{t_0^{(k)}}, \qquad (27)$$

where ${}_{W(1)_1}\overline{t_1^{(k)}}$ – the average handling time of inventory of current storage in the reporting period, which is calculated as the weighted arithmetic mean value, and as feature-weight in this calculation is the value of a one-day turnover in the reporting period – $W(1)_1^{(k)}$:

$${}_{W(1)_1}\overline{t_1^{(k)}} = \frac{\sum_{k=1}^{s} t_1^{(k)} W(1)_1^{(k)}}{\sum_{k=1}^{s} W(1)_1^{(k)}} = \frac{26\,620.0}{806.0} = \qquad (28)$$
$$= 33.027 \text{ days};$$

value ${}_{W(1)_0}\overline{t_0^{(k)}}$ – average handling time of inventory of current storage in the base period, and it is estimated in the same prescribed manner, at the same time the one-day turnover of the reference period – $W(1)_0^{(k)}$ acts as the weight characteristic:

$$W(1)_0\overline{t_0^{(k)}} = \frac{\sum_{k=1}^{s} t_0^{(k)} W(1)_0^{(k)}}{\sum_{k=1}^{s} W(1)_0^{(k)}} = \qquad (29)$$
$$= \frac{25\,260.0}{641.0} = 39.407 \text{ days}.$$

Finally, the very dynamics of the index of the average time of circulation of inventory in accordance with expression (27), was found to be

$$\mathfrak{I}_{\bar{t}(t_1^{(k)},t_0^{(k)})_{1/0}} = {}_{W(1)_1}\overline{t_1^{(k)}} : {}_{W(1)_0}\overline{t_0^{(k)}} = \qquad (30)$$
$$= 33.027 : 39.407 = 0.8381 \sim 83.81\%.$$

Thus, due to the simultaneous and joint action of the two factors taken into account the average time of circulation of inventory decreased by 16.19 % in the reporting quarter compared to quarter basis. This means that if in 2014 the average current storage of inventory was enough without interruption in trade for 39.41 days, in 2015 it was only for 33.03 days, i.e., a difference of almost one week.

In other words, the average commodity stock in the last year turned into a realized turnover rate of approximately 6.4 days, or 153.6 hours, respectively, faster. This was the result of reducing the actual time reversal of inventory by individual commodity groups and items and changes in the structure of one-day sales of footwear in groups. Changes were noted in the reporting quarter compared to quarter basis in the respective years (see graphs 21 and 19–20 in Tab. 2).

The first circumstance (change time reversal) is reflected quantitatively in the index of constant composition of the following form specially constructed for this case

$$\mathfrak{I}_{\bar{t}(t)_{1/0}} = {}_{W(1)_1}\overline{t_1^{(k)}} : {}_{W(1)_1}\overline{t_0^{(k)}} = \frac{\sum_{k=1}^{s} t_1^{(k)} W(1)_1^{(k)}}{\sum_{k=1}^{s} W(1)_1^{(k)}} :$$
$$\boxed{\begin{array}{c} t^{(k)}{}_0 \rightarrow t^{(k)}{}_1 \\ W(1)^{(k)}{}_1 = \text{const} \end{array}} \quad : \frac{\sum_{k=1}^{s} t_0^{(k)} W(1)_1^{(k)}}{\sum_{k=1}^{s} W(1)_1^{(j)}} = 33.027 :$$
$$: \frac{25.79 \cdot 331.0 + 42.62 \cdot 340.0 + 61.43 \cdot 135.0}{806,0} = \qquad (31)$$
$$= 33,027 : \frac{31\,320.34}{806.00} = 33.027 : 38.859 =$$
$$= 0.8499 \sim 84.99\%.$$

The second circumstance, namely, structural changes that have taken place, in turn, can be quantified by constructing an index structure of the changes in daily sales

$$\mathfrak{I}_{\bar{t}(W(1))_{1/0}} = {}_{W(1)_1}\overline{t_0^{(k)}} : {}_{W(1)_0}\overline{t_0^{(k)}} = \frac{\sum_{k=1}^{s} t_0^{(k)} W(1)_1^{(k)}}{\sum_{k=1}^{s} W(1)_1^{(j)}} :$$
$$\boxed{\begin{array}{c} t^{(k)}{}_0 = const \\ W(1)^{(k)}{}_0 \rightarrow W(1)^{(k)}{}_1 \end{array}} \quad : \frac{\sum_{k=1}^{s} t_0^{(k)} W(1)_0^{(k)}}{\sum_{k=1}^{s} W(1)_0^{(k)}} = 38.859 : \qquad (32)$$
$$: 39.407 = 0.9861 \sim 98.61\%.$$

The index indicates a decline in the average time of circulation of inventory by improving the day-sales structure: in particular, the proportion of third heading significantly decreased (from 20.65 % to 16.75 % – see graphs 16 and 17 in Tab. 2), in which the most significant circulation time was observed (see graph 19 in the same Tab. 2).

Naturally, all built indexes in (30)÷(33) are linked to each other in the *First index system* through the multiplier analytical indexes

$$\underset{\begin{array}{|c|}\hline t(k)_0 => t(k)_1 \\ \hline W(1)(k)_0 => W(1)(k)_1 \\ \hline \end{array}}{\mathfrak{I}_{\bar{t}(t,W(1))_{1/0}}} = \underset{\begin{array}{|c|}\hline t(k)_0 => t(k)_1 \\ \hline W(1)(k)_1 = \text{const} \\ \hline \end{array}}{\mathfrak{I}_{\bar{t}(t)_{1/0}}} \times \underset{\begin{array}{|c|}\hline t(k)_0 = \text{const} \\ \hline W(1)(k)_0 => W(1)(k)_1 \\ \hline \end{array}}{\mathfrak{I}_{\bar{t}(W(1))_{1/0}}} =$$

$$= 0.8499 \cdot 0.9861 = 0{,}8381 \sim 83{,}81\ \%. \quad (33)$$

Verification in expression (33), of course, also gives a numerical linking in this case for the correctly pre-calculated indexes in a closed factor index system.

The constructed system of indices also allows to determine, in accordance with the direction of analysis of the use of current assets indicated above, the absolute amount of free working capital in the mode, for example, immobilization of assets due to a reduction in their circulation time. This sum is estimated using the difference form of an analytic constant index from expression (32)

$$\Delta\overline{3(t)}_{1/0} = \sum_{k=1}^{s}\overline{3(t_1^{(k)})}_1 - \sum_{k=1}^{s}\overline{3(t_0^{(k)})}_1 =$$

$$= \sum_{k=1}^{s} t_1^{(k)} W(1)_1^{(k)} - \sum_{k=1}^{s} t_0^{(k)} W(1)_1^{(k)} = \quad (34)$$

$$= 26\,620.00 - 31\,320.34 = -4700.34 \text{ ths Rub.}$$

In terms of its economic content, the amount to be reduced in expression (34) is the value of the average inventories used in the reporting period, the conversion of which into the daily retail turnover occurred with the time actually spent per one turnover of the stock in the corresponding quarter of the reporting year. The subtrahend is the same conditional amount of working capital indicating how much current assets would be needed in 2015 if the time of circulation would be as large as originally, i.e., a year ago, as shown in expression (34).

The resulting «savings» (which has a negative sign) in the amount of more than 4.7 million rubles indicate the conditional value of immobilized assets. In other words, the volume of the free working capital was estimated as a result of a reduction in the time of the circulation of assets in the channels of commodity circulation of the considered trading network.

Completing this section of the analysis of current assets, we can obtain another interesting derivative dependence of the analyzed indicators. To do this, it is necessary to repeat all the necessary algebraic transformations with the expressions used, which constitute the 1st *IS*. Namely: with the index of the variable composition of the average time of circulation of the commodity stock, depending on changes in the actual turnover time and the volume of one-day turnover.

It is appropriate to use the analytical technique that is already familiar, «replacement of the elements of the secondary diagonal» as the aggregate value of the ratio of two weighted average values of circulation time counted for dissimilar periods

$$\underset{\begin{array}{|c|}\hline t(k)_0 => t(k)_1 \\ \hline W(1)(k)_0 => W(1)(k)_1 \\ \hline \end{array}}{\mathfrak{I}_{\bar{t}(t,W(1))_{1/0}}} = \frac{\sum_{k=1}^{s} t_1^{(k)} W(1)_1^{(k)}}{\sum_{k=1}^{s} W(1)_1^{(k)}} : \frac{\sum_{k=1}^{s} t_0^{(k)} W(1)_0^{(k)}}{\sum_{k=1}^{s} W(1)_0^{(k)}} =$$

$$= \frac{\sum_{k=1}^{s} t_1^{(k)} W(1)_1^{(k)}}{\sum_{k=1}^{s} t_0^{(k)} W(1)_0^{(k)}} : \frac{\sum_{k=1}^{s} W(1)_1^{(k)}}{\sum_{k=1}^{s} W(1)_0^{(k)}} = \quad (35)$$

$$= \mathfrak{I}_{\bar{3}(t,W(1))_{1/0}} : \mathfrak{I}_{W(1)_{1/0}}.$$

Thus, the index of variable composition analysis of the average time of circulation of inventory of the current storage of the 1st *IS* in expression (27) proved to be reduced to, as shown in expression (35), with respect to the two simple indexes for average inventory of current storage and one-day turnover.

But the resulting ratio is definitely not the ultimate goal of the transformations done and is only an intermediate structure for the purpose of a more detailed study of the state and dynamics of current assets with the involvement of other optional examined similar analysis systems. It is also permissible to involve the already used technique of *index cross connection*, which allows to implement a kind of factorial addition due to differences in the analyzed attributes index systems.

So, on the one hand, according to expression (36), the variable composition index $\mathfrak{I}_{\bar{t}(t,W(1))_{1/0}}$ is equal to the product of two factor indices of circulation time and one-day turnover

$$\mathfrak{I}_{\bar{t}(t,W(1))_{1/0}} = \mathfrak{I}_{\bar{t}(t)_{1/0}} \mathfrak{I}_{\bar{t}(W(1))_{1/0}}. \quad (36)$$

On the other hand, the same index $\mathfrak{I}_{\bar{t}(t,W(1))_{1/0}}$ in accordance with equation (35) coincides with the expression

$$\mathfrak{I}_{\bar{t}(t,W(1))_{1/0}} = \mathfrak{I}_{\bar{3}(t,W(1))_{1/0}} \ : \ \mathfrak{I}_{W(1)_{1/0}}. \qquad (37)$$

Considering the last two entries in expressions (36) and (37) as a system of two equations with the same left-hand sides, we solve the system of equations for the index $\mathfrak{I}_{\bar{t}(t,W(1))_{1/0}}$, taken as an unknown variable. Then place all the existing (pre-built) indices on the right side of the multiplier factor in a strictly meaningful sequence with the goal of linking these indices in the system.

In the cause and effect mechanism of statistical relations that has been updated in this way, the resultant factor, and in this case the primary indicator, is the index of the dynamics of average commodity reserves of the reporting period in comparison with the base period.

$$\mathfrak{I}_{\bar{3}(t,d_{W(1)},W(1))_{1/0}} = \mathfrak{I}_{\bar{t}(t)_{1/0}} \times \mathfrak{I}_{\bar{t}(d_{W(1)})_{1/0}} \times \mathfrak{I}_{W(1)_{1/0}}, \qquad (38)$$

1,0538 0,8499 0,9861 1,2574

$\mathfrak{I}_{\bar{t}(t,W(1))_{1/0}} = 0{,}8381$

$\mathfrak{I}_{\bar{3}(t,d_{W(1)},W(1))_{1/0}} = 1{,}0538$

As a result of the transformations we obtained a three-factor index model of average inventory-dependent changes in the mean time reversal of inventory ($\bar{t}$), a one-day change in the structure of trade turnover ($dW(1)$) and the dynamics of one-day sales ($W(1)$).

This pattern of expression (38) can be called *three-factor t-model* analysis of average inventory, depending on the changes in the average time of circulation of assets, changes in one-day sales structure and dynamics of the one-day turnover. In terms of content and organizational terms the above-mentioned medium model of inventory of current storage must also be «ordered» or «linked» in a way that has already been used above, and as it is shown in the diagram, located directly under the multiplier from expression (38).

This ordering of the mechanism of the cause-and-effect relationships of the analyzed phenomenon allows the expert analyst to perform, in addition to analyzing the influence of the factors considered in relative form, an analysis of the influence of all the considered characteristic factors on the average size of the current stock and in absolute terms, which is extremely important in the operational work of the specialists of the enterprise.

The data from this example in Tab. 2 permit to conduct such analysis of the impact of factors taken into account in absolute terms by the example of the same shoe product groups. For this it is necessary to arrange the characteristic factors in the scheme of expression (38), starting with *a primary feature*, which is one-day trade $W(1)$, and further, in order of the content of their linkage in the index multiplier of the average inventory ($\bar{3}$), as shown in the scheme of expression (39).

We can then move on to the absolute level of characteristic factors, taking into account the indices already calculated and performing the calculations by the difference forms of the indices, using the method of *chain substitutions.*

$$\mathfrak{I}_{\bar{3}(W(1),d_{W(1)},t)_{1/0}} = \mathfrak{I}_{W(1)_{1/0}} \times \mathfrak{I}_{\bar{t}(d_{W(1)})_{1/0}} \times \mathfrak{I}_{\bar{t}(t)_{1/0}}, \qquad (39)$$

1.0538 1.2574 0.9861 0.8499

$\mathfrak{I}_{\bar{3}(W(1),d_{W(1)})_{1/0}} = 1.2399$

$\mathfrak{I}_{\bar{3}(W(1),d_{W(1)},t)_{1/0}} = 1.0538$

It follows from the calculations by the scheme in expression (39) that due to a change in the structure of one-day sales (−1.39 %), the mean inventory increased by 23.99 %. But due to the reduction of the time reversal of this reserve at 15.01 %, the increase in the average stock of goods necessary for the reporting period was limited to only 5.38 % compared to the baseline.

Let us estimate the change in absolute terms due to the influence of each of the three characteristic factors taken into account. The total deviation of inventory due to the cumulative effect of all the factors is:

$$\Delta\sum_{k=1}^{s}\bar{3}(W(1),d_{W(1)},\bar{t})_{1/0} = \sum_{k=1}^{s}\bar{3}(W(1),d_{W(1)},\bar{t})_1 -$$

$$-\sum_{k=1}^{s}\bar{3}(W(1),d_{W(1)},\bar{t})_0 = 26\,620.0 - 25\,260.0 = \qquad (40)$$

$$= 1360.0 \text{ thsRub.}$$

The impact of one-day sales in the amount of inventories was equal to

$$\Delta\sum_{k=1}^{s}\bar{3}(W(1))_{1/0} = \sum_{k=1}^{s}\Delta W(1)^{(k)}_{1/0}\, d^{(k)}_{W(1)0}\,\bar{t}^{(k)}_0 =$$

$$= (806.0 - 641.0)[0.4255 \cdot 25.79 +$$

$$+ 0.3680 \cdot 42.62 + 0.2065 \cdot 61.43] = \qquad (41)$$

$$= 165.0[10.97 + 15.678 + 12.69] =$$

$$= 165.0 \cdot 39{,}34 = 6491.1 \text{ ths Rub.}$$

Influence of the structure of one-day sales in the amount of inventories in absolute terms is estimated as follows:

$$\Delta\sum_{k=1}^{s}\overline{3}(d_{W(1)})_{1/0} = \sum_{k=1}^{s}W(1)_1^{(k)}\Delta d_{W(1)1/0}^{(k)}\overline{t_0^{(k)}} =$$
$$= 806,0\ [(0,4107-0,4255)25,79 +$$
$$+(0,4218-0,3680)42,62+(0,1675- \quad (42)$$
$$-0,2065)61,43] = 806,0[-0,3817 +$$
$$+2,2930-2,3958] =$$
$$= 806,0(-0,4845) = -390,51 \text{ ths Rub.}$$

Effect of changes in commodity-supply circulation time by the amount of stock in absolute terms is estimated as follows:

$$\Delta\sum_{k=1}^{s}\overline{3}(\overline{t})_{1/0} = \sum_{k=1}^{s}W(1)_1^{(k)}d_{W(1)1}^{(k)}\Delta\overline{t^{(k)}}_{1/0} =$$
$$= 806,0[0,4107(18,52-25,79) +$$
$$+0,4218(36,29-42,62)+0,1675\ (60,37-(43)$$
$$-61,43)] = 806,0(-2,9858-2,6700-$$
$$-0,1776) = -4701,72 \text{ ths Rub.}$$

The control counting check of the balance of the factorial influences (increments) for the change in the size of the commodity stock in the reporting period in comparison with the base period gives the amount of the total increment from expression (40) with reservations regarding the possible acceptable rounding errors. All partial factorial increments can, if necessary, for the sake of clarity, be consolidated into a single standard analytical table.

The results of research. In this article the author presents the conceptual hybrid *v*|*t*-model of multivariate analysis (velocity-time), allowing to explore the phenomenon of turnover of tangible assets of the economic entity in more detail.

Using the index schemes from expressions (25) and (38), we can easily obtain the analytical relations that allow both indexes of variable composition and three simple indexes of the dynamics of commodity turnover, dynamics of average commodity stocks and dynamics of one-day sales to be integrated into a single index scheme. A resultative characteristic of the linear dependence (direct characteristic of the statistical connection) of all indices in the form of a multiplier is the index of the dynamics of retail turnover, which depends on the factors that are taken into account in the relative analysis of the characteristic factors according to the rules of the following *five-factor model*

$$\Im_{W_{1/0}} = \Im_{\overline{v}(v)_{1/0}} \times \Im_{\overline{v}(3)_{1/0}} \times \Im_{\overline{t}(t)_{1/0}} \times \Im_{\overline{t}(d_{W(1)})_{1/0}} \times \Im_{W(1)_{1/0}}.$$

1,2579 | 1,2224 | 0,9764 | 0,8499 | 0,9861 | 1,2574

$\Im_{\overline{v}(v,3)_{1/0}} = 1,1935$

$\Im_{W(v,3)_{1/0}} : \Im_{3(W(1))_{1/0}} = 1,0144$

$\Im_{W_{1/0}} : \Im_{W(1)_{1/0}} = 1,0003$

$\Im_{W_{1/0}} = 1,2579$ (44)

While *quantitative linkage* of all indices into a system directly characterizing the link does not cause technical difficulties, the economical connection of each step with a characteristic factor (change in retail turnover) is not always obvious. Here the expert analyst should exercise patience in building a causal chain of interconnected features, in searching for the necessary links of this chain with the real indicators attached to them, and, finally, to carry out a thorough interpretation of the results obtained successively. This is extremely important and is connected, first of all, with the fact that the factors included in the hybrid model are controllable, they can be predicted and planned in the orientation to final financial and economic results.

Bearing in mind the analysis of the absolute influence of the factors taken into account on a productive feature (in this case – the amount of retail goods turnover), the starting index of the chain in the formula of expression (44) should be the primary composite index only for its statistical nature trait-factor on the right side of the multiplier. He is a simple index of the dynamics of one-day sales – $\Im_{W(1)_{1/0}}$.

The next element of the chain linking «begs» to be an index that contains, at least in the numerator or the denominator, the aggregate characteristic of one-day sales volumes throughout the shoe assortment. That index is the index of one-day sales structure – $\Im_{\overline{t}(d_{W(1)})_{1/0}}$. Therefore, by carefully calibrating the meaningful economic aspect of the method of chain substitutions, you can build the required analytical chain indices in a strictly specified sequence recorded below by the scheme from expression (45).

$$\mathfrak{I}_{W(W(1),\bar{t}(d_{w(1)},t(t),\bar{v}(d_{\bar{3}}),\bar{v}(v))1/0} = \mathfrak{I}_{W(1)1/0} \times \mathfrak{I}_{\bar{t}(d_{W(1)})1/0} \times \mathfrak{I}_{\bar{t}(t)1/0} \times \mathfrak{I}_{\bar{v}(d\bar{3})1/0} \times \mathfrak{I}_{\bar{v}(v)1/0}.$$

1,2579 1,2574 0,9861 0,8499 0,9764 1,2224

$\mathfrak{I}_{\bar{3}(d_{W(1)})1/0} = 1.2399$

$\mathfrak{I}_{\bar{3}1/0} = 1.0538$

$\mathfrak{I}_{W(d_{\bar{3}})1/0} = 1.0289$

$\mathfrak{I}_{W(W(1),\bar{t}(d_{w(1)},t(t),\bar{v}(d_{\bar{3}}),\bar{v}(v))1/0} = 1.2579$ (45)

As a control test is necessary to carry out an algebraic coherent meaningful linkage of each of the index built into the hybrid *v|t*-model (velocity-time) of turnover of tangible assets represented by the formula of expression (45) one by one, moving phases of this scheme in the direction *of the left − right*:

We carry out a second factor linking the analytical index of expression (45) in the scheme of the index multiplier model. The second account is the index of the influence of the structure on the daily sales average time of circulation of the current inventory storage − $\mathfrak{I}_{\bar{t}(d_{W(1)})1/0}$. The product of the first pair of indices gives the following interesting and understandable analytical dependence

$$\mathfrak{I}_{W(1)1/0} \times \mathfrak{I}_{\bar{t}(d_{W(1)})1/0} = \begin{matrix} \boxed{W(1)_0 \Rightarrow W(1)_1} & \boxed{\begin{matrix} d_{W(1)_0} \Rightarrow d_{W(1)_1} \\ t_0 = \text{const} \end{matrix}} \end{matrix}$$

$$= \frac{\sum_{k=1}^{s} W(1)_1^{(k)}}{\sum_{k=1}^{s} W(1)_0^{(k)}} \times \left[\frac{\sum_{k=1}^{s} t_0^{(k)} W(1)_1^{(k)}}{\sum_{k=1}^{s} W(1)_1^{(k)}} : \frac{\sum_{k=1}^{s} t_0^{(k)} W(1)_0^{(k)}}{\sum_{k=1}^{s} W(1)_0^{(k)}} \right] = \quad (46)$$

$$= \frac{\sum_{k=1}^{s} t_0^{(k)} W(1)_1^{(k)}}{\sum_{k=1}^{s} t_0^{(k)} W(1)_0^{(k)}} = \mathfrak{I}_{\bar{3}(d_{W(1)})1/0}. \qquad \boxed{\begin{matrix} d_{W(1)_0} \Rightarrow d_{W(1)_1} \\ t_0 = \text{const} \end{matrix}}$$

As a result of the transformations in expression (46), we obtained an analytical index of commodity stock, depending on changes in the structure of one-day sales $\mathfrak{I}_{\bar{3}(d_{W(1)})1/0}$. The next (third in a row) factorial analytical index in the formula of expression (45), which is to be linked to the multiplier circuit, is the index of constant composition, the average time of inventory turnover − $\mathfrak{I}_{\bar{t}(t)1/0}$ of course, affecting the size of the average stocks of this storage. We show below the necessary transformations

$$\mathfrak{I}_{\bar{3}(d_{W(1)})1/0} \mathfrak{I}_{\bar{t}(t)1/0} = \frac{\sum_{k=1}^{s} t_0^{(k)} W(1)_1^{(k)}}{\sum_{k=1}^{s} t_0^{(k)} W(1)_0^{(k)}} \times \frac{\sum_{k=1}^{s} t_1^{(k)} W(1)_1^{(k)}}{\sum_{k=1}^{s} t_0^{(k)} W(1)_1^{(k)}} =$$

$$= \frac{\sum_{k=1}^{s} t_1^{(k)} W(1)_1^{(k)}}{\sum_{k=1}^{s} t_0^{(k)} W(1)_0^{(k)}} = \mathfrak{I}_{\bar{3}(d_{W(1)},t)1/0} = \mathfrak{I}_{\bar{3}1/0}. \quad (47)$$

Next, it is necessary to implement the linkage of the multiplier of the fourth component (the index of the change in the average rate of turnover of tangible assets due to a structural shift in the composition of commodity stocks) into the scheme.Here the result of the previous link of the index $\mathfrak{I}_{\bar{3}1/0}$, i.e. a simple index of expression (47) should be multiplied by an analytical index $\mathfrak{I}_{\bar{v}(d_3)1/0}$. Each time, the procedure of circular linking of indices into the system should be carefully guided by the rules for constructing the index scheme, the economic content of the technical and economic indicators, and by carefully carrying out the necessary transformations in the aggregate parts of the conjugate factorial analytic indices. Let us implement these recommendations with respect to the following scheme:

$$\mathfrak{I}_{\bar{3}1/0} \mathfrak{I}_{v(d_3)1/0} = \frac{\cancel{\sum_{k=1}^{s} t_1^{(k)} W(1)_1^{(k)}}}{\cancel{\sum_{k=1}^{s} t_0^{(k)} W(1)_0^{(k)}}} \times$$

$$\times \left[\frac{\cancel{\sum_{k=1}^{s} v_0^{(k)} 3_1^{(k)}}}{\cancel{\sum_{k=1}^{s} 3_1^{(k)}}} : \frac{\cancel{\sum_{k=1}^{s} v_0^{(k)} 3_0^{(k)}}}{\cancel{\sum_{k=1}^{s} 3_0^{(k)}}} \right] = \frac{\sum_{k=1}^{s} \bar{3}_1^{(k)} v_0^{(k)}}{\sum_{k=1}^{s} \bar{3}_0^{(k)} v_0^{(k)}} = \mathfrak{I}_{W(\bar{3})1/0}. \quad (48)$$

The analytical index of the dynamics of retail turnover obtained in expression (48) depends on the change in the structure of the commodity stock by assortment positions. And, finally, the last, fifth factor influencing the size of the commodity stock, which is also subject to linkage in the index scheme of the multiplier of the relative effect on the volume of retail turnover of shoes is the analytical index of constant composition of inventory velocity – $\Im_{\bar{v}(v)_{1/0}}$. It should «agree» with the previous result in the form of turnover changes index depending on changes in the value of inventory of current storage – $\Im_{W(\bar{3})_{1/0}}$.

$$\Im_{W(\bar{3})_{1/0}}\Im_{\bar{v}(v)_{1/0}} = \frac{\sum_{k=1}^{s} v_0^{(k)} 3_1^{(k)}}{\sum_{k=1}^{s} v_0^{(k)} 3_0^{(k)}} \frac{\sum_{k=1}^{s} v_1^{(k)} 3_1^{(k)}}{\sum_{k=1}^{s} v_0^{(k)} 3_1^{(k)}} = \frac{\sum_{k=1}^{s} v_1^{(k)} 3_1^{(k)}}{\sum_{k=1}^{s} v_0^{(k)} 3_0^{(k)}} = \frac{\sum_{k=1}^{s} W_1^{(k)}}{\sum_{k=1}^{s} W_0^{(k)}} = \Im_{W(\bar{3},v)_{1/0}}. \quad (49)$$

We should draw attention to the fact of the 'seemingly' automatic refinement of the location of primary and secondary factors $(W(1)^{(k)}, d_W^{(k)}, t^{(k)}, d_3^{(k)}, v^{(k)})$ in the corresponding intermediate chain links of the hybrid $v|t$-model up to the resultant variable factor – W from expression (49). However, this apparently natural simplicity is established by the analyst in advance, with the preliminary selection of the factors taken into account and aligning the interrelated indicators into meaningful chains.

Conclusions. As a result of the subject study, a hybrid index model was constructed for analyzing the value of the quarterly commodity turnover, which depends on the quantity of the stock of current storage and on the volume of daily sales. The economic sense of the final result of the transformations from expression (49), which is fairly transparent to the reader, allows managers handling the logistical and marketing business processes of production, trade, wholesale and retail enterprises to establish standards of on-hand inventory.

With this approach, it is also possible to make timely adjustments to these standards, both taking into account the intensity of daily sales, and taking into account the precisely estimated seasonal factor of purchases and sales. Thus, even taken separately but in a row and in a pairs, the analytical indices provide economically understandable and transparent results in the process of linkage, provided that the actual factor scheme in the multiplier of the direct characteristic of the statistical linkage is previously sufficiently verified.

The semantic analysis scheme, represented by separate expressions (47) and (49), can be interestingly interpreted as a constructed group of analytic indices evaluating the «dual structural shift» that occurred, firstly, as part of the commodity stock that ensures the turnover of the reported period, due to the change in the structure of the company's daily sales of shoes. This apparently unfavorable structural shift was the reason for another shift, which already happened in the range of sales for the analyzed period. This second circumstance, as a result, led to a slight increase by only 1.44 % in retail turnover in the reporting period compared to the base one (compared to the previous growth rate of +19.35 % by the formula from expression (44)) in the calculations by the analytical chain.

In fact, the first structural shift in the assessment of significant symptoms caused the second structural shift of another, no less significant feature similar to the movement of geologic plates or reservoirs under tectonic phenomena. The proposed model allows the author to simultaneously and jointly explore and speed, and time of turnover of tangible assets with respect to typical primary reporting indicators and standard indicators of economic activity of the economic entity.

The hybrid model provides a reliable estimate of the factor-based influences on the resultant indicator and, accordingly, the circular balance linkage of the factorial increments not only in a relative form, but also in absolute terms, i.e., by cost, applying the first-difference method as a particular case of the method of chain substitutions with respect to dynamics, the planned task, and the level of the plan. Tab. 3 shows the magnitudes of the absolute effect of each of the five characteristic factors on the volume of quarterly retail turnover, as well as the values of these increments in comparison with both the overall increase (row 6) and in comparison with the base level of the resultant indicator (row 7).

Table 3

Summary description of the analysis of the dynamics of material circulating assets of retailer Limited Liability Company «Trading House»

Order №	Factor name, which has been taken into account	Unit measurement	Contingent designations	Impact in absolute terms, Rub.	Relative deviation, % to	
					the total change	the level of the base period
$k=\overline{1,K}$	x_k	module	$\Delta W(x_k)_{1/0}$	$\Delta W(x_m)_{1/0} = x_{11}x_{21}... \Delta x_{m1/0}...x_{k0}$	$\frac{\Delta\sum_{j=1}^{m} W(x_k^{(j)})_{1/0}}{\Delta\sum_{j=1}^{m} W(x_1,x_2,x_3,x_4,x_5)_{1/0}}$	$\frac{\Delta\sum_{j=1}^{m} W(x_k^{(j)})_{1/0}}{\sum_{j=1}^{m} W_0^{(j)}}$
1	2	3	4	5	6	7
1	The volume of one-day sales	Rub. per day	$\Delta W(W(1))_{1/0}$	15 043 700.13	101.10	26.08
2	The structure daily sales average time of treatment of the current inventory storage	days	$\Delta W(\bar{t}(d_{W(1)}))_{1/0}$	−3 008 815.39	−20.22	−5.22
3	The average stock turnover time	days	$\Delta W(\bar{t}(t))_{1/0}$	−6 073 615.21	−40.82	−10.53
4	Change in the average rate of in-ventory turnover due to a structural shift	speed for the period	$\Delta W(\bar{v}(d_{\bar{3}}))_{1/0}$	−4 374 671.48	−29.39	−7.58
5	The average velocity of circulation of inventory	speed for the period	$\Delta W(\bar{v}(v))_{1/0}$	13 293 401.95	89.33	23.04
–	In total:	Rub.	$\Delta W(x_1,x_2,x_3,x_4,x_5)_{1/0}$	14 880 000.00	100.00	25.79

Summary. Of course, the above scheme of factor analysis based on the hybrid index model is not the only possible one. There are other, equally interesting schemes for conducting the economic analysis of the state and dynamics of current assets with a different set of factors that characterize the level of commodity stocks from different standpoints and from other aspects, not necessarily using the index method, but also methods of correlation and regression analysis, as well as other analytical techniques with a more complex mathematical apparatus, say, using matrix methods of research [12], etc.

The direction of future research. Nevertheless, in view of the considerations presented in the two-part article, it seems very promising to use the hybrid *v|t*-model in integrated systems for the complex analysis of the financial and economic state of an economic entity, along with, say, coefficient analysis and multi-factor forecasting models for predicting bankruptcy. The definite possibilities offered by the author of the model for the purpose of adjusting the state accounting (financial) reporting of the enterprise are of particular interest in cases when reasonable management decisions need to be made for the enterprise, in assessing the market value of businesses, and also in providing the technology for operational and long-term planning [11].

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