FORECASTING OF VOLUMES OF SALES IN MODEL OF MANAGEMENT OF STOCKS

Key words: commodity stocks, storekeeping, forecast of sales, seasonal prevalence, trend, seasonal wave, casual deviations, method of the least squares, seasonal factors, level of performance of the orders, insurance stock.

The paper discusses how to use the statistical data of the Head Company for its branch's annual planning. The relative seasonality index remains constant for each month of the year in the ratio of the trend.

The commodity stocks of the trade enterprises make of the basic weight in cost of their actives and are the basic source of updating of own means as the profit from realization. At the same time, the commodity stocks represent the basic problem of the daily control. In Russia till now optimization of stocks of the trade enterprises, as a rule, was carried out intuitively, trial and error method.

The concepts, underlying in model of management of stocks, mainly, are universal. However ways of the decision of problems of management of stocks on the basis of existing methods are individual for each concrete company and depend on character of sales.

The basis of any model of management of stocks is made system of forecasting of demand, methods and criterion of its estimation.

The forecast of sales is a starting point in planning activity of the company. The formation of the annual, quarter, monthly budgets for profit and receipts of the goods, and consequently, planning of movement of money resources, profits and losses begins with the plan of sales. Budgeting of the rests the end of the period and turnover of commodity stocks directly influence on financial result of activity of the company.

For formation of the plan of sales the department of marketing uses a standard set variable: the share of the market of the company, temps of its growth, capacity of the market, competitive advantages etc. A parameter of seasonal prevalence causes the greatest difficulties.

There are some methods for an estimation of seasonal variations. The basic idea of all these methods is, that in an initial line at first is estimated and is allocated trend, and then smooths out of a probable irregular component, which develops of a seasonal wave and casual deviations.

The history of sales not less than for 7 years is necessary for realization of the correct analysis of a seasonal wave, differently sample of the data will not be representative. It is possible wrongly to characterize the period by a high level of seasonal prevalence at presence of significant emissions in a history of sales, connected with shipment of the single large orders. If in any period the company tested deficiency in production on fault of the supplier, the insignificant sales can underestimate a level of seasonal prevalence in the given period.

For today in the Russian market basically the firms having a history of sales for 3-4 years are submitted. Such volume of the data does not allow allocating correct seasonal waves that limits temporary horizon of forecasting.

The seasonal changes usually are present at the quarter, monthly or week data. Seasonal waves are the changes with more or less stable structure, having annual cyclic and repeating from year to year.

Let's assume, that for planning activity of the enterprise it is possible to use statistical data of other company, engaged realization of a similar product and developing the activity in similar climatic conditions. For planning activity of new division most suitable are data of the head company or for a long time of its working representation.

In offered work on an example of the wholesale-trade company, existing in the Russian market more of 7 years, we shall consider how it is possible to use its statistical data for planning demand on new representation.

The company is engaged in wholesale realization of hire (metal structures of a various

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Table 1

The data of sales of the company for two products (for years), thousand running metres

Month	2001	2002	2003	2004	2005	2006	2007
January	38	81	108	151	194	195	181
February	37	100	165	192	220	233	237
March	65	124	201	232	262	256	229
April	63	205	272	275	277	211	229
May	108	145	293	287	280	301	83
June	87	175	313	326	338	337	
July	105	184	333	339	346	242	
August	156	257	314	364	414	310	
September	118	231	367	392	416	305	
October	105	243	360	399	437	310	
November	145	236	305	330	355	294	
December	102	199	339	367	395	257	

configuration) for building sphere. The head office is in Moscow. From 2004 regional representations for Russia begin to open. For company it is necessary a task to balance a commodity stock in regions, using statistics of sales on places and own 7-year's experience of work.

First of all we shall make the analysis of assortment and we shall divide it into commodity groups by a principle of seasonal prevalence. The character of seasonal waves is defined further for group of the goods on the basis of data of sales not of all groups, but only its several positions. Owing to this the influence on process of the stable factors is excluded and the level of disorder of the data is reduced. As frequently large deviations in a history of sales are connected not to seasonal prevalence, and with non-uniformity of demand, for example, because of the characteristics of the goods (price, colour, non-standard form etc.)

For definition of a seasonal wave for the first commodity group we shall choose the data of sales for two stably sold goods, described uniform demand. The data, submitted by the head company, are given in table 1. Let's note, that in similar tasks the calculation of meanings of various sizes with greater, than accepted in an example, accuracy is deprived of sense, as initial data have disorder, leaving for limits of this accuracy.

In a figure 1 are submitted data of head firm for 2001-2003 years. From the diagram it is visible, that the regularity of change of sales from month to month is traced. The regularity is kept for each year.

Let's assume, that considered temporary *(t)* line $Y = Y(t)$ is represented by the sum

$$Y = T + S + \varepsilon,$$

where $T = T(t)$ - trend; $S = S(t)$ - seasonal component (wave); $e = e(t)$ - casual component.

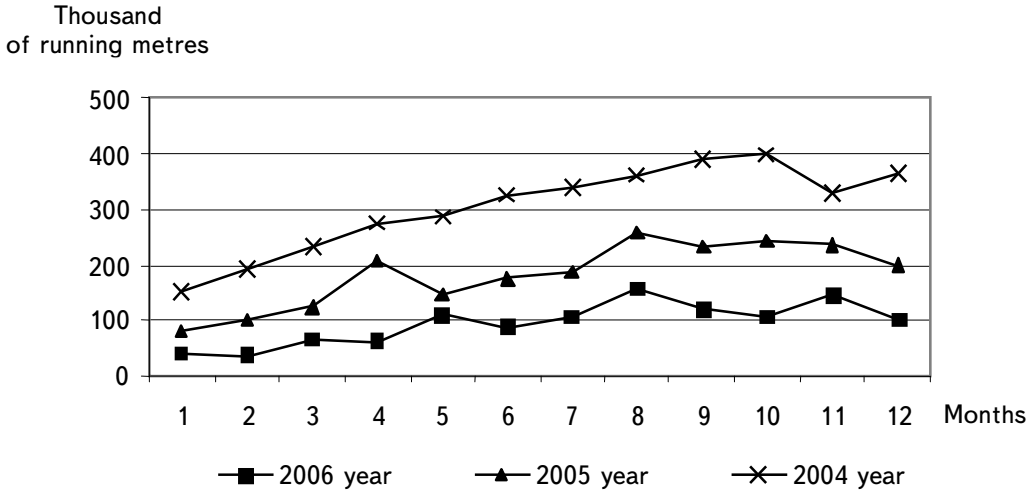


Figure 1. **The data of sales**

Table 2

Meanings of a seasonal wave in the second approximation S^2 (for years), t housand running metres

Month	2002	2003	2004	2005	2006
January	-74	-107	-126	-132	-113
February	-53	-76	-90	-94	-80
March	-32	-46	-54	-57	-49
April	-7	-11	-13	-13	-11
May	-5	-7	-9	-9	-8
June	19	27	32	33	29
July	10	15	17	18	16
August	38	55	65	68	58
September	43	61	73	76	65
October	37	53	63	66	
November	11	15	18	19	
December	19	27	32	33	

Let's equalize a line with allocation of its components. Alignment is provided by one of the widespread iterative methods - method of a filtration of Chetverikov[1]. The results of calculations for the second approximation (top index 2 in variable) are submitted in table 2 and 3. A casual component *e(t)* it turns out so small, that it can neglect.

As function $T^0(t)$, describing trend, we shall choose polynomial of the second degree. Use of this function for approximation of the given data gives greatest coefficient of determination in comparison with other tested functions.

The coefficients of polynomials were defined by a method of the least squares. In result the formula is received

$$T^0(t) = -1{,}143t^2 + 10{,}67t + 123{,}6.$$

Let's present components of a line as the diagrams, shown in a figure 2, for smoothed trend and seasonal wave.

From the diagram it is visible, that the demand is subject to significant seasonal fluctuations, repeating from year to year. Dynamics of demand is characterized by growth of sales since January till October, and then the small decrease is observed during November - December. During December - January the sharp recession of sales, probably, is connected in many respects to New Year's holidays.

Objectively to estimate, as far as the deviations of demand from the smoothed line of trend are natural, we shall pass to relative size

(1)

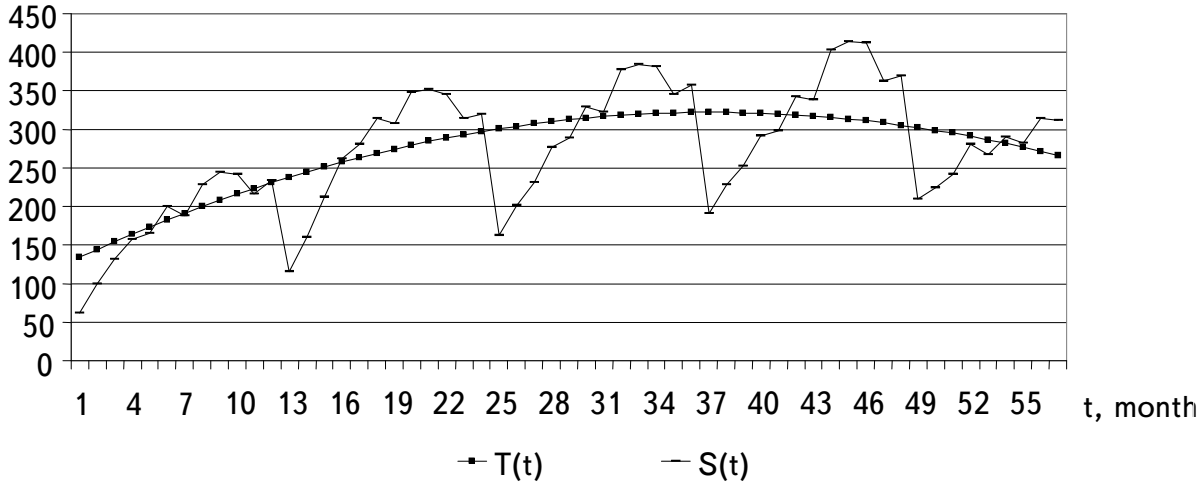
The received meanings y are given in table 4. The data of tables for relative size of a seasonal wave specify to its stability in the greater degree, than data table 2.

From here it is possible to make a conclusion: at research of regularity of casual processes for the analysis the seasonal components is expedient to pass to their sizes, referred to meanings of function trend. The same conclusion follows from the analysis of casual

Table 3

Meanings of level of trend in second approximation T^2 (for years), thousand running metres

Month	2002	2003	2004	2005	2006
January	155	215	278	326	308
February	153	241	282	314	313
March	156	247	286	319	305
April	213	282	287	291	223
May	151	301	296	290	309
June	156	286	294	305	308
July	173	318	322	328	226
August	219	259	299	346	252
September	189	306	319	341	240
October	207	307	336	372	
November	225	290	312	336	
December	181	312	335	362	



Pic. 2. **Meanings of trend and seasonable wave**

component of processes, though in a considered task its are small in comparison with trend.

From a figure 3 it is visible, that the deviations of relative meanings of seasonal components inside one month change insignificantly for years.

After some estimations (appropriate to different years) seasonal coefficients[2] for each month are received, they should be generalized, to define average size y_{cp}. For exception of influence of casual emissions (for example, January, 2002) is used median, but not of average meaning.

$Y(t) = T(t)y_{cp}(t).$

The received values, describing seasonal prevalence, reflect dynamics of demand of the company, engaged wholesale realization of products in Moscow. Let's apply the given coefficients of seasonal prevalence to new division of the company, which is taking place in similar climatic region - in Samara, and engaged the realization of same production. For this purpose we should do the following.

On the basis of the initial data for Samara, we shall allocate trend, having divided an initial line on received coefficient of seasonal prevalence. As function, describing trend, we shall choose polynomial of the second degree, which coefficients we shall define, using a method of the least squares.

In result we shall receive

$$T(t) = -0.54t^2 + 3{,}19t + 7{,}1. \qquad (2)$$

Using (1) and the regularity of change of trend (2), it is possible to construct the forecast of sales *Y (t)* for the subsequent periods for new division:

As an example in table 5 the results of calculations and fact data of volumes of sales for the period since December, 2007 till February, 2008 are given in view of seasonal prevalence.

The data of table 5 specifies that a deviation of the fact data from the forecast do not exceed 5 %. In practice the majority of the trade

Table 4

Relative value *y(t)* (for years)

Month	2002	2003	2004	2005	2006	y_{cp}
January	0,30	0,58	0,62	0,58	0,67	**0,58**
February	0,63	0,67	0,74	0,73	0,70	**0,70**
March	0,84	0,86	0,82	0,79	0,79	**0,82**
April	0,66	0,92	0,97	1,00	1,20	**0,97**
May	1,08	0,92	0,98	1,03	0,86	**0,98**
June	1,24	1,10	1,11	1,12	0,94	**1,11**
July	1,08	0,96	1,00	1,03	1,20	**1,03**
August	1,05	1,32	1,25	1,18	1,23	**1,23**
September	1,27	1,16	1,21	1,23	1,27	**1,23**
October	1,16	1,13	1,14	1,13		**1,14**
November	0,96	1,08	1,11	1,09		**1,09**
December	1,23	1,02	1,07	1,02		**1,05**

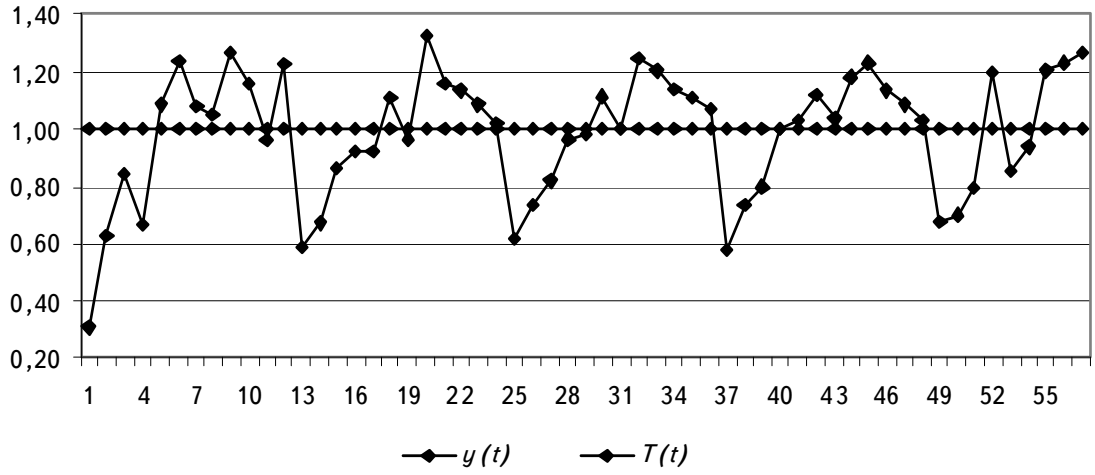


Figure 3. **Relative size *y(t)***

Table 5

Parameters of volumes of sales, for months

company establishes for itself a level of realization of the orders 95 % that will be coordinated to disorder received data of the forecast.

The level of realization of the orders directly is connected to a level of a supported commodity stock. On the basis of importance of deviations of the fact data from the forecast the size of an insurance stock pays off. If the size of a mistake of the forecast does not exceed 5 %, the size of an insurance stock will be optimum and will be supported at a planned level.

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[1] *N.S. Chetverikov.* Statistical researches (Theory and practice). M., 1975. P. 52.

[2] *D.E. Henk, D.U. Uichern, A.J. Rayts.* Business - forecasting. M., 2003. P.207.