METHODOLOGICAL JUSTIFICATION AND ANALYTICAL SUPPORT FOR CASH FLOW FORECASTING

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Abstract

Based on the industry specifics of the agricultural business and on the basis of the results of the structural and coefficient analysis of the organization's cash flows, the article substantiates the need for rational cash management and forecasting their future flows. To carry out competent coordination of calculations and ensure timely cash flow, methodological approaches to forecasting cash flows based on the use of a multiplicative time series model and a study of the influence of seasonal and random components are proposed. Application of the proposed methodology on the example of a specific agricultural organization led to the conclusion that when using an adaptive model with a seasonal component, the calculated values have significant discrepancies with the actual data. The average value of the relative error exceeded 5%. Checking the randomness of the levels of the residual component based on the turning point criterion made it possible to characterize the constructed model as adequate, make a forecast for the coming year, and identify the main tools for improving the efficiency of cash flow management.

Key words: *analysis, forecasting, cash flow, time series model*

INTRODUCTION

Most of the participants in the agricultural business of Russia in their economic activities are faced with the problem of a shortage of funds. One of the reasons for this phenomenon is ineffective cash flow management [11]. For a stable and stable operation of an enterprise, it must have the optimal amount of funds at its disposal. A sufficient volume of money supply ensures the solvency of the enterprise, a high level of liquidity and decent indicators of the efficiency of its work [1, 2, 17]. However, in the agricultural sector of production, the influence of seasonal changes in the levels of expenses and income from the main activity is significant, which inevitably affects the adequacy of funds [3, 5]. «If other factors have a deeper influence on production, either the farmers have to manage much better their business or the level of the acquisition price has to be much higher» [16]. To smooth out the negative impact of the seasonality of agricultural production on the formation of cash flows from current activities, it is necessary to analyze their movement and develop forecasts of their possible fluctuations [8, 12, 14, 17]. This would allow making informed decisions on the use of existing and attracting additional funds, timely identify problematic moments and possible growth points. For competent planning and regulation of future cash flows, a detailed study of their behavior [9, 15] in the past and current periods is necessary using special methods [7, 10, 13].

MATERIALS AND METHODS

In the process of work, the methods used in economic science were used: general scientific (dialectical, analysis and synthesis, comparison and analogy); special (systemic, comparative analysis, economic and mathematical). The information base of the research was the data of official statistics; data of annual financial statements and accounting registers of funds of an agricultural organization of the Penza region; reference materials of specialized publications on the subject under study; materials of our own research; Internet data (scientific articles and works of practitioners, industry portals, economic reviews). In the course of the study, a structural and coefficient analysis of cash flows was carried out, an indicator of a comprehensive assessment of the quality of cash management was calculated [4]. For short-term forecasting of cash flows, an adaptive model with a seasonal Holt-Winters component was used, based on a combination of a trend with a multiplicatively superimposed seasonal component [6]. With the help of the model, forecasts with expired validity are calculated, that is, those relating to periods in which the actual value of the indicator has already been realized, and real forecasts for a period that has not yet come.

RESULTS AND DISCUSSIONS

The analysis of cash flows and their forecasting were carried out according to the accounting data of a real participant in the agricultural business. For this, an agricultural organization of the Penza region was chosen, which has characteristics inherent in most agricultural producers in the region. A significant share of them is engaged in the production of agricultural raw materials, without providing for its primary or industrial processing.

When analyzing cash flows, the tendency of their changes in the directions of receipt and consumption (Table 1) was determined, their structure was analyzed.

Both positive and negative cash flows of the organization are formed due to current (main) activities.

Table 1. Cash flow structure (%)

Cash flow	Positive cash flow (income)				Negative cash flow (consumption)			
	2018	2019	2020	Changes (columns 2 - 4)	2018	2019	2020	Changes (columns 6 - 8)
1	2	3	4	5	6	7	8	9
Current	92.5	94.6	100.0	7.5	85.60	79.95	96.29	10.69
Investment	-	-	-	-	1.11	9.86	-	-1.11
Financial	7.5	5.4	-	-7.5	13.29	10.19	3.71	-9.58
Total	100.00	100.00	100.00	x	100.0	100.00	100.00	x

Source: Compiled by the authors on the basis of accounting data and financial statements of an agricultural organization.

As of 2020 the entire money supply was received solely from current operations. The share of financial transactions in the organization's expenses was less than 4%.

The coefficient analysis of the quality of cash flows from current activities (Table 2) showed a downward trend.

Table 2. Dynamics of indicators of the quality of cash flows from current activities

Indicator name	2018	2019	2020	Changes (col. 2 - 4)	Baseline growth rate ($T_{pc,\%}$)
1	2	3	4	5	6
Solvency ratio for current activities	1.0748	1.1838	1.0392	-0.0356	0.9668
Ratio of positive cash flow to assets	0.9336	0.9808	0.7621	-0.1715	0.8163
The ratio of the ratio of net cash flow to positive cash flow	0.0696	0.1553	0.0377	-0.0319	0.5413
Net cash flow to assets ratio	0.0650	0.1523	0.0287	-0.0363	0.4417
Revenue-to-asset ratio,	0.8436	0.9603	0.7713	-0.0723	0.9143
The ratio of the ratio of net cash flow to negative cash flow	0.0748	0.1838	0.0392	-0.0356	0.5234
Ratio of positive cash flow to revenue	1.107	1.021	0.9880	-0.1190	0.8925
The ratio of the ratio of net profit and net cash flow	0.2612	0.1105	0.4038	0.1426	1.5461

Source: Authors' compilation based on the accounting data and financial statements of an agricultural organization.

The value of the generalizing quality indicator, calculated as the geometric mean of the growth rates of eight separate indicators, is less than 1.0 ($T_{pc} = (\prod T_p(K_k))^{1/8} = 0.7708$

или 77.08 %). The value $T_{pc} > 1$ indicates an increase in the quality of cash flows. $T_{pc} > 1$, confirms the opposite trend. Thus, the indicator of a comprehensive assessment indicates a decrease in the quality of cash flow management for the period 2018 - 2020. by 22.92%. To improve the efficiency of the use of funds, to determine their shortage or surplus for individual periods of the calendar year, the forecast indicators of cash flows were calculated using the Holt-Winters model. To build the model, data on cash balances at the end of each quarter of the study period were used (Table 3).

Table 3. Cash balances at the end of the period

Period	t	Y(t), thousand roubles	Период	t	Y(t), thousand roubles
Q1 2017	1	474	Period	9	11
Q2 2017	2	654	Q1 2019	10	150
Q3 2017	3	323	Q2 2019	11	9
4th quarter 2017	4	612	Q3 2019	12	42
Q1 2018	5	106	4th quarter 2019	13	17
Q2 2018	6	962	Q1 2020	14	148
Q3 2018	7	1,742	Q2 2020	15	326
4th quarter 2018	8	27	Q3 2020	16	98

Source: Compiled by the authors based on the accounting data of an agricultural organization.

To align the time series the following equation was used:

$Y_p(t) = a(0) + b(0)\cdot t$.

To find the values of the parameters a (0) and b (0) required for further calculation, auxiliary Table 4 was compiled.

The values of the parameters a (0) and b (0) were calculated using the formulas:

$$b(0) = \frac{\sum(Y(t)-Y_{cp})(t-t_{cp})}{\sum(t-t_{cp})^2} = 44.31;$$

$$a(0) = Y_{cp} - b(0)*t_{cp} = 413.11.$$

Table 4. Auxiliary data for the calculation

	t	Y(t)	$t-t_{cp}$	$Y-Y_{cp}$	$(t-t_{cp})^2$	$(Y-Y_{cp})\cdot(t-t_{cp})$
	1	474	-3.5	-138.5	12.25	484.8
	2	654	-2.5	41.5	6.25	-103.8
	3	323	-1.5	-289.5	2.25	434.3
	4	612	-0.5	-0.5	0.25	0.3
	5	106	0.5	-506.5	0.25	-253.3
	6	962	1.5	349.5	2.25	524.3
	7	1,742	2.5	1,129.5	6.25	2,823.8
	8	27	3.5	-585.5	12.25	-2,049.3
∑	36	4,900	0	0.0	42	1,861.0
Average	4.5	1,477	0	0	5,25	232,6

Source: own calculations.

The linear model for the presented data is:
$Y_p(t) = 413.11 + 44.31*t$.
The results of calculating the value of $Y_p(t)$ in comparison with the actual data are presented in Table 5.
The data in Table 5 show significant discrepancies.

Table 5. Calculated values

T	**Y(t)**	**$Y_p(t)$**
1	474	457.4
2	654	501.7
3	323	546.0
4	612	590.3
5	106	634.7
6	962	679.0
7	1,742	723.3
8	27	767.6

Source: own calculations.

Therefore, to assess the accuracy of the model, it is necessary to calculate a number of indicators: parameters a(t) and b(t), seasonality coefficient F(t), predicted values Y_p, absolute deviations E(t) and relative error. For the value t=0, the parameters a(t) and b(t) would be equal to those calculated earlier, and for t≥1, the values of the parameters are determined by the formulas:

$$a(t) = \frac{\alpha_1 \cdot Y(t)}{F(t-L)} + (1-\alpha_1)\cdot[a(t-1)+b(t-1)]$$

$$b(t) = \alpha_3 \cdot [a(t) - a(t-1)] + (1-\alpha_3)\cdot b(t-1),$$

where: α_1 = 0.900; α_3 = 0.251.

The values of the seasonality coefficients for negative and zero values of the argument *t* are calculated as the arithmetic mean over several corresponding periods.

The values of the seasonality coefficients for positive values of the argument *t* are determined by the formula:

$$F(t) = \frac{\alpha_2 \cdot Y(t)}{a(t)} + (1-\alpha_2)\cdot F(t-L),$$

where: α_2 = 0.001, a L = 4.

Forecasted Y_p values are calculated by the formula:

$$Y_p(t+k) = [a(t) + k\cdot b(t)]\cdot F(t+k-L)\ ,$$

where: k = 1.

The absolute deviations of the predicted values from the actual ones is determined as the difference between them:

$$E(t) = Y(t) - Y_p(t).$$

The relative error would be calculated using the formula:

$$ABS(E(t))\ /\ Y(t)\%.$$

For this indicator, it is necessary to calculate the total and the average in order to assess the accuracy of the model (Table 6).

Table 6. Estimation of the accuracy of the Holt-Winters model

t	Y(t)	a(t)	b(t)	F(t)	Yp(t)	E(t)	Imprecision, %
-3				0.60			
-2				1.36			
-1				1.50			
0		413.11	44.31	0.54			
1	474	754.81	118.95	0.60	275,20	198,80	41,94
2	654	520.11	30.19	1.36	1,188.47	-534.47	81.72
3	323	248.83	-45.48	1.50	825.46	-502.46	155.56
4	612	1,048.08	166.55	0.54	108.98	503.02	82.19
5	106	280.02	-68.04	0.60	730.80	-624.80	589.43
6	962	657.78	43.86	1.36	288.32	673.68	70.03
7	1,742	1,115.49	147.73	1.50	1,052.32	689.68	39.59
8	27	171.66	-126.25	0.54	677.06	-650.06	2,407.63
9	11	21.00	-132.38	0.60	27.31	-16.31	148.29
10	150	88.11	-82.30	1.36	-151.49	301.49	200.99
11	9	5.98	-82.26	1.50	8.71	0.29	3.18
12	42	62.95	-47.32	0.54	-40.86	82.86	197.27
13	17	27.01	-44.46	0.60	9.40	7.60	44.70
14	148	96.16	-15.94	1.36	-23.75	171.75	116.05
15	326	203.64	15.04	1.50	120.31	205.69	63.09
16	98	186.50	6.96	0.54	117.15	-19.15	19.54
						Total	4,261.23
						Average	266.33

Source: Own results.

Any imprecision is considered acceptable if its value does not exceed 5%. It follows from the above calculations that the accuracy condition is not met. It was not possible to establish a clear trend in the change in funds. This is due to large fluctuations in the indicator. As a result, the relative imprecision is many times exceeds the permissible value, which entails inaccuracy of the forecast.

Based on the obtained result, it is required to evaluate the model for adequacy by fulfilling the condition of randomness, the independence of successive levels (there is no autocorrelation) and the normal distribution of a number of residuals. The randomness of the levels of the residual component is checked on the basis of the turning point criterion. To do this, each level E(t) is compared with two adjacent ones. If it is more or less than both adjacent indicators, the point is considered a turning point, 1 is set, otherwise 0 is set.

Table 7. Intermediate calculations to assess the adequacy of the model

T	E(t)	Turning point	$E(t)^2$	$(E(t)-E(t-1))^2$	E(t)*E(t-1)
1	198.8011	—	39,521.9	—	—
2	-534.4745	1	285,662.9	537,693.1	-106,254.1
3	-502.4596	0	252,465.6	1,025.0	268,551.8
4	503.0205	1	253,029.6	1,010,990.2	-252,747.5
5	-624.7995	1	390,374.5	1,271,978.1	-314,287.0
6	673.6839	0	453,850.1	1,686,059.4	-420,917.4
7	689.6793	1	475,657.6	255.9	464,625.9
8	-650.0605	1	422,578.7	1,794,902.8	-448,333.3
9	-16.3123	0	266.1	401,636.8	10,604.0
10	301.4895	1	90,895.9	100,997.9	-4,918.0
11	0.2864	1	0.1	90,723.3	86.3
12	82.8554	1	6,865.0	6,817.6	23.7
13	7.5994	1	57.8	5,663.5	629.7
14	171.7481	0	29,497.4	26,944.8	1,305.2
15	205.6882	1	42,307.7	1,151.9	35,326.6
16	-19.1493	1	366.7	50,551.9	-3,938.8
Total	487.5963	11	2,743,397.4	6,987,392.1	-770,242.9

Source: Own calculations.

The data in Table 7 confirm the presence of 11 turning points. For further calculation, it is required to determine the value of q by the formula:

$$int\left[2\cdot(N-2)/3-2\sqrt{\frac{16N-29}{90}}\right]$$

This formula means that only the whole part is taken from the obtained value:

$$q = int[2\cdot(16-2)/3\ -2\sqrt{\frac{16\cdot16-29}{90}} = int[6.1570] = 6.$$

The condition of randomness of levels is satisfied if the number of turning points is greater than the value q. Thus, the fulfillment of this condition has been established.

The absence of autocorrelation can be checked using the d-Durbin-Watson test:

$$d = \frac{\sum(E(t)-E(t-1))^2}{\sum E(t)^2} = \frac{44{,}169{,}636.0}{28{,}875{,}148.4} = 2.5470.$$

The forecast values are calculated as follows:

If the obtained value is greater than 2, the value of d requires clarification by subtracting it from 4. Based on the results of calculating the value of d, the revised value was:

$$d = 4 - 2.5470 = 1.4530.$$

The refined value of the d value showed that the levels of a number of residuals are independent, and the constructed model is adequate, therefore, it allows us to make a forecast for the next year or 4 quarters (t =17 to t=20). The predicted values of the indicator can be determined by the formula:

$$Y_p(t+k) = [a(t)+k\cdot b(t)]\cdot F(t+k-L).$$

for $Y_p(17)$ k=1, для $Y_p(18)$ k=2, $Y_p(19)$ k=3, for $Y_p(20)$ k=4.

The forecast values are calculated as follows:

Y_p (17) = [a(16) + 1 · b(16)] · F(13);
Y_p (18) = [a(17) + 2 · b(17)] · F(14);
Y_p (19) = [a(18) + 3 · b(18)] · F(15);
Y_p (20) = [a(19) + 4 · b(19)] · F(16) [2, 7].

The results of calculating the forecast values of cash are presented in Table 8.

To compare the actual and calculated data for previous periods and determine the general trend in the behavior of the predicted indicator in the next four quarters of 2021, the results of the calculations are presented graphically (Figure 1).

The graphical display of the forecast values of cash flows has visible discrepancies with the actual indicators only in the first half of the time series. The subsequent behavior of the calculated and actual data, despite the low level of forecast accuracy, does not show significant fluctuations.

At the same time, the predicted values of the indicator for the coming year characterize the diminishing dynamics of funds with small fluctuations throughout the entire period. The amount of money supply will be sufficient to carry out current activities, but it is necessary to take measures to manage cash flows.

The main tools for improving the efficiency of cash flow management can be:

- an increase in cash flow due to an increase in sales, improving the quality of manufactured products, conducting effective advertising to attract new customers, implementing measures to collect accounts receivable, etc.;

- reducing the outflow of funds by optimizing the costs of production and sales of products, prioritizing when planning purchases, rationing stocks, high-quality legal support when concluding contracts, tax planning.

Table 8. Forecast of cash flows from current activities for 2021

t	Y(t)	Yp(t)
1	474	275.20
2	654	1,188.47
3	323	825.46
4	612	108.98
5	106	730.80
6	962	288.32
7	1,742	1,052.32
8	27	677.06
9	11	27.31
10	150	-151.49
11	9	8.71
12	42	-40.86
13	17	9.40
14	148	-23.75
15	326	120.31
16	98	117.15
17		116.35
18		272.72
19		311.07
20		114.83

Source: Own results.

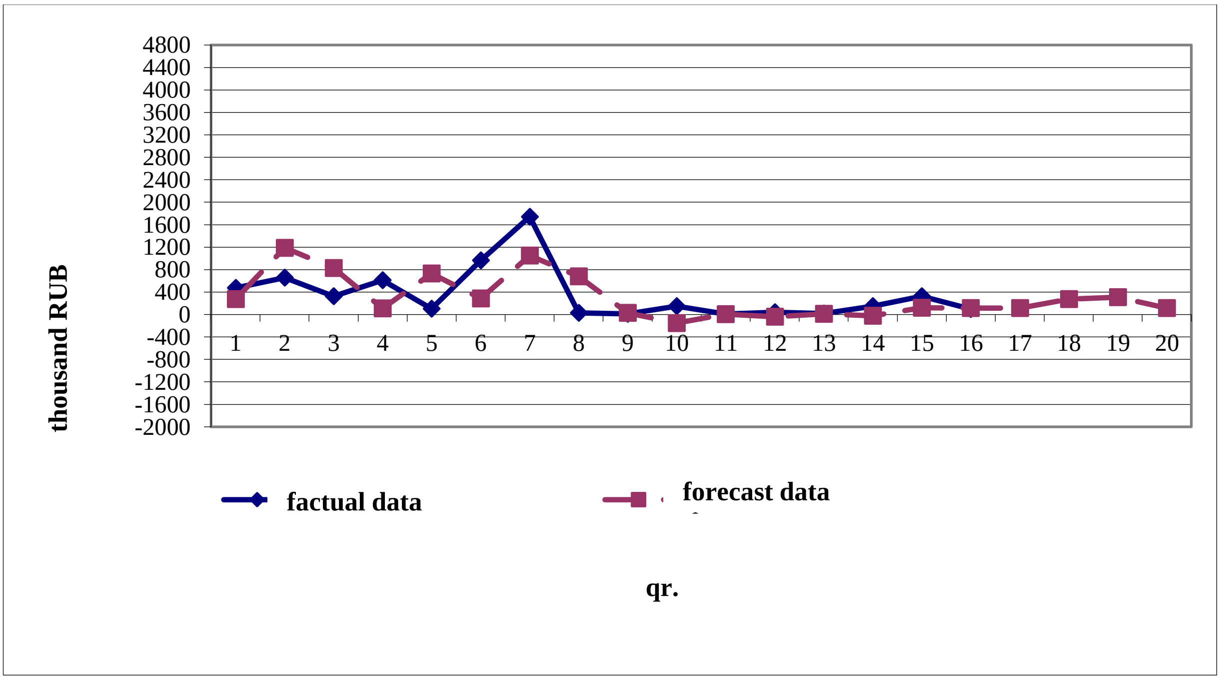

Fig. 1. Dynamics of cash flows according to actual and forecast data
Source: Authors' results and design.

CONCLUSIONS

Effective cash flow management is one of the most important problems of modern agricultural business, the solution of which cannot be based only on the intuition and business qualities of a manager. Such decisions should be preceded by a business case and well-conducted analytical procedures.

The use of the Holt-Winters model to predict the cash flows of an agricultural organization made it possible to study the influence of the seasonal component on their dynamics. As a result of the calculations, a clear dependence of the volume of cash flows on this parameter was not revealed, but checking the randomness of the levels of the residual component based on the turning point criterion confirmed the adequacy of the constructed model and made it possible to form a cash forecast for the coming year. The constructed forecast identified the primary tasks in cash flow management, aimed at their more rational use for the further development of production and increasing competitiveness, as well as the timely adoption of economically sound management decisions for the future.

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