Risk management methodology in Latvian economics

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Abstract
One of the topical problems of the economics sciences and practices is Latvian national economy risk management scientific basis working out. The main tasks of risk management are risk management methodology elaboration, identification of risk factors, analysis, assessment, acceptation of decision, components and principles of monitoring and adaptation to Latvia's conditions. The main components of risks analysis were considered and gross domestic product (GDP) model has been examined for GDP forecasting. GDP forecast a risk has been evaluated using time series model and additive model with Monte-Carlo simulation method. The best GDP forecast model has been offered and comparison with real data has been made.

Introduction

After becoming the member of the World Trade Organization (WTO), Latvia has deliberately taken active part in the globalization processes and the process of market localization. Moreover, Latvia is in the process of intensive integration into the European Union. It means that:

- Latvia is aware, which sectors of national economy will be the most appropriate in the competitive open market;
- Latvia, founding on the guidelines of the World Trade Organization (WTO), has to carry out risk analysis importing animals or agricultural products.

When evaluating the significance of the separate sectors, we can state the risk level of the influence of separate sectors on the increase of gross domestic product (GDP) and make suggestions, how to decrease the risk. The main goals of the research are to:

- find out the significance of influence of Latvia national economy sectors' output and unemployment level on GDP;
- evaluate the potential risk factors and the consequences of their influence on GDP increase.

According to the WTO requirements, Latvia has to carry out the risk analysis. The risk evaluation methods have to be based on international standards, guidelines and suggestions worked out by corresponding international organizations.

Until now there was no scientific research done on risk methodology in Latvia, therefore it is indispensable to work out the principles of risk methodology in three main components: risk assessment, risk management and risk monitoring. The main objectives are to find out economically the most significant potential risk types and factors, to find out and examine the economical threat of negative risk factors, and to assess the economical consequences of risks or their groups. The results of research will help the farmers, businessmen, state institutions and local authorities to make economically based preventive appropriate decisions in order to maximize potential gains and to minimize losses caused by risk.

The interrelation between GDP and the output of sectors

According to the average prices of the year 1995, GDP in Latvia in 1995 was 2349.223 mln LVL (exchange rate per USD 0.630 LVL) and 2957.846 mln LVL in the year 2000. According to the average prices of the year 1995, GDP per capita was 945.86 LVL and 1246.46 LVL, respectively, but the increase rate regarding the previous year was, respectively, in 1996 – 3.3%, in 1997 – 8.6%, in 1998 – 3.9%, in 1999 – 1.1% and in the year 2000 – 6.8%. The comparative analysis of the proportion of sectors output allows drawing a conclusion that the most significant proportion belongs to the manufacturing – 19.7% out of GDP in the year 2000 (see Table 1).

Table 1. Output of the sectors (% out of GDP)

Sector	1995	1996	1997	1998	1999	2000
Manufacturing	19.4%	19.6%	21.1%	21.1%	19.7%	19.7%
Transports and communications	13.8%	15.2%	15.0%	14.1%	13.9%	14.0%
Wholesale and retail trade	9.8%	9.6%	10.0%	11.6%	12.6%	13.0%
Agriculture, hunting, forestry	9.0%	8.2%	7.9%	7.2%	6.6%	6.7%
Construction	4.4%	4.5%	4.4%	5.0%	5.4%	5.4%
Real estate, renting	3.7%	3.8%	3.9%	4.0%	4.7%	5.0%
Financial intermediation	4.9%	4.3%	4.2%	4.0%	4.1%	4.2%
Public administration and defence	4.4%	4.6%	4.5%	4.3%	4.3%	4.1%
Education	4.6%	4.5%	4.2%	4.2%	4.1%	3.9%
Electricity, gas and water supply	4.8%	4.5%	4.1%	4.1%	3.8%	3.4%
Health and social work	3.4%	3.2%	3.0%	2.8%	2.7%	2.6%
Hotels and restaurants	0.9%	1.0%	0.9%	0.9%	1.0%	1.0%
Fishing	0.4%	0.3%	0.2%	0.2%	0.3%	0.3%
Mining and quarrying	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%
Other activities	16.3%	16.6%	16.4%	16.4%	16.6%	16.5%

According to the data, presented in the table 1, 58.8% out of GDP consists of the output of the following sectors: manufacturing, transports and communications, wholesale and retail trade, agriculture and forestry, construction. As we can see, the output of manufacturing and transports remained in the year 2000 on the level it was in 1995, whereas the output of construction and wholesale increased, but the proportion of agriculture – decreased.

The following questions arise:

- how GDP depends on the output of separate sectors;
- how significant is the influence of a sector on GDP increase;
- what is the correlation among the output of sectors;
- how GDP increase depends on the unemployment level (A. Okun's law);
- what is the forecast of GDP for the year 2002.

The analysis of regression was done, using the power model $Y=\alpha X^{\beta}$, in order to assess, what would be the increase of GDP in percentage, if there would be 1% increase of a separate sector. The results of the analysis (see Figure 1) show that the increase of 1% in the manufacturing would give 0.7% GDP increase, the increase of 1% in the sector of transports would give 0.8% GDP increase, 1% increase in the wholesale – 0.4% GDP increase and 1% increase in the construction sector – 0.3% GDP increase. Agricultural sector is 6.7% out of GDP, however, the increase or decrease in this sector does not significantly influence the increase rate of GDP.

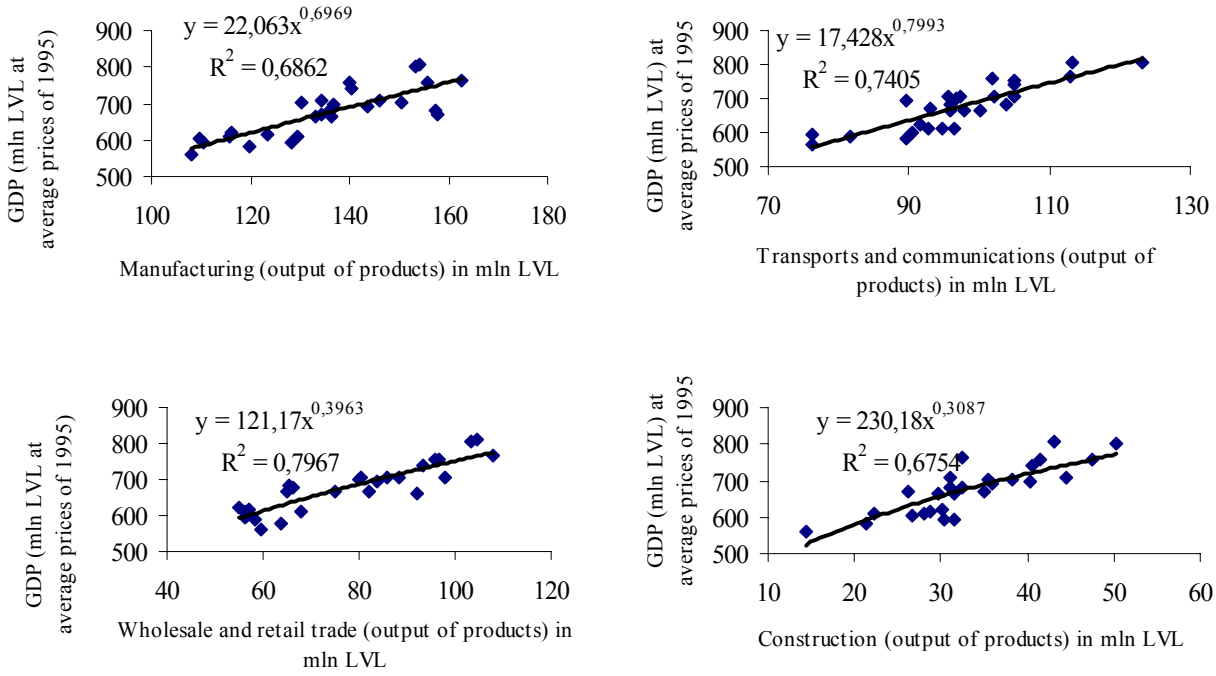

Figure 1. Regression models for the increase of GDP according to the output.

In order to find out, whether there exists correlation among separate sectors, the correlation analysis was carried out. The results of the analysis show that all sectors are closely correlated, except agriculture.

It is necessary to get free from the multicolinearity in order to carry out the analysis of GDP multiple regression, because all the features of a factor (output of a separate sector) are closely intercorrelated. Principal Component Analysis was carried out in the result of which 15 new variables (components) were established as the linear combinations out of the existing 15 variables of a factor. The first four components explain 87.608% of all the variations of features, besides – the new variables do not intercorrelate (see Table 2).

Table 2. Principal Component Analysis

Initial Eigenvalues			
Component	Total	% of Variance	Cumulative %
1	6.995	46.633	46.633
2	3.231	21.539	68.173
3	1.869	12.459	80.631
4	1.046	6.976	87.608
5	.501	3.337	90.945

As we can see, most of the output can be explained, using the first two components, which give 68.173% of the common variant. If the output of sectors is depicted, using two new coordinates, it is possible to draw a conclusion that the first component reflects the output according to the years, but the second – according to the quarters. It means that the nature of the first component can be explained by the influence of a year, whereas the nature of the second component – by the influence of a quarter (see Figure 2).

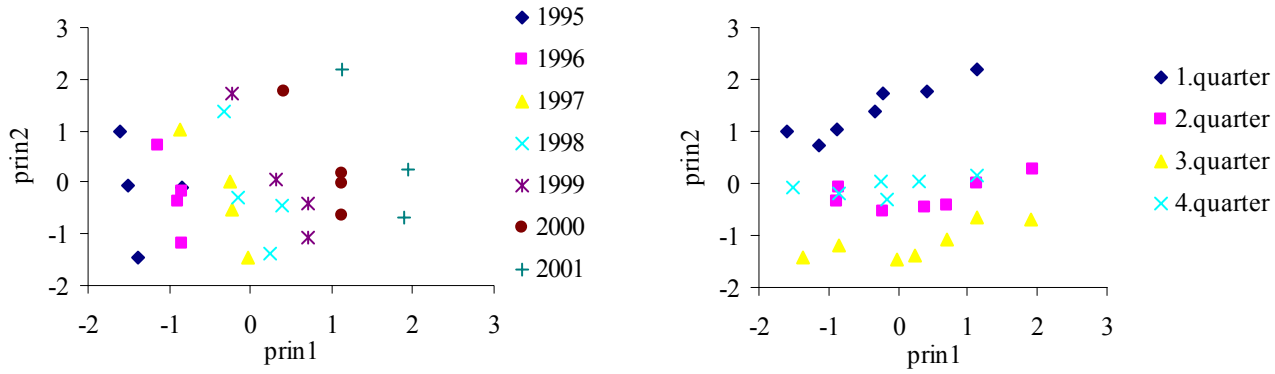

Figure 2. The output of the sectors according to two components

The analysis of multiple regression was carried out, using newly established four components, which are not correlated. The result of the analysis shows that GDP significantly depends on the first component (p-value < 0.001) and on the fourth component (p-value<0.05), but does not essentially depend on the second (p-value>0.7) and the third component (p-value>0.15). Therefore the first component can be used to forecast the changes of GDP, because the first component explains almost 50% of all the variants of GDP and also the influence of a year.

Unemployment is a negative phenomenon regarding society and an individual. The main economical and social consequences of unemployment are:

- the production of GDP decreases. It in its turn causes the losses of the income and savings of individuals;
- human capital's qualification and skills decrease;
- crime rate increases;
- an individual looses his self-respect, possibility to express himself as a personality through his work.

Economists first of all estimate the economical losses caused by unemployment. It is additional production that could be produced by the unemployed if they would be employed. Arthur Okun, well-known economist from the U.S.A., has developed methodology, which forms the basis for the statement that, if the actual level of unemployment is 1% higher than the natural level of unemployment, then the non-produced nominal GDP is equal to 3%. This statement was verified according to the data obtained in Latvia. The results show that, if unemployment is higher than 8%, alongside with the increase of unemployment for 1% we can observe decrease of GDP for 6.4% (see Figure 3). Until 8% of unemployment there was no decrease of GDP, therefore we can draw a conclusion that the natural level of inflation in Latvia might be lower than 8%.

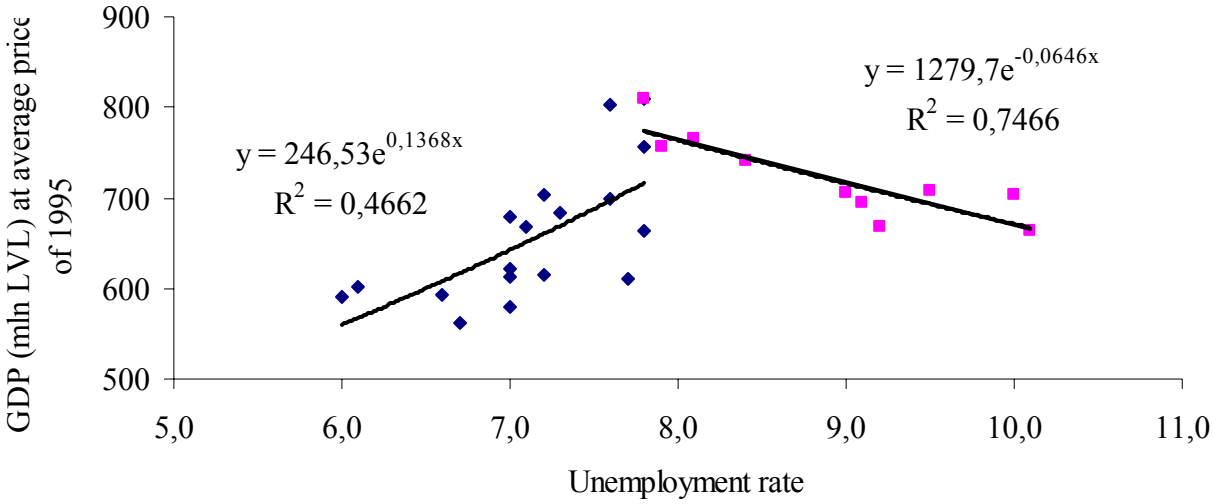

Figure 3. GDP according to the level of unemployment

GDP forecast

Until now there had been relatively little research done on GDP econometric model and its forecast, and there was no assessment of GDP econometric model with the aim of further structural analysis and appraisal of policy. Keynesian model was used to assess GDP. This model consists of three structural equations. The model enables to assess and forecast the dynamics of GDP increase, if there had been the assessment done on the expenses of households and the expenditures of administrative institutions, the development of common capital, export and import of goods and services. If potential values of structural equation features have not been assessed, it is impossible to assess GDP forecast. One of the possible models for GDP forecast is the model of time series. The example of time series model is the extrapolation of trend and the analysis of decomposition. On the basis of developed models the forecast, using Monte-Carlo simulation, is carried out and the forecast risk is assessed. In order to decrease the forecast risk at work, it is suggested to apply mixed models for the forecast of GDP: econometric, time series and simulation models. Keynesian model consists of three structural equations

$$C_t = \gamma_1 Y_t + \beta_1 + \varepsilon^C{}_t \quad (1)$$

$$I_t = \gamma_2 Y_t + \beta_2 Y_{t-1} + \beta_3 + \varepsilon^I{}_t \quad (2)$$

$$Y_t = C_t + I_t + G_t \quad (3),$$

where C_t is the individual consumption, G_t – public consumption, I_t – investments plus exports minus import, Y_t – GDP according to time t , γ_i, β_i are model parameters and ε error member. Balance equation (3) may be modified, using equations (1) and (2) and as a result obtaining a new equation $Y_t = \pi_1 Y_{t-1} + \pi_2 G_t + \pi_3 + u_t$, where π_1, π_2, π_3 – equation parameters and u – error member. The new econometric model can be used to forecast GDP, if we know the public consumption G forecast.

The time series additive model of decomposition analysis is $Y_t = T_t + S_t + K_t$, where Y is GDP, T is trend member, S is seasonal effect and K error member. Index t means, that model members depend on time t. Evaluations of the additive model coefficient are determined by multiple linear regression model with fictive variables $Y_t = \alpha_0 \cdot t + \alpha_1 \cdot Q_1 + \alpha_2 \cdot Q_2 + \alpha_3 Q_3 + \alpha_4 + \varepsilon$, where α_0, α_1, α_2, α_3, α_4, are evaluations of coefficients, $Q_1, \cdot Q_2$, Q_3 are fictive variables and ε - error member. Besides Q_i=1, if data correspond to i quarter and Q_i=0 in other cases. Monte-Carlo simulation method is applied in estimation of GDP values to be forecast, using evaluations of coefficients of models and their

standard deviations. Indicators *RMSE* and *RMSPE* are used to compare, how precise are the values of models, where *F* is GDP forecast and *Y* is actual GDP:

$$RMSE = \sqrt{\frac{\sum (F-Y)^2}{n}}; \qquad RMSPE = \sqrt{\frac{100}{n}\sum\left[\frac{F-Y}{Y}\right]^2} \quad .$$

The evaluations of the econometric model coefficients are $Y_t = 0.879Y_{t-1} + 0.428G_t + 29.748 + u_t$ with the determination coefficient R^2=0.842 and regression standard deviation *s*=22.142. The standard deviations of model coefficients, p-value and 95% confidence intervals are shown in Table 3. The results show that GDP is significantly dependent on GDP of the previous period and is not essentially dependent on the public consumption.

Table 3. Evaluations of econometric model coefficients

	Coefficient	*Standard deviation*	*p-value*	*95% confidence interval*	
π_3	29.74778	101.4546	0.77238	-181.883	241.3783
π_1	0.878843	0.109975	1.19E-07	0.64944	1.108247
π_2	0.427657	0.929831	0.650527	-1.51194	2.367251

Actual values of GDP and expected GDP values of econometric model, as well as GDP forecast for the 1st and the 2nd quarter of 2001 with 95% confidence intervals are shown in Figure 4. The forecast errors of econometric model RMSE=20.647 and RMSPE=0.314.

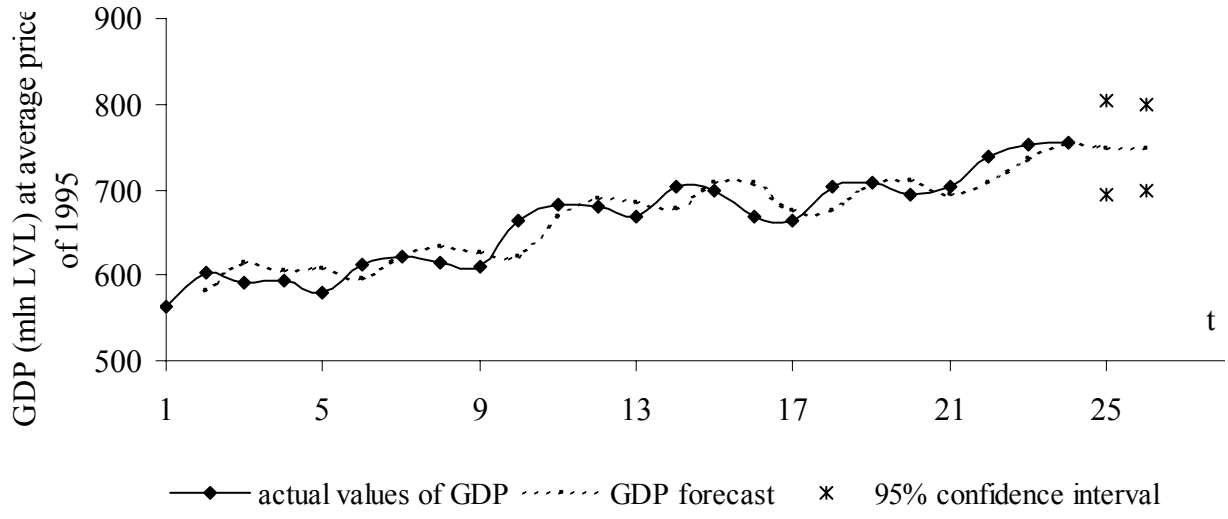

Figure 4. GDP forecast, obtained using econometric model and actual values of GDP

Additive model is $Y_t=7.379\cdot t-14.037\cdot Q_1+17.917\cdot Q_2+15.465\cdot Q_3+564.259+\varepsilon$, with determination coefficient $R^2=0.945$ and regression standard deviation $s=14.507$. The standard deviations of model coefficients, p-value and 95% confidence intervals are shown in Table 4. The results show that GDP is significantly dependent on time *t* and seasonal effect.

Table 4. Evaluations of additive model coefficients

	Coefficient	*Standard deviation*	*p-value*	*95% confidence interval*	
α_4	564.259	8.47994	5.62E-24	546.5103	582.0077
α_0	7.379321	0.433493	5.83E-13	6.472009	8.286634
α_1	-14.037	8.476246	0.114136	-31.778	3.703957
α_2	17.91731	8.420639	0.046667	0.292704	35.54192
α_3	15.46499	8.387098	0.08085	-2.08942	33.01939

The forecast deviations of additive model RMSE=12.908 and RMSPE=0.192, GDP forecast of additive model with 95% confidence interval are shown in Figure 5.

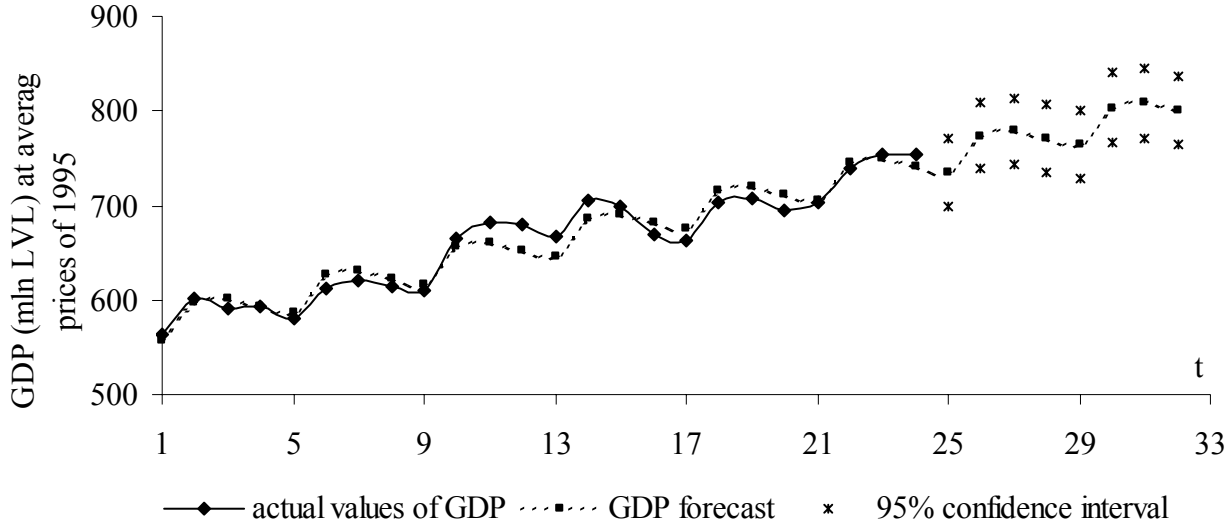

Figure 5. GDP forecast, obtained using additive model and actual values of GDP

By means of evaluations of time series and additive model coefficients and their standard deviations obtained using Monte-Carlo simulation model, the probability distribution of forecasted values were obtained.

The comparative analysis of the exactness of models and forecasted values, and the actual value of GDP of the 1st and the 2nd quarters of 2001 allows to draw a conclusion that the additive model is the most appropriate. The individual forecast of GDP with the probability of 95% for the additive model of the year 2002 is situated in within the interval:

Y_{29}(2002, I) $\in$ (727.584; 800.861), Y_{30}(2002, II) $\in$ (766.917; 840.195),

Y_{31}(2002, III) $\in$ (771.844; 845.122), Y_{32}(2002, IV) $\in$ (763.759; 837.036).

Obtained forecast GDP values may be used to make decisions only concerning short-term forecast, because there are only a few real data and suggested models do not reflect the real economic connections. In fact the real way to forecast GDP is an application of mixed models, because the econometric model has to model the expected values of factors in order to forecast GDP.

Conclusion

The problem of GDP forecast, using risk monitoring methodology, is defined as:

1. Process initialization: goal – topicality of GDP forecast risk problem – budget drafting, risk users – government;
2. Risk expansion: geographical expansion – on the scale of Latvia;
3. Risk assessment: forecast credibility interval of different models;
4. Risk control: application of forecast results in decision making on governmental level;
5. Risk monitoring: correction of a chosen model according to the latest information.

Concerning risk factors we should mention that transports and communications, wholesale and retail trade are essential GDP components, which are the indicatives of a low production level in Latvia. Latvia should implement the structural policy of GDP to become full-scale member of WTO and the EU. The most essential sectors should become those with the highest added value.

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