FORECASTING THE DYNAMICS OF YIELDS OF AGRICULTURAL CROPS IN THE REPUBLIC OF ARTSAKH[61]

I.V. Arutyunyan, V.Z.Vardanyan

Keywords: *agricultural crops, harvest gross crops, forecasting, extrapolation, exponential smoothing and analytical alignment.*

Introduction

Planning and forecasting of agricultural production is impossible without reliable prediction of the dynamics of crop yields for short-term prediction is possible to use adaptive methods, mathematical apparatus which is well developed in economic statistics. Thus the main problem of their application is the justification of numerical values of the corresponding tool parameters at short-term forecasting.

The response of the model to the change of dynamics characterizes the parameter gross yield, providing an adequate portrayal of the trends in simultaneous filtering of random fluctuations, characteristic of the BP yield in the Republic of Artsakh.

Broadly speaking, statistical approaches to economic forecasting fall into two categories: time-series methods and structural economic models. Time-series methods use economic theory mainly as a guide to variable selection, and rely on past patterns in the data to predict the future. In contrast, structural economic models take as a starting point formal economic theory and attempt to translate this theory into empirical relations, with parameter values either suggested by theory or estimated using historical data. In practice, time-series models tend to be small with at most a handful of variables, while structural models tend to be large, simultaneous equation systems which sometimes incorporate hundreds of variables (see Economic Panel Data; Simultaneous Equation Estimation: Overiew). Time-series models typically forecast the variable(s) of interest by implicitly extrapolating past policies into the future, while structural models, relying on economic theory, can evaluate hypothetical policy changes. In this light, perhaps it is not surprising that time-series models typically produce forecasts as good as, or better than, far more complicated structural models. Still, it was an intellectual watershed when several studies in the 1970s (reviewed in Granger and Newbold 1986) showed that simple univariate time-series models could outforecast the large structural models of the day, a result which continues to be true (see McNees 1990). This good forecasting performance, plus the relatively low cost of developing and maintaining time-series forecasting models, makes time-series modeling an attractive way to produce baseline economic forecasts.

Statement of the problem

At a general level, time-series forecasting models can be written

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n \text{ , [1]}$$

where β_0 *is the intercept,* $\beta_1, \beta_2, \ldots, \beta_n$ *are coefficients representing the contribution of the independent variables* $x_1, x_2, \ldots, x_n$.

The leading linear models are autoregressive models, autoregressive–integrated moving-average (ARIMA) models.

[61] [61] Հոդվածն ընդունվել է 03.02.2017:
Հոդվածը տպագրության է երաշխավորել ՄՄՀ տնտեսագիտության, կառավարման և ՏՀ ամբիոնը

An autoregressive model is when a value from a time series is regressed on previous values from that same time series, for example, y_t *on* y_{t-1}*:*

$$y_t = \beta_0 + \beta_1 y_{t-1} + \varepsilon_t \text{ [2]}$$

A variety of factors are likely influencing data. It is very important in the study that these different influences or components will be separated or decomposed out of the 'raw' data levels.

In general, there are four types of components in time series analysis: Seasonality, Trend, Cycling and Irregularity.

$$Y_t = S_t \cdot T_t \cdot C_t \cdot I \text{ [3]}$$

The first three components are deterministic which are called "Signals", while the last component is a random variable, which is called "Noise". To be able to make a proper forecast, we must know to what extent each component is present in the data. Hence, to understand and measure these components, the forecast procedure involves initially removing the component effects from the data (decomposition). After the effects are measured, making a forecast involves putting back the components on forecast estimates (recomposition).

Trend: A time series may be stationary or exhibit trend over time. Long-term trend is typically modeled as a linear, quadratic or exponential function.

Suppose we wish to calculate a trend, then calculate the forecasted gross grain harvest, but first in order to determine which line to carry out the alignment, we plot the yield and gross harvest curves (Figure 1) of agricultural crops, according to which we can observe the general trend of the change in indicators, that we will consider the dynamics of all the indicators presented in the table:

Table 1

Dynamics of productivity of agricultural crops of the Republic of Artsakh for 1995 - 2016

Time	Sown areas grains	Grain	Sown areas potatoes	Sown areas vegetables	Sown areas water-melons	Gross harvest grains	Gross harvest potatoes	Gross harvest vegetables
1995	21236	177	811	540	17	28749	4525	4453
1996	34461	180	833	562	24	39066	6984	7617
1997	38801	172	883	684	35	36701	5004	5122
1998	39793	187	915	808	120	29047	8723	8571
1999	26504	195	1053	1029	213	32631	9034	8871
2000	29274	202	1152	1023	249	36586	12661	10127
2001	27829	200	1220	1049	226	36408	12662	11444
2002	31643	204	1377	1114	276	60943	12531	10357
2003	41148	198	1349	1120	273	87466	12756	9581
2004	57396	249	1407	1124	255	81355	13138	9672
2005	63620	265	1395	1150	268	88497	13235	9740
2006	56822	245	1400	1098	226	64443	10275	8803
2007	47980	243	1211	1020	278	52863	8855	8169
2008	37013	245	1143	978	342	80348	13358	9939

2009	55377	258	1116	908	349	82762	13116	8661
2010	48930	289	966	907	207	59135	8094	6825
2011	53116	293	898	1002	322	97250	8597	8085
2012	60102	303	831	871	290	104977	8344	8040
2013	58687	288	783	872	297	101613	8594	8725
2014	61285	296	790	1050	290	67943	6607	8106
2015	48585	299	677	846	316	123889	4089	6857
2016	59974	287	612	926	267	148159	4922	10563

Table 2

Correlation Matrix for agricultural crops and Times

Correlations (agricultural grops) Marked correlations are significant at p < ,05000 N=22 (Casewise deletion of missing data)

	Time	**Sown areas grains**	**Gra-in**	**Sown areas pota-toes**	**Sown areas vege-tables**	**Sown areas water-melons**	**Gross harvest grains**	**Gross harvest potatoes**	**Gross harvest vegetables**
Time	1	0,77	0,95	-0,32	0,31	0,76	0,84	-0,14	0,17
Sown areas grains	0,77	1,00	0,82	-0,08	0,32	0,52	0,71	-0,02	0,10
Grain	0,95	0,82	1,00	-0,28	0,29	0,70	0,78	-0,12	0,08
Sown areas potatoes	-0,32	-0,08	-0,28	1,00	0,68	0,22	-0,26	0,85	0,49
Sown areas vegetables	0,31	0,32	0,29	0,68	1,00	0,72	0,24	0,68	0,73
Sown areas water-melons	0,76	0,52	0,70	0,22	0,72	1,00	0,65	0,45	0,56
Gross harvest grains	0,84	0,71	0,78	-0,26	0,24	0,65	1,00	-0,10	0,23
Gross harvest potatoes	-0,14	-0,02	-0,12	0,85	0,68	0,45	-0,10	1,00	0,71
Gross harvest vegetables	0,17	0,10	0,08	0,49	0,73	0,56	0,23	0,71	1,00

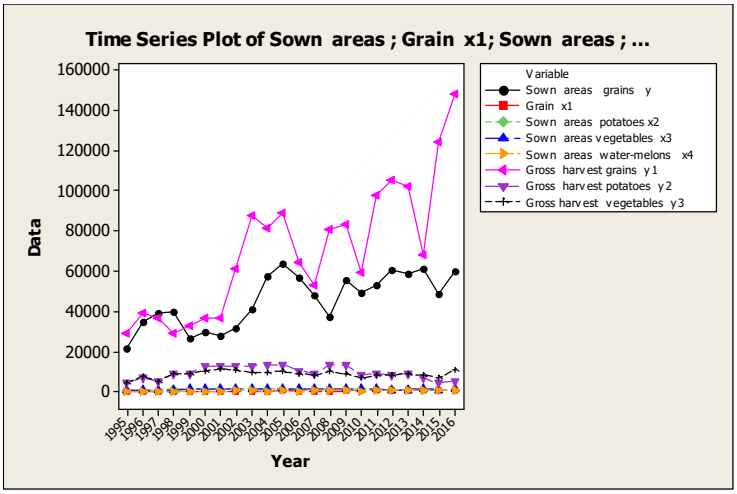

Fig. 1. Time series plot key indicators

According to the graph of the yield of grain crops, one can observe a general trend in the growth of grain yields. The same trend can be seen on the graph of the gross harvest of grain crops. Proceeding from this, the analytical equalization of yield and gross harvest of grain crops will be carried out using the equation of a straight line:

$$\hat{y}_t = a + bt \quad [4]$$

where $\hat{y}_t$ *- the calculated or leveled level, and* a *- the coefficient, as a rule, has no economic sense,* b *- coefficient showing the average absolute increase or decrease in the indicator as* t *changes by one,* t *- time.*

Forecasting always relies on the experience of development of the phenomenon studied in the past. Therefore, any forecast as a way out of the study period can be considered as extrapolation. The forecast is expressed in the form of a point estimate (that is, an estimate of the projected indicator in a particular year) by an equation describing the indicator trend.

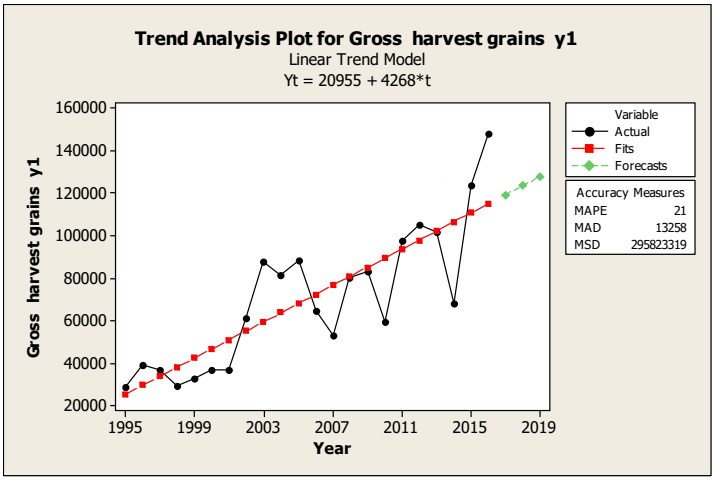

Fig.2. Trend Analysis for Gross harvest grain.

Fitted Trend Equation

Yt = 20955 + 4268*t

Accuracy Measures

MAPE 21
MAD 13258
MSD 295823319

Forecasts
Period Forecast

2017 119121
2018 123389
2019 127657

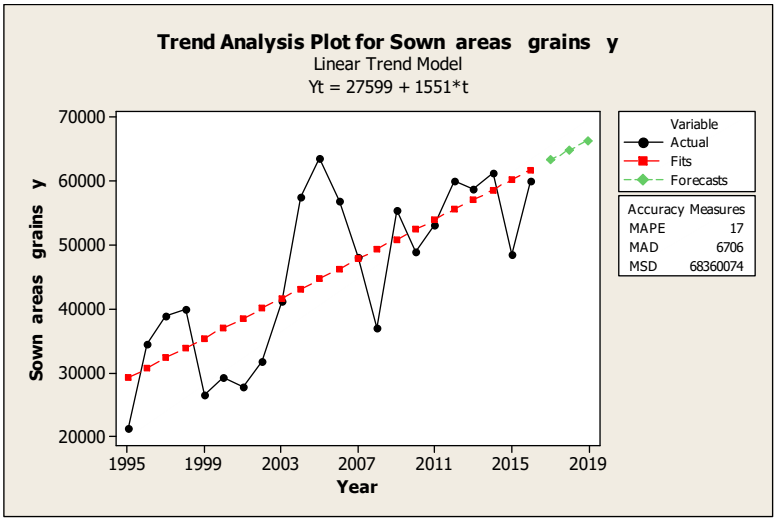

Fig.3. Trend Analysis for Sown areas grains

Trend Analysis for Sown areas grains y

Data Sown areas grains y
Length 22
NMissing 0

Fitted Trend Equation

Yt = 27599 + 1551*t

Accuracy Measures

MAPE 17
MAD 6706
MSD 68360074
Forecasts

Period Forecast

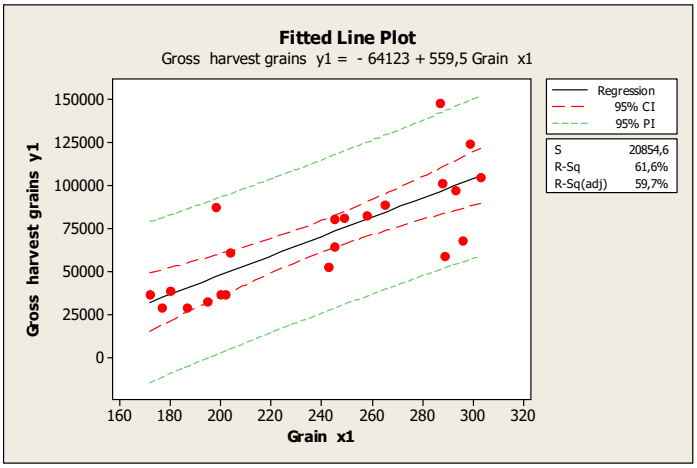

Fig.4. Fitted line plo

2017 63271,8
2018 64822,8
2019 66373,8

t

Analysis of Variance

Source DF SS MS F P
Regression 1 1,39407E+10 1,39407E+10 32,05 0,000
Error 20 8,69831E+09 4,34916E+08
Total 21 2,26390E+10

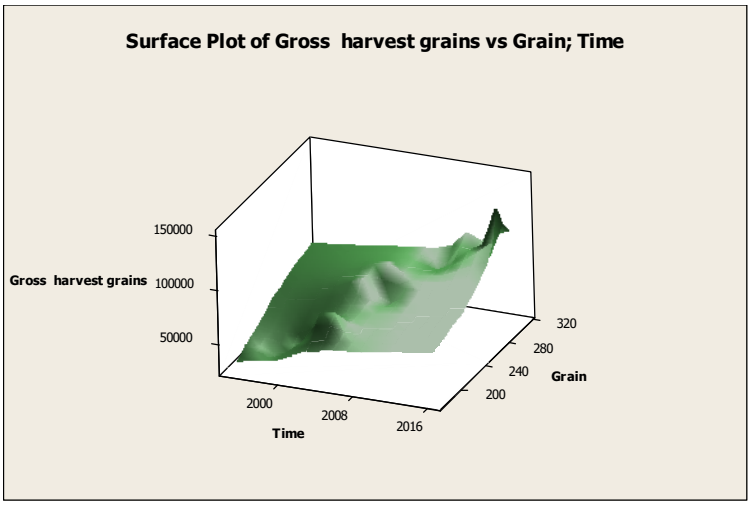

Fig.5. Surface plot of Gross harvest vs. Grain; Time

Conclusion

In general, the conditions for growing the main agricultural crops in the Republic of Artsakh, in particular cereals, can be characterized as favorable, as evidenced by the conducted economic and statistical analysis, the results of which allow to draw a conclusion about the existence trends of dynamics in the constructed dynamic series of grain yields.

As a result of the economic and statistical analysis of yield and gross harvest of grain crops for the period 1995-2016, a point forecast was made for the level of yield and gross harvest of cereals for 2018 and 2019:

Period Forecast

2018 123389
2019 127657

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SUMMARY

Forecasting the dynamics of yields of agricultural crops in the Republic of Artsakh

Irena Arutyunyan, Valya Vardanyan

The article analysis the current state of agricultural crops in the Republic of Artsakh, describes the main mathematical methods of forecasting and the forecast crop yields in the future. Time series forecasts are used in a wide range of agricultural policies. The main elements of forecasting in agriculture include the choice of the forecasting model (s) suitable for the problem under consideration.

РЕЗЮМЕ

Прогнозирование динамики урожайности сельскохозяйственных культур в Республике Арцах

Ирена Арутюнян, Валя Варданян

Ключевые слова: *сельскохозяйственные культуры, валовый урожай культур, прогнозирование, экстраполяция, экспоненциальное сглаживание, аналитическое выравнивание.*

В статье анализируется текущее состояние производства сельскохозяйственных культур в Республике Арцах. Описываются основные математические методы для решения задач прогнозирования в сельском хозяйстве. Прогнозы временных рядов используются широко при управлении сельским хозяйством. К основным элементам прогнозирования в сельском хозяйстве относятся выбор адекватной модели прогнозирования из разработанных моделей, решающей задачи рассматриваемой проблемы.

ԱՄՓՈՓՈՒՄ

Գյուղատնտեսական մշակաբույսերի բերքատվության դինամիկայի կանխատեսումը Արցախի Հանրապետությունում

Իրենա Հարությունյան, Վալյա Վարդանյան

Բանալի բառեր՝ *Գյուղատնտեսական մշակաբույսեր, մշակաբույսերի համախառը բերք, կանխատեսում, էքստրապոլացիա, էքսպոնենցիալ հարթեցում, վերլուծական հավասարեցում:*

Հոդվածում վերլուծվում է մշակաբույսերի համախառը բերքի արդի դինամիկան Արցախի Հանրապետությունում: Քննարկվում են կանխատեսման հիմնական մաթեմատիկական մեթոդները եւ բերքատվության կանխատեսումը: Ժամանակային շարքերի կանխատեսումը օգտագործվում է գյուղատնտեսության քաղաքականության լայն շրջանակներում: Գյուղատնտեսության մեջ դիտարկվող հիմնահարցի կանխատեսման հիմնական տարրերից է մոդելի ընտրությունը ստացված մոդելներից: