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INTERPRETATION OF SEASONAL FLUCTATION OF PRICES BY MEANS OF FOURIER SERIES IN THE REGIONAL MARKET AGRICULTURAL PRODUCTS

ИНТЕРПРЕТАЦИЯ ИЗМЕНИЙ СЕЗОННИХ ЦЕНОВЫХ КОЛЕБАНИЙ ПРИ ПОМОЩИ РЯДОВ ФУРЬЕ НА РЕГИОНАЛЬНОМ РЫНКЕ СЕЛЬСКОХОЗЯЙСТВЕННОЙ ПРОДУКЦИИ

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Abstract. This paper studies the analysis of price fluctuation with periodic functions as infinite trigonometrically series in sine and cosine terms and presents the basic analysis of Fourier series with regard to its applications in price fluctuation. Data used for the analysis was collected by ZEF/UNESCO Khorezm project over a 97 month on weekly basis, during 01.05.2002–01.05.2013 yy. on Urgench market for ten commodities. The findings show that seasonal fluctuation is very high for fruits and vegetables in harvesting and before harvesting period, while it is not high for livestock productions, rice and wheat.

Аннотация. В данной статье исследуется анализ колебаний цен с периодическими функциями, как бесконечный ряд тригонометрической в синус и косинус условиях и представляется основной анализ рядов Фурье с учетом его применения в колебания цен. Статистические первичные данные, использованные, при анализе на примере десяти сельскохозяйственных продуктов собраны проектом ZEF ЮНЕСКО/Хорезм в течение 97 месяцев на еженедельной основе в периоде 01.05.2002–01.05.2013 г. г. на рынке города Ургенча. Наши анализы и результаты исследований показывают, что сезонные колебания очень высоки для фруктов и овощей в период заготовки и до сбора урожая, а в тоже время они не является высокой в производстве скота, риса и пшеницы.

Keywords: Agriculture, agricultural commodities, price, price fluctuation, Fourier series, seasonal variation, seasonal cycle.

Ключевые слова: сельское хозяйство, сельскохозяйственная продукция, цена, колебания цен, ряды Фурье, сезонные вариации, сезонные циклы.

The Khorezm region is one of the northern regions of Uzbekistan. The region borders with Karakalpakstan in the north and northeast with the Bukhara region in the southeast and with Turkmenistan in the south and west. It covers an area of 6050 km². The population is 1715,6 thousand approximately 60 percent living in rural areas.

Khorezm Province has divided into 10 administrative districts and the capital is Urganch city. Other major towns include Khonka, Khiva, Shovot and Pitnak. The climate is a typically arid continental climate, with cold winters and extremely hot, dry summers. In 2014, the share of the region's gross regional product in GDP was 3.3 percent, that is 4736.3 milliard UZS (Uzbek soom). But the share of the region in producing agricultural products is 6 percent.

The aim of this section is to give information about an agricultural sector of Khorezm, as well as to get familiar with the role of the sector in Khorezm region.

Agriculture sector contributes great share in the economy of the Khorezm region in comparison with other sectors of the economy. The share of agriculture sector in the regional gross domestic product is almost 29.7 percent [3]. Moreover, 10 percent of the whole labour force is employed by farmers. In addition, 67.7 percent of agricultural commodities are produced by household plots or rural population [4].

1. Data source and methodology

The data used for the research was collected by ZEF/UNESCO Khorezm project on a weekly basis for the key food products in agricultural markets in Urgench, Khorezm. The Urgench agricultural market is the main and the biggest market in Khorezm. The data included: product prices of three categories for each product, moreover a number of sellers and amount of food products brought and sold in Urgench market only for three products. Since we have three categories for each product the main category changes product to product, but in general, the first and second categories are the main ones, so sometimes there would be missing data for the third category as there was not this category in the market.

The survey enclosed 10 products, i. e., grains (wheat and rice), fruits (apple), vegetables (potatoes, carrots, onions and tomatoes), and livestock products (beef, sour cream and egg). Data used for the research on the monthly basis from may 2002 — August 2013 in total 104 valid observations and 32 missing observation, excluding carrot and tomato as they were included in the survey July 2003 so for them in total 90 valid observation and 32 missing observation. Since the survey was stopped June 2010 and began October 2012, as well as there is missing data for March and April 2008, November 2009.

For the analysis, we used real prices, transformed by dividing nominal with the CPI on monthly basis. CPI indicator was taken on a monthly basis from the annual report of Central bank of Uzbekistan which was given its official sight [6].

2. Results and discussion

As the results of our previous analysis, show the seasonal variation of the agricultural commodities price is high enough. Consequently, we could say that they are periodic with periodicity 12. Since deterministic seasonal component with seasonal period s has a discrete spectrum of the harmonic (Fourier) frequencies $\omega_k = 2\pi k / s,\ k = \pm 1, \pm 2, ..., \pm[s/2]$, we can estimate the following model to estimate coefficients and to find cyclical patterns.

$$\Delta y_t = a_0 + \sum_{k=0}^{[s/2]} \left[a_k \cos(2\pi k t / s) + b_k \sin(2\pi k t / s) \right] + a_{[s/n]} \cos(\pi t) + \varepsilon_t \quad (1)$$

$$t = 1, 2, ..., T.$$

It is important to note the equation (1) is equivalent to the deterministic model (2) that we used in our previous analysis.

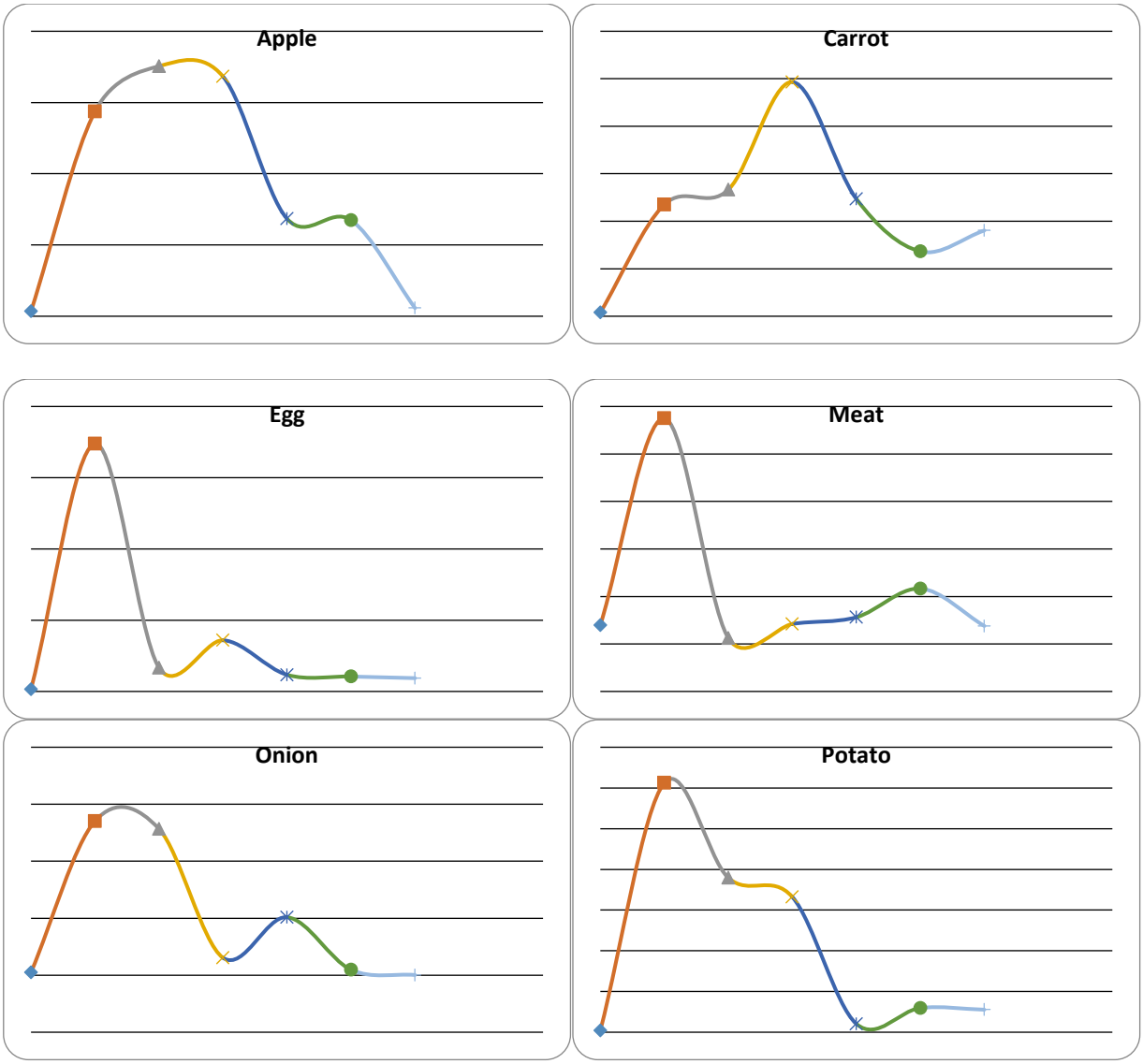
$$\Delta y_t = \sum_{i=1}^{S} \delta_i d_t^i + \varepsilon_t \quad (2)$$

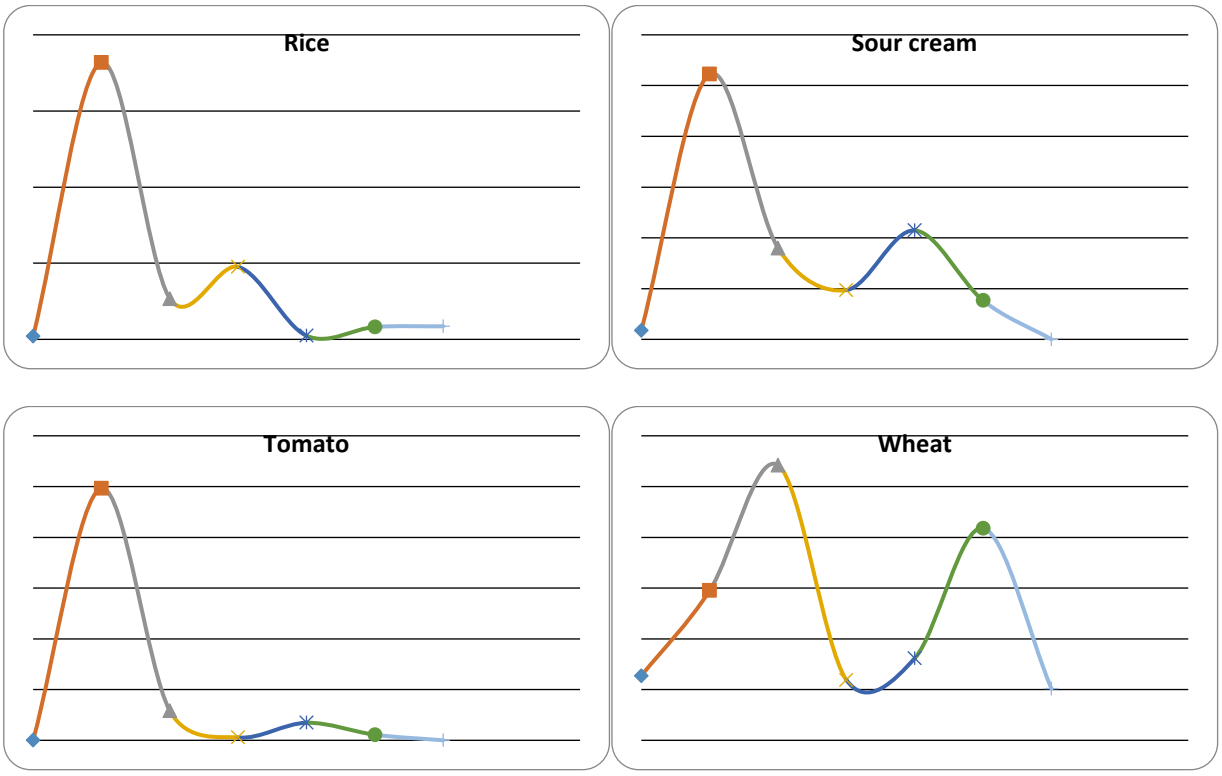
It is simply a reparametrization and, consequently the residuals and R^2 are the same. What this representation allow is to interpret seasonal fluctuations in term of cycles of a different period. In this way, the coefficient a_0 is related to the long term (no cycles) and it can be shown that its estimate coincide with the mean of the growth rates; a_1 and b_1 are related with periodicity of 1 cycle

per year and both measure together the contribution of this cycle to the variation of Δy_t; in general, the a_k and b_k are related to cycles of k fluctuations per year and, finally, $a_{[s/2]}$ measures the bimonthly fluctuation. The results of the analysis are given in the graphs below. According to the graph the price of apple has 5 cycles per year, also we can see from previous analysis apple is the product which has high seasonal fluctuation. Another product which has high seasonal fluctuation is a carrot and the price of the carrot has 4 cycles per year. But interestingly the price of tomato has one cycle per year; despite it also has high seasonal fluctuation. In accordance with our survey apple and carrot have more than one harvesting period; moreover it is easier to keep them for a long time than tomato. So, the price of apple and carrot change step by step, which makes more cycle. When the price of tomato has a strict change in harvesting period and it stays stable.

Another group of the product is livestock products and egg, which do not have harvesting period and low seasonal fluctuation. The analysis shows that egg and meat have two cycles per year. But fascinatingly sour cream has 5 cycles per year, despite it does not have harvesting period and low seasonal fluctuation. Results of the survey show those cycles of the price of sour cream are related with holidays. As in holidays they prepare special food which needs to use more sour cream.

Onion and potato have two harvesting periods in spring and in autumn. From the Figures (vide infra) we can see that onion and potato have three cycles per year. These products are produced in Khorezm but in winter they have imported from other regions also. The price of these products have low seasonal fluctuation, because it is easy to keep them for a long period and as they imported from other regions the role of other factors in fluctuation are higher.





As the previous results show wheat and rice are the products which have very low seasonal fluctuation. The graph shows rice has only two cycles per year, since rice is exported to other regions. But wheat has three cycles per year. As the demand for wheat increased in sowing period and supply of the wheat increased in harvesting period.

Table presents summary statistics for a monthly growth rate of the real price of ten agricultural commodities, since we use for estimation first difference of logged real price. These statistics are computed from a regression of relevant variable on seasonal dummies.

The first statistics is the standard deviation of the fitted values of the regression, which is an estimate of the standard deviation of the seasonal component of the dependent variable. The second statistic is the standard error of the regression, which is an estimate of the standard deviation of the business cycle component of the dependent variable.

Table.

SUMMARY STATISTICS AGRICULTURAL COMMODITIES PRICES

	Standard deviation of dummies	*Standard error of regression*
Apple	0,373	0,223
Carrot	0,279	0,229
Egg	0,072	0,086
Meat	0,035	0,037
Onion	0,177	0,259
Potato	0,168	0,181
Rice	0,071	0,101
Sour cream	0,069	0,077
Tomato	0,575	0,269
Wheat	0,045	0,087

It is interesting to study, whether exist a common trend in seasonal and non-seasonal cycle, which was introduced as a general similarity of the economic propagation mechanisms for seasonal and non-seasonal cycles [1]. For this we computed seasonal and non-seasonal components of y_t .

Formula (4) is used for estimating seasonal dummies at the same time which explain seasonal components. For defining non-seasonal components, we used the following equation [2].

$$\Delta y_t = \sum_{i=1}^{S} \delta_i d_t^i \tag{4}$$

$$\Delta y_t = y_t^i - \sum_{i=1}^{S} \delta_i d_t^i \tag{5}$$

This decomposition Show that the two components are orthogonal, therefore we can determine seasonal and non-seasonal variation by the standard deviation of the seasonal and non-seasonal components of the variables [2].

$$\sigma_i^s(y) = (\text{var}(y_t^{i,s}))^{\frac{1}{2}} \tag{6}$$

$$\sigma_i^n(y) = (\text{var}(y_t^{i,n}))^{\frac{1}{2}} \tag{7}$$

So, we estimated the following regression to know if the amounts of seasonal and non-seasonal variations are correlated across the products [2].

$$\sigma_i^n = \beta_1 + \beta_2 * \sigma_i^s + \upsilon_i \tag{8}$$

Where i=1, 2, …, I denote products. In view of the fact that β_2 is not zero and statistically significant seasonal and non-seasonal variations are correlated across products.

$$\sigma_i^n = 0.0748744 + 0.379004 * \sigma_i^s + \upsilon_i \tag{9}$$

SE = (0.0228223) *(0.0912428)*

t = (3.281) *(4.154)* *R2=0.6832*

The study shows that there is co movement between seasonal and non-seasonal price fluctuation of agricultural commodities prices.

4. Conclusion

Seasonal fluctuation plays an important role in of agricultural commodities market. In this article, we analyzed seasonality in the prices of ten agricultural products in Khorezm region. According to the results of the analysis, seasonality is high in crop products but low in livestock products. However, seasonality in crop products also, changes crop to crop according to its harvesting periods per year and possibility of stocking them. Analysis shows that seasonality is very high for tomato, apple, a carrot which are difficult to stock and low onion, potato, rice, wheat which are easy to stock.

Results from Fourier frequencies shows the same results where seasonal cycles per years are more for the product which is easy to stock and has more than one harvesting period and vice versa.

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