

A Service of

ZBW

Leibniz-Informationszentrum Wirtschaft Leibniz Information Centre for Economics

Agbo, Hanan Mahmoud Sayed

Article

Forecasting agricultural price volatility of some export crops in Egypt using ARIMA/GARCH model

Review of Economics and Political Science (REPS)

Provided in Cooperation with: Cairo University, Cairo

Suggested Citation: Agbo, Hanan Mahmoud Sayed (2023) : Forecasting agricultural price volatility of some export crops in Egypt using ARIMA/GARCH model, Review of Economics and Political Science (REPS), ISSN 2631-3561, Emerald, Bingley, Vol. 8, Iss. 2, pp. 123-133, https://doi.org/10.1108/REPS-06-2022-0035

This Version is available at: https://hdl.handle.net/10419/316076

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.



https://creativecommons.org/licenses/by/4.0/

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



WWW.ECONSTOR.EU

Forecasting agricultural price volatility of some export crops in Egypt using ARIMA/GARCH model

Hanan Mahmoud Sayed Agbo Faculty of Economics and Political Science, Cairo University, Giza, Egypt

Abstract

Purpose – This study focuses on forecasting the price of the most important export crops of vegetables and fruits in Egypt from 2016 to 2030.

Design/methodology/approach – The study applied generalized autoregressive conditional heteroskedasticity (GARCH) model and autoregressive integrated moving average (ARIMA) model.

Findings – The results show that ARIMA (1,1,1), ARIMA (2,1,2), ARIMA (1,1,0), ARIMA (1,1,2), ARIMA (0,1,0) and ARIMA (1,1,1) are the most appropriate fitted models to evaluate the volatility of price of green beans, tomatoes, onions, oranges, grapes and strawberries, respectively. The results also revealed the presence of ARCH effect only in the case of Potatoes, hence it is suggested that the GARCH approach be used instead. The GARCH (1,1) is found to be a better model in forecasting price of potatoes.

Originality/value – The study of food price volatility in developing countries is essential, since a significant share of household budgets is spent on food in these economies, so forecasting agricultural prices is a substantial requirement for drawing up many economic plans in the fields of agricultural production, consumption, marketing and trade.

Keywords Forecasting, Agricultural price, Volatility, Export crops, ARIMA, GARCH model Paper type Research paper

1. Introduction

Monitoring the volatility commodity prices can play a key role in a country's overall economic performance. Therefore, the commodity price forecast helps decision-makers to develop appropriate economic policies and strategies that are compatible with the future changes (Bhardwaj *et al.*, 2014).

Commodity prices, especially the prices of agricultural commodities, are subject to high degrees of volatility; therefore, the predictable price decreases the negative impact of uncertainty, in other words, decrease producer aversion to risk (Sedghy *et al.*, 2016).

In general, fluctuations in prices of agricultural commodity occur primarily from shocks of the supply side. These disturbances, combined with the short-term demand and supply elasticity coefficients, lead to sharp instability of the price (Sendhil *et al.*, 2014; Piot-Lepetit and M'Barek, 2011), which lead both farmers and consumers to uncertainty and risk and so volatility of commodity prices has been studied (Apergis and Rezitis,2011; Ahmed and Serra, 2015).

More critical is the analysis of food price fluctuations in developing countries, since a significant share of household income is spent on food in these economies, so uncertainty

© Hanan Mahmoud Sayed Agbo. Published in *Review of Economics and Political Science*. Published by Emerald Publishing Limited. This article is published under the Creative Commons Attribution (CC BY 4.0) licence. Anyone may reproduce, distribute, translate and create derivative works of this article (for both commercial and non-commercial purposes), subject to full attribution to the original publication and authors. The full terms of this licence may be seen at http://creativecommons.org/licences/by/4.0/ legalcode

Price volatility of some export crops

123

Received 2 October 2022 Revised 2 October 2022 Accepted 2 October 2022



Review of Economics and Political Science Vol. 8 No. 2, 2023 pp. 123-133 Emerald Publishing Limited e-ISSN: 2356-9800 DOI 10.1108/REPS-06-2022.0035 about food prices has a direct effect on welfare. Instability of food price is particularly affecting low income people, small agricultural producers who depend on crop sales for a significant portion of their income (Ceballos *et al.*, 2017; Sedghy *et al.*, 2016).

The research problem is identified the most suitable models to evaluate the volatility of the most important Egyptian export crops of vegetables and fruits, so this study aims to forecast agricultural prices for green beans, potatoes, tomatoes, onions, oranges, grapes and strawberries using the ARIMA or GARCH approach.

2. Literature review

Various empirical studies have analyzed measuring and forecasting agricultural price volatility of different products using ARIMA-GARCH models. Felis and Garrido (2015) studied price volatility in Spain of fresh fruits and vegetables, using multivariate GARCH model. In the Spanish tomato marketing chain, Sidhoum and Serra (2016) applied the MGARCH model to test spillovers of uncertainty.

Lama *et al.* (2015) analyzed the price volatility in agricultural market, especially for three main commodities: the international price of edible oils, the international price of cotton and the domestic price of edible oils depending on ARIMA model, GARCH model and EGARCH model. Ramirez and Fadiga (2003) and Sanjuan-Lopez and Dawson (2017) studied the volatility price of soybeans and wheat in the United States futures markets through the GARCH model. Sekhar *et al.* (2017) applied GARCH and EGARCH to examine volatility in agricultural price in India, while Guerrero *et al.* (2017) used these models to analyze agricultural price volatility in both Mexican agricultural market and international agricultural market.

For the period from January 1990 to February 2014, Ojogho and Egware (2015) studied the price volatility of sugar, meat, grain, dairy and gross food in the Nigeria. Also Kamu *et al.* (2010), Onour and Sergi (2011), Sukati (2013), Bhardwaj *et al.* (2014), Sendhil *et al.* (2014), Sedghy *et al.* (2016), Solanki and Sharma (2016) and Lama *et al.* (2016) applied ARIMA-GARCH model to analyze and forecast price volatility of some selected agricultural products.

Yang *et al.* (2001) analyzed the impact of the liberalization of agricultural sector on the volatility of commodity price through GARCH application; results of the study showed that agricultural liberalization policy increases the market volatility for some grain crops. Siami and Hudson (2017) used an AR-EGARCH model to analyze the interdependent relationship between futures prices of crude oil, international prices of agricultural products and exchange rate.

Other empirical studies focused on measuring and forecasting price volatility of agricultural products using other econometric models. Corrêa *et al.* (2016) used a new causal forecasting approach, called (WARIMAX-GARCH) method; Benavides (2009) used an option implied approaches, GARCH model, a multivariate ARCH and composite approaches to predict futures prices of some cereal. Li *et al.* (2017) proved that the two-state normal mixture (NM)-GARCH approach is more accurate than the GARCH model in modeling agricultural price volatility. Jin and Frechette (2004) confirmed that the results of fractional integration (FI) GARCH model perform significantly better than traditional normal GARCH.

Anggraeni *et al.* (2017) applied Vector Autoregressive model and an ARIMAX model to predict the price volatility of rice in Indonesia. Xiong *et al.* (2015) predict some of agricultural commodity prices in China with VECM–MSVR model, which is a combination of the linear and nonlinear methods. On the other hand Zou *et al.* (2007) ensured that the artificial neural network (ANN) model is the best model for forecasting the future price of Chinese cereal. While Haofei *et al.* (2007) used a multi-stage optimization approach (MSOA) to predict cereal price in China. Xiong *et al.* (2018) applied a hybrid STL and ELM methodology to predict the Chinese vegetable price and to evaluate the volatility of it in the short and long run.

The main contribution of this paper is that the published works regarding price volatility of agricultural prices in Egypt are so little. El-Rasoul and Tolba (2018), analyzed the price

REPS

8.2

volatility in the Egyptian food markets to find the major macroeconomic factors that] influence it during the period 1995–2015 through the exponential function model. The results revealed that there is some link between the seasonality of retail prices and the wholesale prices of the commodities studied.

Abdelfattah *et al.* (2015) studied price volatility in the Egyptian markets of surge crops from 1998 to 2013 using ARIMA model. Abdel-Radi and Ahmed (2018) aims to study the price volatility of the Egyptian wheat market during the period (2008–2013) depending on BEKK-GARCH model, and the study also examined how the shocks in the international wheat market influence the Egyptian domestic market.

3. Materials and methods

3.1 The data

The study employs observations for producer prices of the most important Egyptian export crops of vegetables and fruits, including green beans, potatoes, tomatoes, onions, oranges, grapes and strawberries. All the variables are in logarithmic form. The study period 1967: 2015 except strawberries the available data only from 1991 to 2015. The main source of data was Food and Agriculture Organization (FAO) database.

3.2 Methodology

3.2.1 ARIMA model. The ARIMA is among the most common models for the study of time series forecasting. In this model, the future value of a variable is supposed to be a linear combination of past values and past errors (Guerard, 2013; Khashei and Hajirahimi, 2017; Badmus and Ariyo, 2011).

The ARIMA methodology is performed in four stages or steps, including: identification, estimation, diagnostic checking and forecasting (Kamu *et al.*, 2010).

3.2.2 ARCH–GARCH model. The autoregressive conditional heteroskedasticity (ARCH) model and the generalized ARCH (GARCH) model specify explicitly how conditional variances evolve over time (Han *et al.*, 1990; Wang *et al.*, 2002; Luger, 2012).

ARCH models permit the shocks in more recent periods to have a positive effect on current volatility; on other hand the GARCH models assume that current volatility is influenced not only by past shocks, but also by past volatilities (O'Connor and Keane, 2011; Engle, 2001, 2002; Bauwens *et al.*, 2006).

4. Results and discussions

4.1 ARIMA model

4.1.1 Model identification. The stationary of variables was tested by augmented dickey fuller (ADF) test; Table 1 shows that all the variables have unit roots in levels and are stationary in first-differences as all values of ADF test are insignificant in levels, but significant at 1% level in both only intercept case, and trend and intercept case, which mean series become stationary.

4.1.2 Model estimation. We estimated various models in order to determine the right specification from BIC point of view, Table 2 reveals that ARIMA(1,1,1), ARIMA(2,1,2), ARIMA(1,1,0) ARIMA(1,1,2), ARIMA(0,1,0) and ARIMA(1,1,1) models are the most adequate fitted models to evaluate the price volatility of green beans, tomatoes, onions, oranges, grapes and strawberries, respectively.

Table 3 shows the parameter estimates of the ARIMA fitted model. The results show that most of the coefficients were significant at the 1% level. Lagged variables are important factors for producer decisions; Table 3 also shows that the producer response to lagged prices is statistically significant for all selected crops except green beans.

Price volatility of some export crops

125

REPS 8,2		Intercept	ckey–Fuller (ADF) Log Intercept	-Fuller (ADF) Log difference Intercept Trend and intercept		
126	Green beans Potatoes Tomatoes Onion Oranges Grapes Strawberries	$\begin{array}{c} 0.043 \\ -1.393 \\ -0.604 \\ -0.893 \\ -2.019 \\ -1.388 \\ -0.415 \end{array}$	$\begin{array}{r} -2.344 \\ -1.508 \\ -3.0.81 \\ -1.504 \\ -0.218 \\ -1.167 \\ -2.497 \end{array}$	-7.380^{***} -9.944^{***} -8.316^{***} -10.69^{***} -7.009^{***} -5.611^{***} -4.669^{***}	-7.503^{***} -10.019^{***} -8.223^{***} -10.623^{***} -7.666^{***} -5.705^{***} -4.556^{***}	
Table 1. Results of Augmented Dickey–Fuller (ADF) test	Note(s): *** ind 10% level Source(s): Comp www.fao.org/face	icates statistical s biled by researcher stat/en/#data/PP	significance at 1% level, **s from unit root test dependin	ignificance at 5% lev g on e-views. See Tabl	rel and * significance at le A1 in appendix, http://	

4.1.3 Diagnostic checking. There are no spikes outside the insignificant zone for both autocorrelation function and partial autocorrelation function residuals squared plot, we can conclude that residuals are white noise; hence, our ARIMA models are fitted. See Figure A1-A6 in appendix.

4.2 ARCH–GARCH model

4.2.1 Testing of ARCH effect. A fundamental assumption of the Box–Jenkins method is that the residuals remain constant over time (Jordaan *et al.*, 2007). Table 4 reveals the results of the ARCH-LM tests, the results of the test revealed the presence of ARCH effect only in potatoes crop case; hence we need to apply the GARCH approach. Keep in mind that the volatility in the agricultural prices of all the other crops remains constant over time.

4.2.2 Applying the GARCH approaches. In this study both akaike information criterion (AIC) and bayesian information criterion (BIC) were employed to select an appropriate GARCH model for potatoes. Table 5 displays the summaries of the AIC and BIC of different GARCH models. Therefore, GARCH (1,1) model is the best volatility models for the prices of potatoes. Table 6 shows estimation results of GARCH (1,1) model for potatoes price.

4.2.3 Model diagnostics GARCH (1,1) model for potatoes price. The ARCH-LM test was 1.251,189 under chi-square distribution for one lag difference of residuals squared, and the null hypothesis was not rejected. On the other hand, *F*-statistic was 1.230,710 and the test also not rejected the null hypothesis at the same condition. The results of the test indicated that the ARCH effect in potatoes' price series was no longer present.

Also, there are no spikes outside the insignificant zone for both autocorrelation function and partial autocorrelation function plot of the residuals squared, and we can conclude that residuals are white noise; hence, our GARCH (1,1) model is fitted. See Figure A7 in appendix.

4.3 Forecasting values of the model's variables

The forecasted value for producer price of some export crops is given in Table 7. As seen from the table, all prices will still be increasing in the forecasted period from 2016 to 2030. Forecasted value for green beans will increase from 2589.17 pound/ton in 2016–9752.392 pound/ton in 2030; forecasted value for potatoes will increase from 2399.156 pound/ton in 2016–8928.388 pound/ton in 2030; forecasted value for tomatoes will increase from 1556.775 pound/ton in 2016–5052.167 pound/ton in 2030; forecasted value for onion will increase from 1119.612 pound/ton in 2016–4103.752 pound/ton in 2030; forecasted value for oranges will increase from 1211.640 pound/ton in 2016–4621.151 pound/ton in 2030;

	ARIMA model	AIC	BIC	SEE	Price volatility
	(110)	-0.654449	-0.575719	0 170849	or some export
	(1,1,1)	-0.698718	-0.580623	0.165440	crops
Price of green beans	(2,1,1)	-0.651745	-0.492733	0.167582	
0	(1,1,2)	-0.675285	-0.517825	0.165760	
	(0,1,1)	-0.535757	-0.457790	0.181372	
	(1,1,0)	-0.098697	-0.019968	0.225576	127
	(0,1,1)	-0.098139	-0.020172	0.225735	
Price of potatoes	(1,1,1)	-0.069454	0.048640	0.226612	
	(2,1,0)	-0.050214	0.069046	0.228655	
	(0.1.2)	-0.059767	0.057183	0.227853	
	(0,1,0)	-0.073934	0.004033	0.228483	
	(2,1,1)	-0.109701	0.049311	0.219751	
Price of tomatoes	(0,1,2)	-0.093246	0.023704	0.224071	
	(2,1,2)	-0.207549	-0.008784	0.207241	
	(2,1,0)	-0.095961	0.023298	0.223484	
	(1,1,0)	-0.325772	-0.247045	0.201365	
	(0,1,1)	-0.316133	-0.238166	0.202424	
Price of onion	(1,1,1)	-0.290233	0.172139	0.202928	
	(2,1,1)	-0.257396	-0.098384	0.204108	
	(2,1,3)	-0.406647	-0.168129	0.185850	
	(1,1,3)	-1.311786	-1.114962	0.119436	
	(3,1,1)	-1.357026	-1.156285	0.116523	
Price of oranges	(1,1,1)	-1.312217	-1.194122	0.121736	
	(2,1,1)	-1.329224	-1.170211	0.119430	
	(1,1,2)	-1.354267	-1.196808	0.118043	
	(0,1,0)=(1,0,0)	-1.376484	-1.298517	0.119127	
	(1,1,0)	-1.343734	-1.265004	0.121042	
Price of grapes	(0,1,1)	-1.365305	-1.287338	0.119794	
	(1,1,1)	-1.317650	-1.199556	0.121406	
	(2,1,3)	-1.394781	-1.156263	0.113394	
	(0,1,0)	-2.483603	-2.385432	0.067187	
	(1,1,0)	-2.426575	-2.327837	0.068997	
Price of strawberries	(0,1,1)	-2.476709	-2.378538	0.067399	
	(1,1,1)	-2.590858	-2.442750	0.062354	
	(2.1.0)	-2.355158	-2.206379	0.069978	T-11.0

Note(s): The criterions to judge for the best model are: (1) relatively small of BIC; (2) relatively small of SEE Com **Source(s)**: Compiled by researcher depending on e-views, See table A1 in appendix http://www.fao.org/ faostat/en/#data/PP

models' statistical

results

forecasted value for grapes will increase from 3340.546 pound/ton in 2016–7411.219 pound/ton in 2030; forecasted value for strawberries will increase from 2659.23 pound/ton in 2016–6316.64 pound/ton in 2030.

We also note that the growth rate of forecasted prices for oranges, green beans, potatoes and onions, respectively is more than the growth rate of other selected crops, so it is expected during the forecast period the production and exports of oranges, green beans, potatoes and onions will increase at increasing rate, and will be more attractive for agricultural producers and exporters compared to tomatoes, grapes and strawberries, but this result depend on some facts which are:

 The rise in the prices of food commodities is reflected in the cropping pattern and the orientation of agricultural resources toward the production of high-priced food crops. (FAO. 1987)

KEPS	Crop	Variable	Coefficie	nt Crop	Variable	Coefficient
0,2	Green beans	C AR(1)	0.105307*** (0.415593 (0.25	0.020331) onion 3390)	C AR(1)	0.092780*** (0.020489) -0.433562*** (0.134097)
198	Tomatoes	MA(1) C AR(1) AR(2)	-0.533474^{*} (0.2 0.084106*** (-0.235949^{*} (0.1 0.587482*** (53390) 0.004669) Orange 34240) 0.124705)	s C AR(1)	0.095622*** (0.033818) 0.836817*** (0.204140)
120	Grapes	AR(2) MA(1) MA(2) C AR(1)	$0.387485^{++}($ $0.002845(0.05)^{-}-0.997075^{***}($ $11.95011^{***}(4)^{-}0.983506^{***}($	9.124703) 6911) 0.056696) 480532) Strawb 0.011885)	MA(1) MA(2) erries C AR(1) MA(1)	-0.941907 (0.237210)*** 0.250431 (0.151468) 0.061796*** (0.004029) 0.553773*** (0.216238) -0.990812*** (0.16/08)
Table 3. Estimation results of fitted ARIMA models	Note(s): Nun *** indicates s Source(s): C faostat/en/#da	nbers in pare statistical sig ompiled by ata/PP	enthesis are stanc mificance at 1% le researcher depen	lard error vel, **significance a ding on e-views, Se	t5% level and * sig e Table A1 in app	gnificance at level 10% level bendix, http://www.fao.org/
	Crop	(Obs* <i>R</i> squared	<i>p</i> -value	F-sta	tistic <i>p</i> -value
	Green beans Potatoes Tomatoes Onion Oranges Grapes Strawberries		0.058240 12.12621 0.058312 1.451642 0.080358 0.237142 0.003756	0.8093 0.0005*** 0.8092 0.2283 0.7768 0.6263 0.9511	0.05 15.64 0.05 1.43 0.07 0.22 0.00	5778 0.8144 726 0.0003*** 5793 0.8144 3777 0.2376 6999 0.7827 8202 0.6352 3415 0.9540
Table 4. ARCH- LM test summary statistics	Note(s): *** Source(s): C faostat/en/#da	indicates sta compiled by ata/PP	atistical significar researcher depen	ce at 1% level ding on e-views, Se	e Table A1 in app	pendix, http://www.fao.org/
		GARCH	(1 1)	GARCH (1 2)	GARCH (21) GARCH (2.2)
Table 5. GARCH model selection	AIC BIC	-0.2337 -0.0778	753 320	-0.191402 0.003515	-0.124254 0.070663	-0.175014 0.058887

- (2) The rewarding prices stimulate agricultural investment which is the main driver for sustainable agricultural development, where increasing investment means adding new production projects that lead to absorption a number of unemployed workers, in addition to increasing production, exports, then improving the trade balance. (Syed and Miyazako, 2013)
- (3) Egypt already has comparative advantage of the selected crops in many foreign markets.
- (4) There are several macroeconomic factors affecting the volatility of food commodity prices that must be taken into consideration such as: productivity, climate change,

	Coefficient	Standard error	z-statistic	Prob	Price volatility
Mean equation Constant	0.093866***	0.020949	4.480667	0.0000	crops
Variance equation					
Constant	0.035902***	0.011137	3.223592	0.0013	
$\text{RESID}(-1)^2$	0.413,469***	0.203434	2.032450	0.0421	129
GARCH(-1)	-0.333,808	0.280911	-1.188305	0.2347	123
ARCH-LM test	,				
F-statistic	1.230710 (0.2732)				
Obs*R-squared	1.251189 (0.2633)				Table 6

Note(s): - Numbers in parenthesis are *p*-value, *** indicates statistical significance at 1% level Source(s): Compiled by researcher depending on e-views, See Table A1 in appendix, http://www.fao.org/ GRACH (1,1) model for faostat/en/#data/PP

Estimation results of potatoes price

year	Green beans	Potatoes	Tomatoes	Onion	Oranges	Grapes	Strawberries
2016	2589.17	2399.156	1556.775	1119.612	1211.640	3340.546	2659.23
2017	2846.429	2635.262	1692.235	1228.461	1333.211	3558.747	2828.75
2018	3129.246	2894.604	1841.824	1347.892	1466.981	3787.247	3009.07
2019	3440.163	3179.468	2002.359	1478.934	1614.175	4026.283	3200.88
2020	3781.972	3492.366	2179.098	1622.717	1776.139	4276.087	3404.93
2021	4157.742	3836.058	2369.286	1780.478	1954.355	4536.884	3621.98
2022	4570.849	4213.572	2578.163	1953.576	2150.455	4808.888	3852.86
2023	5025.001	4628.239	2803.423	2143.504	2366.233	5092.307	4098.47
2024	5524.277	5083.714	3050.339	2351.896	2603.662	5387.339	4359.73
2025	6073.160	5584.013	3317.083	2580.548	2864.917	5694.173	4637.64
2026	6676.579	6133.548	3609.017	2831.430	3152.387	6012.985	4933.27
2027	7339.953	6737.163	3924.832	3106.702	3468.703	6343.945	5247.75
2028	8069.239	7400.182	4270.043	3408.737	3816.759	6687.209	5582.27
2029	8870.985	8128.450	4643.907	3740.135	4199.740	7042.922	5938.11
2030	9752.392	8928.388	5052.167	4103.752	4621.151	7411.219	6316.64
Source http://w	e(s): Calculated l ww.fao.org/faost	oy researcher tat/en/#data/H	depending on o	e-views			

agricultural policy adjustments, large government purchases, and from outside the agricultural sector: exchange rate, variation in oil price and trade policies (El-Rasoul and Tolba, 2018).

Future policy options will concentrate on increasing the efficiency of water usage and (5)keeping the sustainability of both land and water. (Abdou Abdelaal and Thilmany, 2019)

Then forecasting agricultural prices is an essential requirement for decision-makers to develop suitable agricultural policies in both short and long term, in the fields of production, consumption, marketing and trade (Lama et al., 2015; Solanki and Sharma, 2016).

Furthermore, it is also relevant for the private sector to study the differences in price volatility among products for production and marketing decision (Heifner and Kinoshita, 1994; Jordaan et al., 2007). On the other hand, several study results indicated that agricultural price variability has a major impact on food security (El-Rasoul and Tolba, 2018), so it is extremely necessary to provide decision-makers with a database of future agricultural price to deal with any food crisis.

REPS 5. Conclusion

Commodity prices are subject to high degrees of volatility, especially the prices of agricultural commodities. Production decisions and risk-management require the producers, traders and policy-makers to have good knowledge about the trend and reasons of agricultural commodity price volatility (Riazi, 2016).

This study focuses on forecasting the prices of the most important export crops of vegetables and fruits in Egypt using ARIMA model and GARCH model from 2016 to 2030.

The results show that ARIMA (1,1,1), ARIMA (2.1,2), ARIMA (1,1,0) ARIMA (1,1,2), ARIMA (0,1,0) and ARIMA (1,1,1) models are the most appropriate fitted models to evaluate the volatility of price of green beans, tomatoes, onions, oranges, grapes and strawberries, respectively. The results also revealed the presence of ARCH effect only in the case of potatoes, hence it is suggested that the GARCH approach be used instead. The GARCH (1,1) was found to be a better model in forecasting price of potatoes. The results revealed that all the forecasted prices of selected crops will still be increasing in the forecasted period from 2016 to 2030.

We also note that the growth rate of forecasted prices for oranges, green beans, potatoes and onions, respectively is more than the growth rate of other selected crops, so it is expected during the forecast period the production and exports of oranges, green beans, potatoes and onions will increase at increasing rate, and will be more attractive for agricultural producers and exporters compared to tomatoes, grapes and strawberries.

The study recommends more studies in the field of forecasting in terms of prices, production and trade, production costs for other agricultural crops that lead to have a database on the future status of Egyptian agriculture that helps agricultural producers and investors as well as it helps decision-makers in drawing different agricultural policies.

References

- Abdelfattah, S., Baghdadi, S. and Izz al-Din, M. (2015), "Using the dynamic time series models for forecasting the prices of Surge crops in Egypt", Assiut Journal Agricultural Science, Vol. 46 No. 1, pp. 93-107.
- Abdel-Radi, F. and Ahmed, O. (2018), Futures and Spot Prices Nexus of Egyptian Wheat, IAMO forum, Germany.
- Abdou Abdelaal, H. and Thilmany, D. (2019), "Grains production prospects and long run food security in Egypt", Sustainability, Vol. 11 No. 4457, pp. PP1-17.
- Ahmed, O. and Serra, T. (2015), "Economic analysis of the introduction of agricultural revenue insurance contracts in Spain using statistical copulas", *Agricultural Economics*, Vol. 46, pp. 69-79.
- Anggraeni, W., Andri, K.S. and Mahananto, F. (2017), "The performance of ARIMAX model and vector autoregressive (VAR) model in forecasting strategic commodity price in Indonesia", 4th Information Systems International Conference 2017, ISICO 2017, Bali, Indonesia.
- Apergis, N. and Rezitis, A. (2011), "Food price volatility and macroeconomic factors: evidence from GARCH and GARCH-X estimates", *Journal of Agricultural and Applied Economics*, Vol. 43 No. 1, pp. 95-110.
- Badmus, M.A. and Ariyo, O.S. (2011), "Forecasting cultivated areas and production of maize in Nigerian using ARIMA model", Asian Journal of Agricultural Sciences, Vol. 3 No. 3, pp. 171-176.
- Bauwens, L., Laurent, S. and Rombouts, J. (2006), "Multivariate garch models: a survey", *Journal of Applied Econometrics*, Vol. 21 No. 1, pp. 79-109.
- Benavides, G. (2009), "Price volatility forecasts for agricultural commodities: an application of volatility models, option implieds and composite approaches for futures prices of corn and wheat", *Journal of Management, Finance and Economics*, Vol. 3 No. 2, pp. 40-59.

130

8.2

- Bhardwaj, S.P., Paul, R.K., Singh, D.R. and Singh, K.N. (2014), "An empirical investigation of arima and garch models in agricultural price forecasting", *Economic Affairs*, Vol. 59 No. 3, pp. 415-428. Price volatility of some export
- Ceballos, F., Hernandez, M.A., Minot, N. and Robles, M. (2017), "Grain price and volatility transmission from international to domestic markets in developing countries", *World Development*, Vol. 94, pp. 305-320.
- Corrêa, J.M., Neto, A.C., Teixeira, L.A., Franco, E.M.C. and Faria, A.E. (2016), "Time series forecasting with the WARIMAX-GARCH method", *Neurocomputing*, Vol. 216, pp. 805-815.
- El-Rasoul, A. and Tolba, A. (2018), "Economic analysis of price fluctuations of the most important food commodities in Egypt exchange", *Alexandria University*, Vol. 39, pp. 30-45.
- Engle, R. (2001), "GARCH 101: the use of ARCH/GARCH models in applied econometrics", Journal of Economic Perspectives, Vol. 15 No. 4, pp. 157-168.
- Engle, R. (2002), "New frontiers for arch models", *Journal of Applied Econometrics*, Vol. 17 No. 5, pp. 425-446.
- FAO (1987), Agricultural Price Policies: Issues and Proposals, Food and Agriculture Organization of the United Nations, Rome.
- Felis, A. and Garrido, A.(2015), "Market power dynamics and price volatility in markets of fresh fruits and vegetables, ULYSSES 'understanding and coping with food markets volatility towards more stable world and EU food systems", Working Paper No 7.
- Guerard, J. (2013), "An introduction to time series modeling and forecasting", Introduction to Financial Forecasting in Investment Analysis, Springer Science, and Business Media, New York.
- Guerrero, S., Hernández-del-Valle, G. and Juarez-Torres, M. (2017), "Using a functional approach to test trending volatility in the price of Mexican and international agricultural products", *Agricultural Economics*, Vol. 48, pp. 3-13.
- Han, D.B., Jansen, D. and Penson, J.B. (1990), "Variance of agricultural prices, industrial prices, and money", *American Journal of Agricultural Economics*, Vol. 72 No. 4, pp. 1066-1073.
- Haofei, Z., Guoping, X., Fangting, Y. and Han, Y. (2007), "A neural network model based on the multi-stage optimization approach for short-term food price forecasting in China", *Expert Systems with Applications*, Vol. 33, pp. 347-356.
- Heifner, R. and Kinoshita, R. (1994), "Differences among commodities in real price variability and drift", Journal of Agricultural Economics Research, Vol. 45, p. 3.
- Jin, H. J. and Frechette, D.L. (2004), "Fractional integration in agricultural futures price volatilities", American Journal of Agricultural Economics, Vol. 86 No. 2, pp. 432-443.
- Jordaan, H., Grové, B., Jooste, A. and Alemu, Z. (2007), "Measuring the price volatility of certain field crops in South Africa using the ARCH/GARCH approach", Agrekon, Vol. 46 No. 3, pp. 306-322.
- Kamu, A., Ahmed, A. and Yusoff, R. (2010), "Forecasting cocoa bean prices using univariate time series models", *Journal of Arts Science and Commerce*, Vol. 1 No. 1, pp. 71-80.
- Khashei, M. and Hajirahimi, Z. (2017), "Performance evaluation of series and parallel strategies for financial time series forecasting", *Financial Innovation*, Vol. 3 No. 1, pp. P1-P24.
- Lama, A., Jha, G.K., Paul, R.K. and Gurung, B. (2015), "Modeling and forecasting of price volatility: an application of GARCH and EGARCH models", *Agricultural Economics Research Review*, Vol. 28 No. 1, pp. 73-82.
- Lama, A., Jha, G.K., Gurung, B. and Paul, R. (2016), "A comparative study on time-delay neural network and GARCH models for forecasting agricultural commodity price volatility", *Journal* of the Indian Society of Agricultural Statistics, Vol. 70 No. 1, pp. 7-18.

131

crops

REPS 8,2	Li, N., Ker, A., Sam, A. and Aradhyula, S. (2017), "Modeling regime-dependent agricultural commodity price volatilities", <i>Agricultural Economics</i> , Vol. 48, pp. 683-691.
	Luger, R. (2012), "Finite-sample bootstrap inference in GARCH models with heavy-tailed innovations", <i>Computational Statistics and Data Analysis</i> , Vol. 56, pp. 3189-3211.

132

- Ojogho, O. and Egware, R. (2015), "Price generating process and volatility in Nigerian agricultural commodities market", *International Journal of Food and Agricultural Economics*, Vol. 3 No. 4, pp. 55-64.
- Onour, I. and Sergi, B.S. (2011), "Modeling and forecasting volatility in the global food commodity prices", Agricultural Economics – Czech, Vol. 57 No. 3, pp. 132-139.
- O'Connor, D. and Keane, M. (2011), "Empirical issues relating to dairy commodity price volatility", in Piot-Lepetit, I. and M'Barek, R. (Eds), *Methods to Analyse Agricultural Commodity Price Volatility*, Springer New York, Dordrecht Heidelberg London, pp. 63-83.
- Piot-Lepetit, I. and M'Barek, R. (2011), "Methods to analyse agricultural commodity price volatility", in Piot-Lepetit, I. and M'Barek, R. (Eds), Methods to Analyse Agricultural Commodity Price Volatility Springer New York Dordrecht Heidelberg London, pp. 1-11.
- Ramirez, O. and Fadiga, M. (2003), "Forecasting agricultural commodity prices with asymmetricerror GARCH models", *Journal of Agricultural and Resource Economics*, Vol. 28 No. 1, pp. 71-85.
- Riazi, M. (2016), "The economics of price volatility in commodity futures markets: a survey", *Journal of Business Studies*, Faculty of Business Studies University of Rajshahi, Vol. 9, pp. 45-75.
- Sanjuan-Lopez, A. and Dawson, P.J. (2017), "Volatility effects of index trading and spillovers on US agricultural futures markets: a multivariate GARCH approach", *Journal of Agricultural Economics*, Vol. 68 No. 3, pp. 822-838.
- Sedghy, B., Tamini, L. and Lambert, R. (2016), "Supply response of corn farmers in Quebec: analyzing the impact of prices volatility", Center for Research on the economics of the Environment, Agri-food, Transports and Energy, Working Paper: 2016-1.
- Sekhar, C., Roy, D. and Bhatt, Y. (2017), "Food inflation and food price volatility in India trends and determinants", International Food Policy Research Institute (IFPRI), Discussion Paper 01640.
- Sendhil, R., Kar, A., Mathur, V.C. and Jha, G.K. (2014), "Price volatility in agricultural commodity futures-an application of GARCH Model", *Journal of the Indian Society of Agricultural Statistics*, Vol. 68 No. 3, pp. 365-375.
- Siami, S. and Hudson, D. (2017), "Volatility spillover between oil prices, us dollar exchange rates and international agricultural commodities prices", *The 2017 Annual Meeting, Southern Agricultural Economics Association*, Alabama, February 4-7, 2017.
- Sidhoum, A. and Serra, T. (2016), "Volatility spillovers in the Spanish food marketing chain: the case of tomato", Agribusiness, Vol. 32 No. 1, pp. 45-63.
- Solanki, P. and Sharma, M. (2016), "Forecasting of price volatility in cumin using EGARCH model", International Journal of Seed Spices, Vol. 6 No. 2, pp. 96-99.
- Sukati, M.A. (2013), "Measuring maize price volatility in Swaziland using ARCH/GARCH approach", Munich Personal RePEc Archive (MPRA) Paper No. 51840.
- Syed, S. and Miyazako, M. (2013), Investment in Agriculture for Increased Production and Productivity, FAO, Rome.
- Wang, Z., Salin, V., Hooker, N. and Leatham, D. (2002), "Stock market reaction to food recalls: a GARCH application", *Applied Economics Letters*, Vol. 9, pp. 979-987.
- Xiong, T., Li, C., Bao, Y., Hu, Z. and Zhang, L. (2015), "A combination method for interval forecasting of agricultural commodity futures prices", *Knowledge-Based Systems*, Vol. 77, pp. 92-102.

 Xiong, T., Li, C. and Bao, Y. (2018), "Seasonal forecasting of agricultural commodity price using a hybrid STL and ELM method: evidence from the vegetable market in China", <i>Neurocomputing</i>, Vol. 275, pp. 2831-2844. Yang, J., Haigh, M.S. and Leatham, D. (2001), "Agricultural liberalization policy and commodity price volatility", <i>Applied Economic Letters</i>, Vol. 8, pp. 593-598. 	Price volatility of some export crops
Zou, H.F., Xia, G.P., Yang, F.T. and Wang, H.Y. (2007), "An investigation and comparison of artificial neural network and time series models for Chinese food grain price forecasting", <i>Neurocomputing</i> , Vol. 70, pp. 2913-2923.	133

Appendix

The Appendix files are available online for this article.

Corresponding author

Hanan Mahmoud Sayed Agbo can be contacted at: h_anan_mahmoud@cu.edu.eg

For instructions on how to order reprints of this article, please visit our website: www.emeraldgrouppublishing.com/licensing/reprints.htm Or contact us for further details: permissions@emeraldinsight.com