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Empirical Analysis of Assessing the Factors Affecting Grape Supply in Armenia

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ABSTRACT

Grape is one of the strategic commodities for Armenia as it plays an important role in economy. Wine and brandy production volumes display increasing tendencies and it is of high interest what factors influence grape supply and which is the main input for those industries. To achieve this goal an empirical model of grape supply was developed. The analysis revealed that lagged log of average real price of grape, lagged log of average planted area of grape and technology positively affect log of average quantity of the grape supplied in Armenia. The highest positive influence on the regressand had lagged log of average planted area of grapes, as betta coefficient associated with it had the highest value.

Introduction

The relevance of the research is conditioned by the importance of estimation of grape supply and revelation of the factors affecting it, since grape is the main input in winemaking and brandy making industries which are considered to be vitally important branches in the economy of Armenia, estimation of grape and the revelation of the factors affecting grape supply. The research aims to estimate grape supply in Armenia and find out whether theoretical supply factors have significant influence on grape supply in Armenia and to measure their influence. In order to estimate the influence of traditional supply determinants on grape supply regression model was developed. Selection of variables has been based on similar fruit estimation models developed for China and Armenia. Consultation with local field expert has been conducted for in-depth understanding of sector peculiarities. The outcomes of this research can help to identify problems in the supply and make appropriate adjustments in the policy, help grape producers to increase efficiency of their production planning and help insurance companies providing grape insurance to highlight the main factors affecting the grape yield.

Materials and methods

Based on a research done in China to estimate factors affecting grape supply it becomes clear that the supply of grapes has significant connections with its production volume in the previous production cycle, the price of substitute crops, the volume of imports. It was observed that increase of grape supply does not necessarily lead to a fall in price. (WEISONG, et al., 2007)

L. Mamikonyan and G. Sahakyan (2017) in their article of "Implementation of surplus purchase program for grapes in the Republic of Armenia" estimated a simultaneous-equation model for demand and supply for grapes. The estimation results showed that the lagged average real sale price of grapes, the lagged average planted area of grapes and trend variables had positive influence on the average per capita quantity supplied. The lagged average real price of apple, the average real price of nitrogen had adverse impact on the average per capita quantity supply of grapes (Sahakyan, et al., 2017).

Oczkowski investigated premium wine grapes' demand and supply determinants in the warm inland regions of Australia.

Estimation results showed that current own prices, quantity partial adjustment process, time trend and lagged relative prices with regard to non-premium and other premium varieties are important supply determinants. (Oczkowski, 2014).

In order to provide higher precision and take into account local market specifications an interview with a field expert was conducted (Mkrchyan, 2018. - March 13. Grape production in Armenia [Interview]).

Industry overview

Historical evidence indicates that Armenia is one of the oldest countries engaged in wine production and grape cultivation. Currently, there are about 70 grape species with approximately 600 varieties that become the main input in wine production process. The main grape varieties grown in Armenia are Voskehat, Haghtanak, Karmrahyut, etc (IPGRI, 2016). The mountainous Armenia has favorable climate conditions for grape cultivation. Vineyards constitute almost the 17% of total orchard area in Armenia. Most of vineyards are small-scale orchards with less than a hectare planting area. The main grape production regions are Ararat and Armavir provinces with a margin of 88% of total grape production and 73% of total vineyards in Armenia. The total vineyard area and total grape harvest during the 2006-2017 periods were as follows (Statistical Committee of RA, 2017).

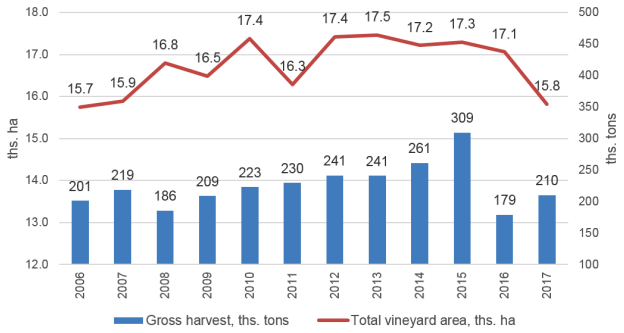

Figure 1. Gross Harvest and Total Vineyard Area

The average productivity of vineyards was on average 13.3 tons per ha in 2017. The regions that had the highest productivity indicators were Ararat and Armavir provinces with correspondingly 20.9 and 14.4 tons of average yield per hectare (Statistical Committee of RA, 2017).

Since grape is the main input for wine and brandy production, most of the harvested grape is obtained and used by the processing companies. Currently, the total number of large and medium companies engaged in wine and brandy production is approximately 90 (Ministry of Agriculture of RA, 2018).

On absolute terms, the total amount of grape used by the processing companies had an increasing trend. However, it is important to notice that from 2015 to 2017 the less portion of harvested grape had been used by the processing companies. This could be due to the increase in the fresh grape export volume or increase in domestic grape consumption by households. The exports and imports of fresh grape during 2013-2017 were shown in Figure 3. Almost 98% of exported grape goes to Russian Federation each year for recent years. (UN Comtrade, 2018).

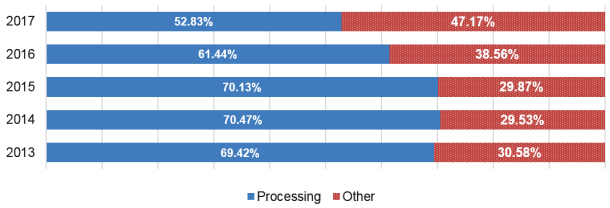

Figure 2. Sales of grape based on the use purpose

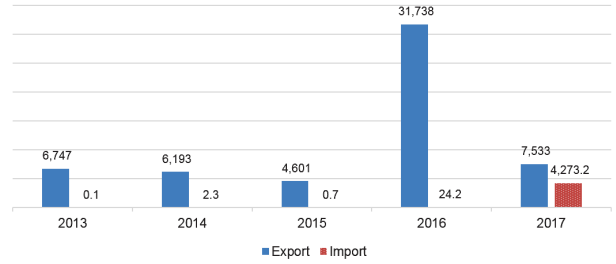

Figure 3. Fresh grape imports and exports, tons

Data Description

Annual time-series data for the period of 2000-2017 were used in this analysis. The dataset consists of the logged average quantity of produced grapes, log of average planted area of grapes, log of average real sale price of grapes, log of real average sale price of apple, log of real average sale price of nitrogen, log of average grape import, artificially created trend variable, which is a proxy for technological developments. The data sources are National Statistical Service (NSS) and the International Monetary Fund (International Monetary Fund, 2018). Prices were adjusted for inflation using producer price index (PPI); the benchmark year in calculation is 2010.

Table 1. Summary Statistics

Variable	Obs.	Unit	Mean	Sd. Dev.	Min	Max
ln_QG_t	18	ths. tons	199.22	64.34	81.6	318.8
ln_A_{t-1}	17	hectares	15,925.35	1,450.64	12,997	17,465
$ln\_rl\_PG_{t-1}$	17	AMD	180.05	44.91	120.05	273.95
$ln\_rl\_PA_{t-1}$	17	AMD	191.88	46.16	117.36	290
$ln\_rl\_PN_{t-1}$	17	AMD	117.47	27.25	73.89	193.65
ln_Import_{t-1}	17	ths. tons	2.606	1.286	0.9	4.6
Technology	18	-	9.5	5.34	1	18

So, we can make the following conclusions:

- The quantity of grapes supplied for the period of 2003 through 2015 displays increasing trend with certain fluctuations. The quantity of grapes supplied sharply decreased in 2016. Mean value of grape supply is 199 thousand tons with sd. deviation of 64.34 thousand tons.
- The planted area of grapes has increasing trend from 2002 to 2011. The area has displayed decreasing trend during the recent 4-5 year. The mean value of this variable is 15,925.35 ha with sd. deviation of 1,450.64 ha.
- Average real sale price of grapes was calculated based on PPI obtained from IMF database. The mean value of the real average grape price is 180.05 AMD/kg with sd. deviation of 44.91.
- Average real sale price of apple was calculated based on PPI. Average real sale price of apple displays decreasing trend during recent 7 year. Mean value of this variable is 191.88 AMD/kg with sd. deviation of 46.16.
- Average real sale price of nitrogen was calculated based on PPI. Mean value of this variable is 117.47 AMD/kg with sd. deviation of 27.25.
- The grape import displays increasing trend over the studied period. Mean value of grape import is 2,606 tons with standard deviation of 1,286 tons.

Empirical Model

Based on MWD test, log linear model was developed to estimate grape supply in Armenia. The logged average quantity of grape supply was observed as the variable dependent on lagged log of average planted area of grapes, lagged log of average real sale price of grapes, lagged log of average real sale price of apple (as the price of a substitute commodity), lagged log of average real price of nitrogen (production input), lagged log of average grape import and artificially created technology variable which is a proxy for technological developments.

$$ln\_QGt = \beta_0 + \beta_1 * ln\_A_{t-1} + \beta_2 * ln\_rl\_PG_{t-1} + \beta_3 * ln\_rl\_PA_{t-1} + \beta_4 * ln\_rl\_PN_{t-1} + \beta_5 * ln\_Import_{t-1} + \beta_6 * Technologyt + u_t$$

Where

- ln_QG_t - the logged average quantity of grape supply in thousand tons in t time period
- ln_A_{t-1} - log of average planted area of grapes in ha in t-1 time period
- $ln\_rl\_PG_{t-1}$ - log of average real sale price of grape in AMD/kg in t-1time period
- $ln\_rl\_PA_{t-1}$ - log of real average sale price of apple in AMD/kg in t-1 time period
- $ln\_rl\_PN_{t-1}$ - log of real average sale price of nitrogen in AMD/kg in t-1 time period
- ln_Import_{t-1} - log of annual import in ths. tons in t-1 time period
- $Technology_t$ - artificially created trend variable which is a proxy for technological developments
- u_t - random error term
- t - time index (2000–2017)

Economic theory suggests that grape supply is Cobweb type of function. Taking this into consideration Akaike values were calculated to understand the lag length to be employed in the model. Calculated Akaike values confirmed the results obtained from the literature review that regressors should be included in the model with 1 lagged value.

The presence of multicollinearity was checked using several tests. Partial correlations between independent variables were calculated. According to this test high partial correlation between lagged log of planted area of grapes and Technology variables gave place to suspect for moderate multicollinearity, which was confirmed by pair-wise correlation results. The VIF values of all regressors are less than 10 and the tolerance values are not close to zero. Therefore, according to rule of thumb we may consider that multicollinearity is not a troublesome problem for this model.

Table 2. Variance Inflation Factor (VIF)

Variable	VIF	1/VIF
ln_A_{t-1}	5.09	0.1965
$ln\_rl\_PG_{t-1}$	4.95	0.2020
$ln\_rl\_PA_{t-1}$	4.45	0.2245
$ln\_rl\_PN_{t-1}$	3.97	0.2516
ln_Import_{t-1}	3.21	0.3116
$Technology_t$	1.85	0.5394
Mean VIF	3.92	

The problem of heteroscedasticity in the error term is mainly observed in cross-sectional data. However, Breusch-Pagan and White tests were conducted to test the error term for the existence of heteroscedasticity. In both cases, we failed to reject H_0: homoscedasticity.

Reset test was conducted to find out if there are omitted variables in the model. there is not enough evidence to state that there are omitted variables in the model.

The results of the autocorrelation tests (graphical, Run's test, Durbin Watson and Breusch Godfrey LM tests) did not provide definite answer. After certain considerations, based on graphical tests it was decided to re-estimate the model with Cochrane-Orcutt iterative procedure.

Results and discussions

Table 3 presents the parameter estimates, standard errors, t statistics, p values, corresponding 95% confidence intervals, R^2 value and F statistic for the supply function. The selected level of significance for this analysis was 10%. The probability of obtaining F statistic greater than 11.46 from the F table was 0.0001. Therefore, we can reject H_0 that all parameter estimates are zero and conclude that parameter estimates are jointly statistically significant at 10% significance level. R squared was 0.873, which means 87.3% of variations in the dependent variable is explained by the model. The model was re-estimated using

Cochrane-Orcutt AR(1) procedure. Coefficient of autocovariance was equal to -0.4.

$$\widehat{ln\_QGt} = -16.104 + 1.917*ln\_A_{t-1} + 0.723*ln\_rl\_PG_{t-1} - 0.188*ln\_rl\_PA_{t-1} - 0.063*ln\_rl\_PN_{t-1} + 0.234*ln\_Import_{t-1} + 0.019*Technology_t$$

Parameter estimates associated with lagged log of average real price of nitrogen and lagged log of grape import were not statistically significant at 10% significance level, however they are left in the model because of right sign. Parameter estimate associated with lagged log of average real price of grape was 0.723 (own price elasticity of supply) and it was statistically significant, meaning that as the lagged average real sale price of grape increases by 1%, on average, grape supply increases by 0.723%, ceteris paribus. The supply of grapes is inelastic. The lagged log of real price of apple is negatively correlated with the dependent variable, meaning that when the lagged real price of apple increases by 1%, on average the grape supply decreases by 0.188%, everything else holds constant. Parameter estimate associated with lagged average planted area of grapes was 1.917 and it was statistically significant. When the lagged planted area of grapes increases by 1%, on average, quantity supplied of grapes increases by 1.917%, ceteris paribus. Parameter estimate associated with proxy variable Technology was 0.019 and it was statistically significant. Technological improvements in each year, on average, contribute 0.019% increase to average quantity of grapes supplied.

Table 3. Estimation results

	Coefficient	Sd. Error	t	P>|t|	Confidence Interval 90%	
Dependent variable is log of average quantity of grapes supplied						
ln_A$_{t-1}$	1.917	0.865	-1.952	***0.079***	0.349	3.485
ln_rl_PG$_{t-1}$	0.723	0.379	2.216	***0.051***	0.036	1.410
ln_rl_PA$_{t-1}$	-0.188	0.380	1.906	***0.086***	-0.877	0.501
ln_rl_PN$_{t-1}$	-0.063	0.255	-0.494	0.632	-0.525	0.398
ln_Import$_{t-1}$	0.234	0.122	-0.249	0.808	0.014	0.454
Technology$_t$	0.019	0.017	1.925	***0.083***	-0.012	0.050
Constant	-16.104	8.249	1.088	0.302	-31.055	-1.153
R^2 = 0.873		R^2 adj = 0.797		F (6, 10) = 11.46 (p-value - 0.0001)		

Conclusion

The aim of this research was to find out how economic supply determinants influence on grape supply in Armenia. Log-log linear equation model was used to estimate the supply function. The parameters of this model were estimated by the OLS method and re-estimated with Cochrane-Orcutt iterative procedure using STATA statistical software. The analysis showed that lagged log of average real price of grape, lagged log of average planted area of grape and technology had positive influence on the grape supply in Armenia. The highest positive influence on the dependent variable had lagged log of average planted area of grapes, as betta coefficient associated with it had the highest value.

Historically winemaking is one of the most important economic sectors of Armenia. As a rule, the government of Armenia pays special attention to the sphere by developing specific policy. The results of the econometric analysis could suggest that government subsidies for fertilizers might neutralize the impact of the latter on grape supply. However, grape prices have the highest impact on the average grape supply. Subsidizing the grape purchase price for grape processors would require significant financing and it hardly could be efficient. Tax advantages granted to grape processing organizations intended to increase their capacities would allow them to produce higher valued products, which would enable processors to pay more for high quality inputs including grapes.

Agricultural market imperfections and data collection methods applied by NSS could cause this outcome. In case of availability of additional micro data, it is recommended to do further research to reveal the influence of certain supply factors such as the number of grape processing firms, investment capacity, related supply taxes and government subsidies suggested by the economic theory on local grape supply.

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