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Exploring the Causal Relationship Among Trout Production, Price and Subsidy in Türkiye

Mehmet AYDOĞAN[1], Orhan GÜNDÜZ[2]
[1,2]Malatya Turgut Ozal University, Faculty of Agriculture, Department of Agricultural Economics, Malatya-Türkiye.
[1]https://orcid.org/0000-0001-8427-5412, [2]https://orcid.org/0000-0002-2357-0802
✉: mehmet.aydogan@ozal.edu.tr

ABSTRACT
Although there have been trout subsidies in Türkiye for many years, the fact that trout production has been below expectations, especially in recent years, has led to the need to investigate the effects of the subsidies. Thus, the present study was conducted to estimate the long-run relationship among trout production, producer price, and subsidy in Türkiye. The time-series data covering 1984-2016 regarding trout production, sales prices, and subsidies were used. The Vector Error Correction Model (VECM) and Granger Causality Analysis were utilized to estimate the time-dependent causality relationship among the variables. The VECM results, which estimate the existence of a long-run relationship among the variables, revealed that 46.8% of the long-run deviations in the price and subsidy variables will be corrected in the next period. The analysis results indicated that sales prices affect trout production negatively in the long term. Granger causality analysis indicated that the prior period values of production and price variables were the reason for the changes in the subsidy variable. In the short-term VECM model, it was revealed that changes in production and prices positively affect the subsidy. A percent increase in production and price increased the subsidy amount by 1.79 and 3.14 percent, respectively. To increase trout production, the current subsidy policy should be revised to improve the infrastructure and capacity of aquaculture farms. Subsidies for the fishery sector should also be increased in real terms to achieve their objectives.

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Türkiye'de Alabalık Üretimi, Fiyatı ve Sübvansiyon Arasındaki Nedensel İlişkinin Araştırılması

ÖZET
Türkiye'de uzun yıllardır alabalık sübvansiyonları olmasına rağmen özellikle son yıllarda alabalık üretiminin beklentilerin altında kalması, sübvansiyonların etkilerinin araştırılması ihtiyacını doğurmuştur. Bu nedenle, bu çalışma Türkiye'de alabalık üretimi, üretici fiyatı ve sübvansiyon arasındaki uzun dönemli ilişkiyi tahmin etmek için yapılmıştır. Alabalık üretimi, satış fiyatları ve sübvansiyonlara ilişkin 1984-2016 yıllarını kapsayan zaman serisi verileri kullanılmıştır. Değişkenler arasındaki zamana bağlı nedensellik ilişkisini tahmin etmek için Vektör Hata Düzeltme Modeli (VECM) ve Granger Nedensellik Analizi kullanılmıştır. Değişkenler arasında uzun dönemli bir ilişkinin varlığını tahmin eden VECM sonuçları, fiyat ve sübvansiyon değişkenlerindeki uzun dönemli sapmaların %46.8'inin önümüzdeki dönemde düzeltileceğini ortaya koymuştur. Analiz sonuçları, satış fiyatlarının uzun vadede alabalık üretimini olumsuz etkilediğini göstermiştir. Granger nedensellik analizi, üretim ve fiyat değişkenlerinin önceki dönem değerlerinin sübvansiyon değişkenindeki değişimlerin nedeni olduğunu göstermiştir. Kısa vadeli VECM modelinde üretim ve fiyatlardaki değişimlerin sübvansiyonu olumlu etkilediği ortaya çıkmıştır. Üretim ve fiyattaki yüzde artış, sübvansiyon miktarını sırasıyla yüzde 1.79 ve yüzde 3.14 artırmaktadır. Alabalık üretimini artırmak için, su ürünleri çiftliklerinin altyapısını ve kapasitesini iyileştirmek için mevcut sübvansiyon politikası revize edilmelidir.

Tarım Ekonomisi

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Alabalık
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Eşbütünleşme
Granger nedensellik
Türkiye

Balıkçılık sektörüne yönelik sübvansiyonlar da amaçlarına ulaşmak için reel olarak artırılmalıdır.

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INTRODUCTION

It has long been recognized that fish and aquatic creatures positively benefit human health and consumer well-being. On the other hand, despite the rapid increase in the world population, the limited increase in the terrestrial production factors, where most food production is provided, increases the demand for fisheries. The supply of fisheries obtained by hunting decreases, and aquaculture products are gradually filling this decreasing gap (Menicou et al., 2010). The Food and Agriculture Organization of the United Nations (FAO) has recently announced that aquaculture is the fastest-growing food production system globally (FAO, 2016). Aquaculture is no longer a recreational activity in the countryside or an activity carried out by small breeders. Nowadays, aquaculture is an important economic sector made by professional managers, scientists, and engineers in modern farms (Nash et al., 2000).

Countries that want to develop the fisheries sector, which has become an important food production sector today, want to get a more significant share from the trade volume created by this sector worldwide, support their fishing sectors. The effects of subsidies are diverse, but they provide cost advantages to producers and increase supply. Diaz (2000) states that subsidies to the fisheries sector negatively affect competition and trade balances by favoring the donor country's producer and trade. The scientific studies showed that when profitability is associated with subsidies in the market situations, it causes the expand investment and creates new enterprises (Bostock et al., 2016; Cisneros-Montemayor et al., 2016; Guillen et al., 2019; Kumar et al., 2019). The studies' common result is that subsidized inputs increase the productivity and the production in the year when the subsidy is utilized. However, subsidy schemes' overall production and welfare effects tend to be lower than initially expected (Jayne et al., 2018).

Recently, to higher production, the governments have increased the fishery subsidies. Subsidies, which increase overfishing and thus the pressure on fish stocks, prevent competition in export, and disrupt market dynamics, are regarded as undesirable subsidies by the European Union (EU) Common Fisheries Policies (EU, 2020). Since 2003, Turkish governments have supported the aquaculture sector to increase production and reduce input costs (MAF, 2019). The improper subsidies provided to the aquaculture sector by Türkiye have been criticized and complained about by some EU countries. On the complaint of Denmark and Spain in 2014 and 2015, respectively, EU Commission launched the countervailing tariffs against the Turkish trout exporters varying between 7% and 9.7%. In the decision of the EU commission, it was argued that the subsidies disrupt the market competition and provide an unfair competitive advantage to aquaculture farms in Türkiye.

The most of the previous studies mainly focused on the effects of subsidies on agricultural outputs, farmer incomes, and economic development (Oyetade et al, 2020; Ali et al., 2020; Georgina et al., 2020; Matchaya, 2020; Orji et al., 2020; Surathkal & Dey, 2020; Leitão & Balogh, 2020). However, the number of studies examining the effects of fishery subsidies on the amount and price of trout production is limited. In addition, there is a negative sense in public and in the reports of various institutions that fisheries subsidies negatively affect competition. On the other hand, there is no scientific evidence that fishery subsidies increase trout production in Türkiye's long term. Thus, the study aimed to determine the long-term causality relationship between trout production amount, trout sales prices, and subsidy values in Türkiye. It was expected that the study results would contribute to close the gap in the similar literature.

The aquaculture in Türkiye began with rainbow trout production in the early 1970s (Üstündağ et al., 2000). In Türkiye, the quantity of farmed trout rose from 990 tonnes in 1986 to 100 thousand tonnes in 2016 (Figure 1). When the changes in the production amount were examined, the trout production increased continuously until 2013; after 2014, the production amount remained flat, at around 105 thousand tones. As the reasons for the decline in trout production in 2013, it can be argued that the demand for trout could not be increased, the real decrease in trout prices due to the continuous increase in the supply in the previous years and recession in the economy (Şen & Rad, 2016).

The varying trout sales prices yearly in Türkiye are presented in Figure 2. In the study, trout prices were converted to US dollars to reflect actual prices. While the trout prices were 5.5 $ kg^{-1} between 1986 and 1992, as a result of the economic crises and the volatility in exchange rates in the country, the sales prices have a fluctuating decline process. The prices of trout became to the lowest level (1.48 $ kg^{-1}) during the economic instability in 2001. They then increased to the level of 3.5 \$ kg^{-1} due to the public supports to the sector. However, trout sales prices remained stable in the following years at 2.50 \$ kg^{-1}.

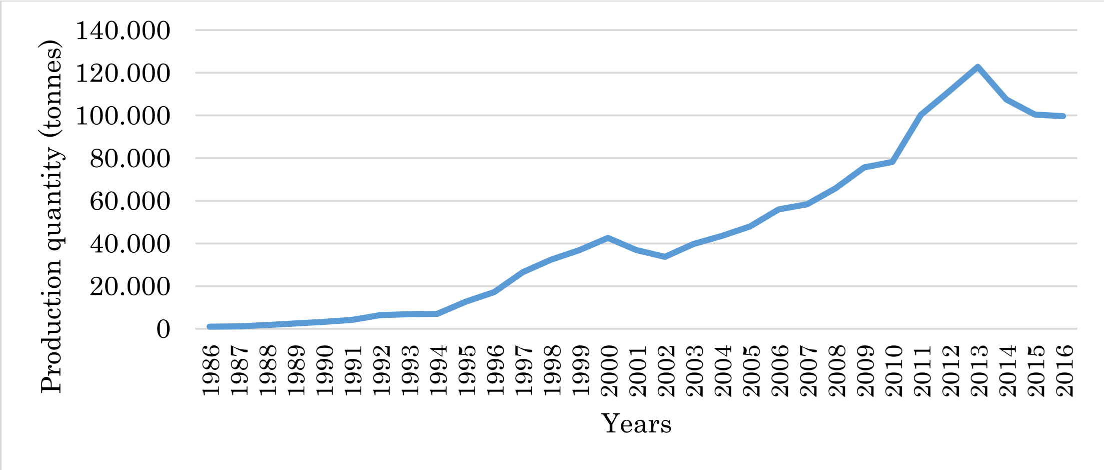

Figure 1. The changes in trout production quantity over the years
Şekil 1. Yıllara göre alabalık üretim miktarındaki değişim

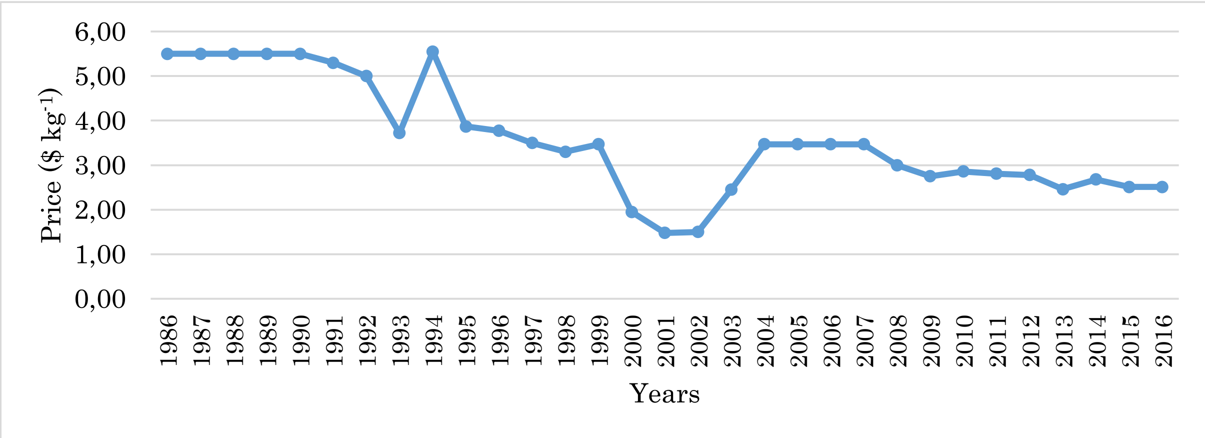

Figure 2. The changes in trout sales prices by years (TurkStat, 2018)
Şekil 2. Yıllara göre alabalık satış fiyatlarındaki değişim

When Figure 3 was investigated, it showed that the growth rate of Türkiye's trout production followed fluctuating progress among the growth rate of trout production was susceptible to political changes. It was observed that the development rate of trout production also decreased during the economic instability of 1994, 2001, and 2008. On the other hand, in 2013, because of adding the new tariffs on trout imported from Türkiye by the European Commission, the trout production growth rate was affected following years.

MATERIALS and METHODS

Data

The time-series data of the trout production amount, unit sales price (\$ tonne-1), and subsidy amount (\$ tonne-1) covering 1984-2016 years were used in the study. The data were obtained from the Ministry of Agriculture and Forestry databases, the General Directorate of Fishery and Aquaculture (BSGM, 2017), and the United Nations Food and Agriculture Organization (FAO, 2017). The subsidy amount series between 1984 and 2002 were accepted as zero because the aquaculture subsidy payment began in 2003 in Türkiye. The researchers calculated the trout unit sales prices by proportioning the total production value (\$) to the production quantities (tonnes) and converted it to US dollars to reflect actual prices.

Method

In the study, the framework model formed by considering the trout production amount as a function of price and subsidy was as follows.

$$LnQ_t = \beta_0 + \beta_1 lnP_t + \beta_1 lnSub_t + u_t \qquad (1)$$

In Eq. (1), Q is trout production amount in tonnes, P is the trout sales price in \$/tonnes, Sub is subsidy amount in \$ tonne^{-1}, *ln* is the natural logarithm, and u_t is the error term.

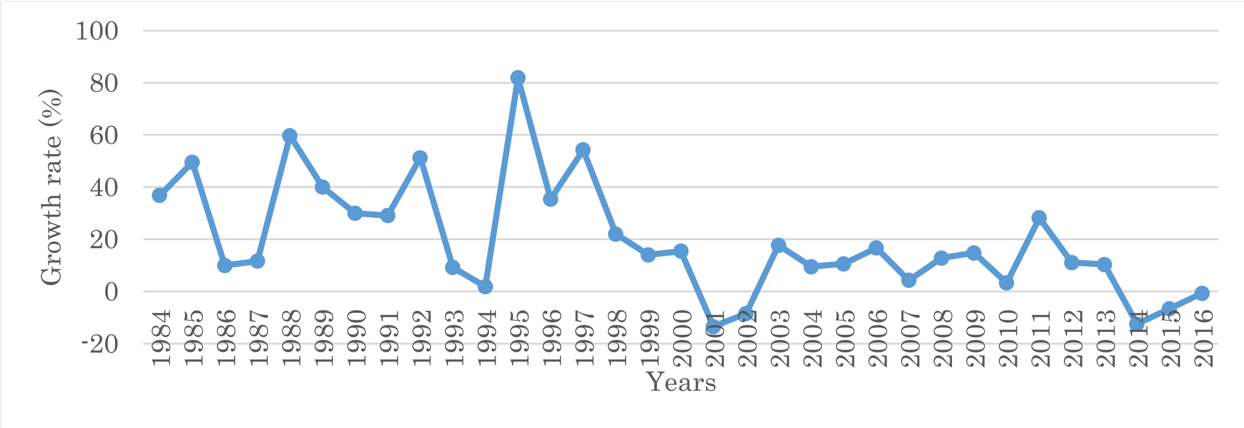

Figure 3. The growth rate of trout production in Türkiye (%)
Şekil 3. Türkiye'de alabalık üretiminin büyüme hızı (%)

Since the literature recommends using logarithmic values as the actual values of the economic variables expressed by time-series do not have a homogeneous distribution, (Işığıçok, 1994) transformed values into natural logarithms of the variables were used in the study.

The use of time series in the further analysis is possible by providing the stationary. The most common tool to detect stationarity in time series variables is the Augmented Dickey-Fuller (hereafter ADF) Unit Root Test (Dickey & Fuller, 1979). In the study, the stationarity of time series was tested with the correlogram and unit root tests. The Augmented Dickey-Fuller method was preferred for the unit root test.

There are three types of equations introduced by yhe Dickey-Fuller;

No constant, no trend Dickey-Fuller eq. : $Y_t = \delta Y_{t-1} + \sum^m \beta_i \, \Delta Y_{t-i} + u_t$ (2)

Constant, no trend Dickey-Fuller eq. : $Y_t = \beta_0 + \delta Y_{t-1} + \sum^m \beta_i \, \Delta Y_{t-i} + u_t$ (3)

Constant and trend Dickey-Fuller eq. : $Y_t = \beta_0 + \beta_t + \delta Y_{t-1} + \sum^m \beta_i \, \Delta Y_{t-i} + u_t$ (4)

In the equations (Eq. 2, Eq. 3, Eq. 4) the existence of unit root is tested by testing whether δ=0. In the equations, *Δ* is the difference operator, *m* is the number of lags. The number of lag to be used in the study was decided according to the Schwarz Information Criterion (SIC) values.

The series' stationarity, whether there is a long-term relationship between them, can be understood through cointegration tests. The cointegration test is used to find a possible correlation between time series processes in the long term. In other words, it can be defined as the joint movement between variables in the long run.

Engle and Granger (1987) reported that if each variable is stationary at the I (1) level, the series's linear compositions may be stationary, although the series is not stationary in terms of level. The study tested the existence and number of cointegration according to two basic statistics (maximum eigenvalue and trace statistics) developed by Johansen (1988, 1991). When at least one cointegration existence is tested between series, it becomes necessary to look for a causality relationship. In this case, since the standard Granger causality inferences based on the VAR model will be invalid, it is appropriate to perform a causality analysis based on the Vector Error Correction Model-VECM (Çetintaş, 2004).

In the study, the trout production quantity (Q), sales prices (P), and subsidy amount (Sub) series were not stationary at the level. However, the series were stationary in the first difference I (1), with at least one cointegration between them. Thus, VECM was used for causality analysis.

The created VECM model to test the short and long-term causality among the study variables was as follows (Engle & Granger, 1987).

With the Eq. (5), three different equations were estimated where every three variables are dependent separately.

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{m} \beta_i \, \Delta Y_{t-i} + \sum_{i=1}^{m} \delta_i \, \Delta X_{1_{t-i}} + \sum_{i=1}^{m} \gamma_i \, \Delta X_{2_{t-i}} + \varphi ECT_{t-i} + u_t \qquad (5)$$

In the study, the direction of causality between variables was predicted by Granger causality analysis based on VECM. The ECT variable in the model is the Error Correction Term. The error correction term (ECT) is used for estimating long-term causality in variables. For the error correction mechanism to function, ECMt−1 must be negative and statistically significant (Badurlar, 2008).

Among the variables with at least one cointegration, the Granger causality analysis created according to VECM was performed with the help of the following equations (Eq.6, Eq.7, Eq. 8).

$$\Delta LnQ_t = \beta_{01} + \sum_{i=1}^{m} \beta_{1i}\,\Delta Q_{t-i} + \sum_{i=1}^{m} \delta_{1i}\,\Delta LnP_{t-i} + \sum_{i=1}^{m} \gamma_{1i}\,\Delta LnSub_{t-i} + \varphi_{1i} ECT_{t-1} + u_{1t} \quad (6)$$

$$\Delta LnP_t = \beta_{02} + \sum_{i=1}^{m} \beta_{2i}\,\Delta LnQ_{t-i} + \sum_{i=1}^{m} \delta_{2i}\,\Delta LnP_{t-i} + \sum_{i=1}^{m} \gamma_{2i}\,\Delta LnSub_{t-i} + \varphi_{2i} ECT_{t-1} + u_{2t} \quad (7)$$

$$\Delta LnSub_t = \beta_{03} + \sum_{i=1}^{m} \beta_{3i}\,\Delta LnQ_{t-i} + \sum_{i=1}^{m} \delta_{3i}\,\Delta LnP_{t-i} + \sum_{i=1}^{m} \gamma_{3i}\,\Delta LnSub_{t-i} + \varphi_{3i} ECT_{t-1} + u_{3t} \quad (8)$$

RESULTS

Unit Root Tests

The stationarity of the trout production (Q), sales price (P) and subsidy (Sub) series were analysed through the correlogram and unit root tests, and the series' level values were not stationary (Figure 4, Figure 5, Figure 6).

The ADF test was applied to determine the presence of Unit Roots in the series, and the results were given in Table 1. For unit root tests, assuming that the series had a deterministic trend, the model with constant and trend was analysed. Then it was shown that the variables had stationarity in I (1).

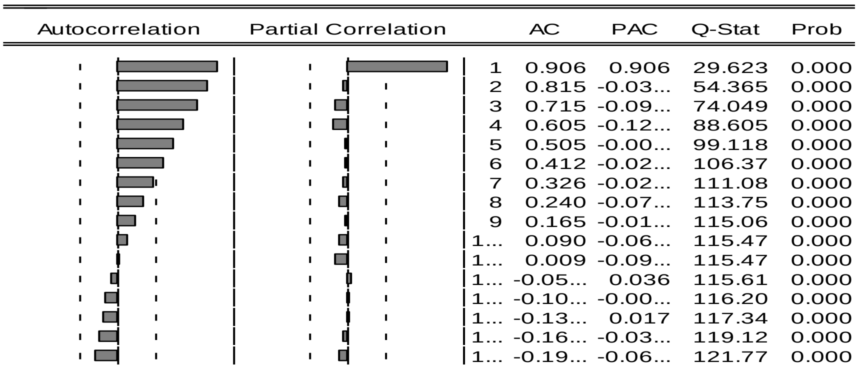

Figure 4. The correlogram of trout production quantity (Q) series
Şekil 4. Alabalık üretim miktarı (Q) serisinin korelogramı

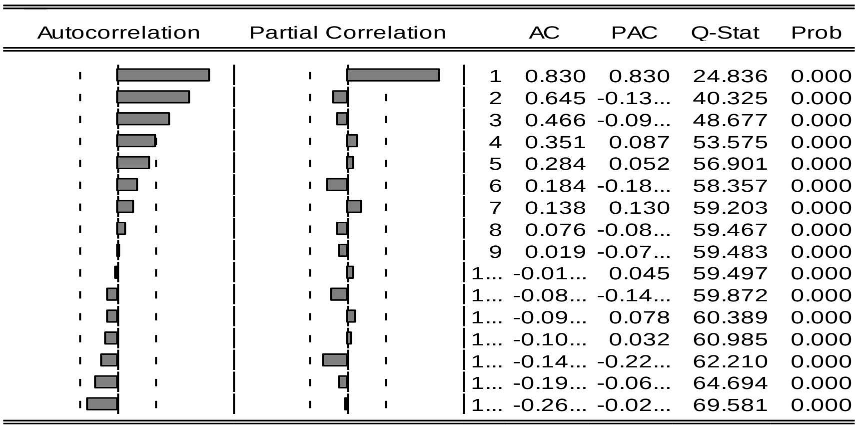

Figure 5. The correlogram of trout sales price (P) series
Şekil 5. Alabalık satış fiyatı (P) serisinin korelogramı

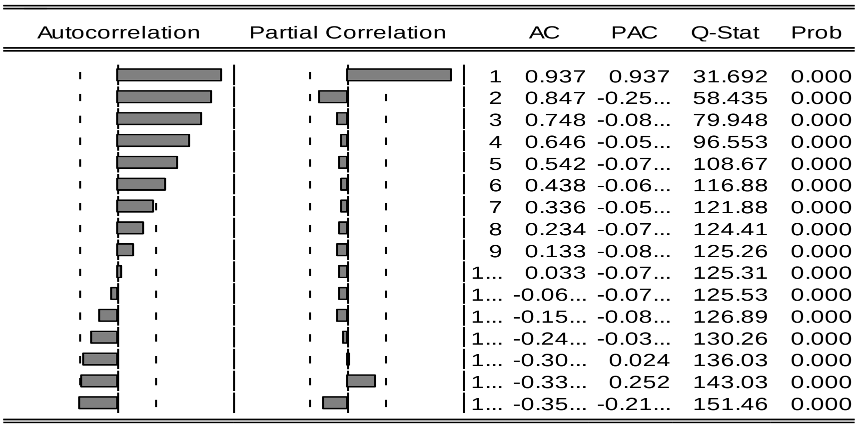

Figure 6. The correlogram of subsidy amount (Sub) series
Şekil 6. Sübvansiyon miktarı (Sub) serisinin korelogramı

Table 1. ADF test statistics
Çizelge 1. ADF test istatistikleri

	Constant and trend model			
	Level		1. Difference	
Variables	t value	Sig.	t value	Sig.
Production quantity (*Q*) (tonnes)	-0.622	0.971	-4.813	0.003***
Producer price (*P*) (\$ tonne^{-1})	-2.148	0.501	-5.100	0.001***
Subsidy amount (*Sub*) (\$ tonne^{-1})	-2.143	0.503	-3.756	0.033***

*, **, *** significant at 10%, 5% and 1%, respectively.

In Table 1, according to the critical values of MacKinnon (1996), all variables had a unit root in their level values and were stationary at the first differences I (1). All variables were stationary at the I (1) level necessitates testing a possible cointegration relationship between them.

Cointegration Test

In the cointegration test, first of all, the lag length should be determined. Schwarz information criterion (SIC) was used to determine the most appropriate lag length, and it was decided to 1 lag length (Table 2).

Table 2. Information criteria showing the optimal number of lags
Çizelge 2. Optimum gecikme sayısını gösteren bilgi kriterleri

The number of lags	SIC
0	7.098
1	***0.681****
2	0.923
3	1.381
4	2.030
5	2.421

SIC: Schwarz information criteria.

In order to select the cointegration model determined for the one lag, five different models were created according to whether the model contains a deterministic trend or not (Table 3). In the study, as the most suitable cointegration model, the cointegration equation with a constant and no trend, which includes a linear deterministic trend, where the Schwarz information criterion (SIC) value was the lowest, was chosen.

When the trace statistics or Maximum eigenvalues are more significant than the critical values, it is assumed that there is cointegration between series. As a result of the Johansen cointegration tests, it can be stated that there was at least one cointegration relationship between trout production (Q), sales price (P), and subsidy amount (Sub).

A cointegration equation with a constant and a linear deterministic trend was created, and the model results were given below (Table 4).

Vector Error Correction Model (VECM)

According to the cointegration test result, a VECM was created to determine the presence of causality and the direction of causality among the variables of production (Q), price (P), and subsidy (Sub). As a result of the model's analysis, the normalized long-term cointegration model emerged as follows.

$$LnQ = 68.316 - \underset{(0.85)}{7.189}LnP + \underset{(0.08)}{0.042}LnSub \quad (9)$$

Eq. (9) reveals that the sales price (P) had a negative effect, and the subsidy amount (Sub) had a positive effect on the production amount (Q) in the long run. While the price (P) variable was statistically significant, the subsidy (Sub) was not. The result of the model can be interpreted as that the trout prices were not satisfactory level for the producers. Therefore, the prices reflected negatively on the production in the long run. On the other hand, although the subsidies (Sub) positively contributed to production, the coefficient of its was estimated as statistically insignificant ($p>0.05$). Due to this finding, it was not interpreted.

The short-term results of VECM analysis were given in Table 5. The ECT variable is the error correction term and gives the correction speed of the short and long-term deviations after a one period.

Table 3. The selection of the cointegration model determined as one lagged
Çizelge 3. Bir gecikmeli olarak belirlenen eşbütünleşme modelinin seçimi

Data trend	Deterministic No trend	Deterministic No trend	Linear Deterministic Trend	Linear Deterministic Trend	Quadratic Deterministic Trend
Cointegration Eq.	No constant No trend	Constant No trend	Constant No trend	Constant Trend	Constant Trend
The number of cointegration	Cointegration model and number according to SIC				
0	1.324	1.324	1.267	1.267	1.370
1	1.217	1.206	***1.099****	1.191	1.186
2	1.612	1.320	1.410	1.583	1.510
3	2.271	1.890	1.890	2.170	2.170

Table 4. The results of Johansen cointegration, trace, and maximum eigenvalue statistics
Çizelge 4. Johansen eşbütünleşme, iz ve maksimum özdeğer istatistiklerinin sonuçları

The number of cointegration	Trace	%5 Critical value	Sig.
1*	42.516	29.797	0.001
2*	16.705	15.495	0.033
3*	5.744	3.841	0.017
The number of cointegration	**Max. Eigen**	**%5 Critical value**	**Sig.**
1*	25.811	21.132	0.010
2	10.961	14.265	0.156
3*	5.744	3.841	0.017

Table 5. The results of VECM model
Çizelge 5. VECM modelinin sonuçları

Error Correction Model	*Δ(LnQ)*	*Δ(LnP)*	*Δ(LnSub)*
ECT_{t-1}	0.007	-0.061	-0.468
	(0.022)[a]	(0.029)	(0.085)
	[0.327[b]	[-2.118]**	[-5.517]***
Δ(LnQ (-1))	0.405	0.160	1.789
	(0.198)	(0.256)	(0.749)
	[2.042]**	[0.624]	[2.389]**
Δ(LnP(-1))	0.555	0.138	3.136
	(0.215)	(0.278)	(0.812)
	[2.581]***	[0.481]	[3.860]***
Δ(LnSub(-1))	-0.089	0.0469	-0.260
	(0.048)	(0.062)	(0.182)
	[-1.851]*	[0.754]	[-1.427]
C	0.115	-0.057	0.0047
	(0.038)	(0.049)	(0.143)
	[3.043]***	[-1.159]	[0.033]
R^2	0.441	0.296	0.613
F	5.154**	2.733	10.2777***

[a]: Values in parentheses are the standard errors, [b]: Values in brackets are the z statistics
*, **, *** significant at 10%, 5% and 1%, respectively.

In the study, VECM was performed with three different models, where each variable was the separately dependent variable, and the coefficients of each model's ECT variable were obtained. Except for the first model, the ECT coefficients were estimated to be negative signed and statistically significant. According to the result of VECM, where production quantity (Q) was the dependent variable, deviations in production amount increase rather than decrease with the effects of the price (P) and subsidy (Sub) variables. However, since this result was statistically insignificant, it can be concluded that the Error Correction Mechanism did not work.

According to the F test result, even if a causality relationship was determined that the price (P) and subsidy amount (Sub) variables may be the cause of the deviations in production amount (Q), although the model had a good fit, since the VECM was not significant, it would be inconvenient to interpret this relationship theoretically.

In the VECM model, where price (P) was the dependent variable, the ECT coefficient was estimated as negative and statistically significant. The result showed that approximately 6% of a deviation in prices (P) would correct after one period. However, the coefficient was close to zero (0), indicating a relatively low balancing speed. Since the F test result of the model was also statistically insignificant, it indicated that a causality relationship could not be established between the deviations in production amount (Q) and subsidy amount (Sub) and price (P) variability.

The F test result of the model in which subsidy amount (Sub) was the dependent variable was statistically significant. The ECT coefficient of the model was negatively signed and statistically significant. The ECT coefficient expresses that 46.8% of the long-term deviations in subsidy amount (Sub) will correct after one period. This result implies that the estimates that producer price (P) and production quantity (Q) may be the cause of changes in subsidy amount (Sub) will be consistent.

When the results of each three models were evaluated separately, it was seen that the lagged values of the other variables affect the short-term variability in the dependent variable. However, some of these effects were statistically insignificant. The residual analysis of the VECM model was tested by autocorrelation LM test and White heteroscedasticity and shown in Table 6.

Table 6. The residual tests of the VECM
Çizelge 6. VECM'nin artık testleri

Lag length	LM Statistics	p value	Heteroscedasticity (White χ^2)	p value
1	9.456	0.396	98.904	0.127

In the residual analyses, to determine whether the estimated VECM model's residuals were auto-related or not, LM statistics showed that residuals were not autocorrelated. To determine whether the residuals' variance was constant for the whole sample, the White Heteroscedasticity test was conducted. In the result of the analysis (χ^2=98.904; p=0.127>0.05), it was determined that the residuals were homoscedasticity.

Granger Causality Test

Based on the VECM results, Wald Block Exogeneity/Granger Causality Analysis was performed to determine the causality, and the direction between variables and the results were given in Table 7.

Table 7. Granger causality analysis results
Çizelge 7. Granger nedensellik analizi sonuçları

Excluded variable	Null Hypothesis (H_0)	Statistics (χ^2)	Sig. level	Decision	Result
		Dependent variable: *Δ(LnQ)*			
Δ(LnP)	*P* doesn't cause *Q*	6.660	0.010	H_0 rejected	*P cause Q*
Δ(LnSub)	*Sub* doesn't cause *Q*	3.426	0.064	H_0 rejected	*Sub cause Q*
As a whole		6.665	0.036	H_0 rejected	
		Dependent variable: *Δ(LnP)*			
Δ(LnQ)	*Q* doesn't cause *P.*	0.389	0.533	H_0 accepted	*Q doesn't cause P.*
Δ(LnSub)	*Sub* doesn't cause *P.*	0.5686	0.451	H_0 accepted	*Sub* doesn't cause *P.*
As a whole		1.694	0.428	H_0 accepted	
		Dependent variable: *Δ(LnSub)*			
Δ(LnQ)	*Q* doesn't cause *Sub.*	5.706	0.017	H_0 rejected	*Q* doesn't cause *Sub.*
Δ(LnP)	*P* doesn't cause *Sub.*	14.897	0.000	H_0 rejected	*P* doesn't cause *Sub.*
As a whole		14.983	0.000	H_0 rejected	

According to the results of the Granger Causality Analysis, both producer price (P) and subsidy amount (Sub) variables were estimated as a Granger cause of production amount (Q) variable. However, in the VECM analysis where the production (Q) was the dependent variable, it was stated that the judgment that the price (P) and subsidy (Sub) variables could be the cause of the production (Q) would not be consistent, since Error Correction Term (ECT) did not have expected sign. Thus, the interpretation of the direction of the result that producer price (P) and subsidy amount (Sub) variables might be a Granger cause of production amount (Q) variable was avoided.

The null hypothesis that trout production amount (Q) and subsidy amount (Sub) could not be considered as causes of price (P) variations was accepted. In this case, it can be concluded that lagged values of production quantities (Q) and unit subsidy amounts (Sub) were not the cause of short-term deviations in-unit trout prices (P). Since the F test result of the model was insignificant in VECM, the justification of the relationship's causality was not discussed.

Thirdly, in the Granger causality analysis, the null hypothesis that the lagged values of the variables trout production amount (Q) and price (P) were not the cause of the deviations in the subsidy amount (Sub) amount was rejected. It means that the production (Q) and price (P) variables were the Granger cause of the subsidy amount variable. The short-term VECM model F test was significant; thus, it was concluded that the changes in production amount (Q) and price (P) positively affected the subsidy amounts (Sub). One per cent increase in production amount (Q) and price (P) increases the subsidy amount (Sub) by 1.79% and 3.14%, respectively.

DISCUSSION

Granger causality analysis has long been used in many scientific studies to determine causality relationships between economic variables. However, causality analysis has a special place in measuring relations between instruments, which have economic value. When the studies in the literature were examined, it was seen that the causality among macroeconomic indicators such as exchange rate, inflation rate, economic growth rate, imports and exports were frequently studied (Aktaş, 2009; Tatlı & Lebe, 2017; Muzammil, 2020; Aluko & Adeyeye, 2020; Umutlu & Bayraç, 2020). Nevertheless, studies examining the causality relationships of agricultural sector variables were more limited. Studies related to the agricultural sector often focused on the causality relationship among macro-level indicators such as fuel prices, electricity consumption, exchange rates, agricultural loans, agricultural products import, exports, and economic growth rates (Oyetade et al., 2020; Ali et al., 2020; Georgina et al., 2020; Matchaya, 2020; Orji et al., 2020; Surathkal & Dey, 2020; Leitão & Balogh, 2020). Another critical issue related to the agricultural sector is the relationship between agricultural subsidies and production (Erdal & Erdal, 2008; Sibande et al., 2017; Nikola et al., 2017; Arisoy, 2020; Othman et al., 2020). These and similar studies focused on the relationship between public expenditures and the agricultural production amount. Although the number of causality studies carried out in the fisheries sector is quite limited, price pass-throughs (Bayramoğlu, 2019; Thong et al., 2020), fish production amount, import-export, and economic (Nguyen & Jolly, 2013; Oyakhilomen & Zibah, 2013) growth rates according to production methods have been frequently studied. However, there were very few studies dealing with the causality relation of price, subsidy, and production amount based on species in the fishery sector. This study examined the causality relationship between trout production amount, trout sales price, and subsidy amount to fill this gap in the literature. VECM and Granger causality analyses were used to determine the extent of causality.

In the study, it was determined that trout sales prices have a negative effect on trout production in the long term. The studies on the relationship between the production amount and the price of agricultural products indicate whether the causality relationship is positive or negative and may differ according to product groups. Xie and Wang (2017) stated that the amount of grain production in China was affected by grain prices and that the change in the price of grains was the Granger cause of the change in grain production. The authors argued a negative causality between prices and production in the short run and a positive causality in the long run. According to Zhan et al. (2008), the increase in China's grain prices caused farmers to increase their grain production. Okumuş (2012) emphasized that the previous year's price in the market determines the cotton production amount. Sun and Yu (1999) found that the grain purchase price effect on the production amount is more significant than retail prices. Wen et al. (2015) stated that prices were affected by the amount of production, labour prices, and inflation rates and national policies.

On the other hand, Qian et al. (2015) argued that the production amount may not result from changes in prices and that production may negatively affect prices. Semerci et al. (2012) found no relationship between the sales price of sunflower and the production amount, which supports the suggestions of Qian et al. (2015). Hüsnüoğlu (2018) stated that a 1% increase in hazelnut production in the long term reduces the hazelnut price by 1.62%. The positive or negative relationship between production quantity and price is not only limited to crop production but also differences are observed in animal production. According to Öztürk and Baysan (2021), meat prices were the reason for meat production, while according to Çelik (2018), there was a negative relationship between milk production amounts and milk price in the long term.

As can be seen, the causality relationship between the production amount and prices of agricultural products may result differently depending on many factors. One of these differences is the argument that the production amount is not only be affected by domestic prices. Sekhar (2003) argued that the international agricultural product price cycle's impact on production decisions was longer than the domestic agricultural product price cycle. Bayramoğlu and Yurtkur (2015) implied that import pressure on Türkiye's agricultural production and food prices. In countries with less developed market infrastructure, agricultural and food products are affected by exchange rates in the short term and oil and international prices in the long term. As a result, it can be inferred that producers can take foreign prices as a reference instead of domestic prices in their production decisions. Another issue is frequent fluctuations in agricultural products' prices (Munir & Esteban, 2011), and unstable prices are not taken as a reference by producers making production planning. Therefore, it can be concluded that a general causality relationship cannot be established between the amount of production and price in agricultural products where price stability cannot be achieved and that the direction of causality between the amount of production and price should be evaluated separately for each product. The research findings were compatible with the studies in the literature. In the research area, it can be concluded that the trout prices are not realized at a satisfactory level for the trout farms, and therefore the prices have negative effects on the production in the long term.

The study determined that 46.8% of the long-term deviations in the subsidy variable were corrected after one period. It was also determined that the production amount and the sales price were the Granger cause for the support. In other words, the amount of production and changes in price affected the amount of subsidy positively. Many studies in the literature examined the relationship between production quantity, product price, and support amount. Demirdöğen (2020) emphasized that the primary approach of agricultural support policies in Türkiye was to increase production, and the number of studies investigating the effects of supports was insufficient. Therefore, it can be deduced from the study of Demirdöğen (2020) that production is a reason for the changes in subsidies. However, it is seen that the results of studies on this subject in the literature differ. Koç and İşlek (2020) determined a two-way causal relationship between agricultural subsidies and agricultural production in China and Türkiye, a one-way causal relationship from agricultural support to agricultural production in Brazil and Russia, and a causal relationship between agricultural production and agricultural support in South Africa.

Nevertheless, they found that there was no causal relationship between these two variables in India. Qian et al. (2015) stated a positive effect between cereals subsidies and grain prices in China and those subsidies contribute to an increase in grain market prices. Aktaş et al. (2015) argued that market price support and input support affected production, but this support negatively affected production in developing countries. Işık and Bilgin (2016) indicated that, in general, agricultural supports positively affected agricultural production, and the effect of market price support on agricultural production was higher than other agricultural supports. However, this finding also indicates that not all agricultural subsidies have the same positive effect on production. Erdal and Erdal (2008) stated no causal relationship between cotton, sunflower, and soybean production and support, whereas there was a two-way relationship between corn production and premium payment. Erdal et al. (2019) determined that the amount of sunflower production was not affected by the change in support. Trendov et al. (2017), Yılmaz and Yaşar (2020) stated a positive relationship between the amount of meat production and the price and a negative relationship with the amount of support.

Similarly, Si (2015) stated that subsidies negatively affect wheat production. On the other hand, Li (2011) emphasized the supply-increasing and cost-increasing features of agricultural subsidies. As seen in the previous studies, the causal relationship between agricultural subsidies, production amount, and product prices may vary depending on the type of subsidies and the nature of the products supported. In general, there is an intense opinion that the supports have positive effects on farmer incomes and economic development (Terin et al., 2014; Shen, 2019; Binuomote and Odeniyi, 2016; Yıldız, 2017; Othman et al., 2020). In contrast, in some studies (Hossain, 2012; Wang et al., 2012; Şaşmaz & Özel, 2019; Trendov et al., 2017; Sakai et al., 2019), the positive effect of agricultural supports is short-term, and the effects of the supports have a negative effect on the production amount and product prices due to the higher economic and social costs in the long term. In common sense, it is expected that the subsidies affect the production amount and the product price. Nevertheless, research findings suggest the opposite of this judgment. The amount of fisheries subsidy in Türkiye is a result of changes in the price and production quantity. The research findings support Trendov et al. (2017)'s finding that agricultural subsidies were not adequately planned for agricultural development in developing and middle-income countries.

CONCLUSION

The basic approach of agricultural subsidy policies in Türkiye is to increase production amount. However, it may not always be correct to expect an increase in production only through subsidies. The research findings concluded that the fishery subsidies are not the reason for the changes in trout production amount in the long term in Türkiye. As the reason for this consequence, it could be put forward that supplying feeds, medicines, and vaccines used in fish farming from abroad, the high volatility in exchange rates, and export-oriented production eliminate the production and price regulation effects of subsidies. Another reason for this negativity is that although the fisheries subsidy amount increased relatively over the years, it has decreased in real terms. Thus, it can be inferred that the subsidy policy for trout farming is inefficient in Türkiye. The aquaculture subsidy policies in Türkiye are executed for fulfilling rituals and political purposes.

Finally, based on the research findings, to increase trout production, the current subsidy policy should be revised to improve the infrastructure and capacity of aquaculture farms. For subsidy policies to achieve their objectives, fishery subsidies amount should also be increased in real terms.

Contribution of the Authors

Authors declares the contribution of the authors is equal.

Statement of Conflict of Interest

Authors have declared no conflict of interest.

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