Determinants of Cotton Prices in Turkey:
A VAR Approach

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Abstract

The study estimates a dynamic vector autoregressive (VAR) model for cotton market prices in Turkey, considering the changes in policies and the market factors. VAR model consists of the annual data for the period between 1960 and 2010. In the cotton pricing model, the domestic stock-to-use ratio and stock-to-use ratio of the two competitive countries in Turkey's cotton market (USA and Greece) are employed so as to obtain the effects of supply and demand factors. In the model, two dummy variables are used in an attempt to determine the effect of government support programs and 1973 oil crisis. The model led us to the result that government support programs do not have an effect on the determination of cotton market prices, and that the oil crisis of 1973 caused a structural change in cotton prices. Cotton price has a causal effect on the stock-to-use ratio of the two competitive countries (USA and Greece) and the domestic stock-to-use ratio. Additionally, there exists a unidirectional causality from the stock-to-use ratio of the two competitive countries to domestic stock-to-use ratio. Cotton price has an indirect causal effect on the domestic stock-to-use ratio.

Key Words: Cotton, stock-to-use ratio, causality test, vector autoregressive.

Türkiye Pamuk Fiyatlarını Belirleyici Faktörler:

Vektör Otoregressif Yaklaşım

Özet

Çalışmada, Türkiye kütlü pamuk fiyatları için politika çerçevesindeki değişiklikleri ve pazar faktörlerini dikkate alan dinamik vektör otoregressif model tahmin edilmiştir. VAR model, 1960-2010 dönemini kapsayan yıllık verileri içermektedir. Kütlü pamuk fiyatının belirlenmesinde, arz ve talep faktörlerinin etkisini elde etmek için yurtiçi stok kullanım oranı ve Türkiye pamuk piyasasında rekabetçi iki ülkenin stok kullanım oranı(USA ve Greece) değişkenleri kullanılmıştır. VAR modelinde devlet destekleme politikasındaki değişikliğin ve 1973 petrol krizinin etkisini belirlemek için iki kukla değişkeni kullanılmıştır. Kütlü pamuk fiyatları üzerinde devlet destekleme politikasındaki değişikliğin önemli bir etkisi olmadığı sonucuna varılmıştır. Dünya 1973 petrol krizinin pamuk fiyatlarında yapısal değişime neden olduğu belirlenmiştir. Pamuk fiyatı ile iki rekabetçi ülkenin stok kullanım oranı ve yurtiçi stok kullanım oranı arasında ileriye doğru tek yönlü nedensellik vardır. Ayrıca, iki rekabetçi ülkenin stok kullanım oranından yurtiçi stok kullanım oranına doğru tek yönlü bir nedensellik vardır. Pamuk fiyatı ve yurtiçi stok kullanım oranı arasında ise dolaylı nedensellik ilişkisi vardır.

Anahtar Kelimeler: Pamuk, stok kullanım oranı, nedensellik testi, vektör otoregressif.

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1. Introduction

Cotton is a significant source of income in Turkey, considering its direct and indirect contributions to the employment in Turkish economy. On the other hand, its contributions to the food and textile industries as a raw material are quite important. Turkey intends to meet a part of its vegetable oil deficit with the cotton oil obtained from cotton seed. Textile industry constitutes 8% of the national income, 16% of the industrial employment and 18% of the whole exports, and continues to be one of the most critical sectors of the Turkish economy (TUIK, 2012). With a cotton production of 900 thousand tons, Turkey ranks the sixth among the cotton-producing countries in the world. However, since the farmers have recently turned towards alternative products, a significant decline is being experienced in cultivation area and production. Domestic cotton production is insufficient to meet the increasing demand of the expanding textile industry, which makes Turkey the second largest importer following China (FAO, 2012). In Turkey, while the textile industry was being developed, raw material procurement was ignored and stable cotton production and foreign trade policies were not implemented. When the Agricultural Reform Implementation Project, which is financed by the economic reform loans of IMF, was approved in 2000, the price support policy was given up and direct income and premium subsidy policy was adopted. The goal of this policy change was to ensure the cotton prices to be determined within the framework of the market mechanism and to pave the way for the cotton prices in Turkey to be formed by the conditions of demand and supply in the world.

Production, imports and stocks carried over from the previous year constitute the cotton supply. Direct price support policy through the purchases made by Agricultural Sale Cooperatives brought about excess supply in the previous production seasons. While the share of Agricultural Sale Cooperatives in cotton purchase was 25% in 1998 after the direct price support practice was terminated in 1994, it fell to 17% in 2004, 9% in 2008 and 2.8% in 2009. Cotton production is the major element of the cotton supply. Despite the increasing productivity in Turkey, the cotton production fell approximately by 50% in the past five years due to the decrease in cultivated area. Cotton production was reduced to a more critical level due to reasons such as high cotton production costs in Turkey, disadvantageous position of subsidy premiums compared to rival countries, the failure to compete with world prices in consequence of policies implemented by countries such as the US, and cultivation of other alternative products in cotton cultivation areas. A Cotton import has been quite significant in the aggregate supply in the recent years. Turkey has become the second largest importer of cotton owing to the customs exemption applied as from the early 1990s. Turkey meets 80% of its cotton import demand from two competitive countries, Greece and USA.

Major items of cotton demand are textile industry consumption, exports and carry-over stocks. Domestic consumption increases on a continuous basis with the increasing demand of the textile industry. Having been a cotton exporter until 1990, Turkey turned into a cotton importer as the increase in cotton consumption could not be met by the increase in domestic production. A Cotton export corresponds to 4% of the total consumption of cotton. Cotton exports fell in parallel to the decrease in production. Carry-over stocks are inversely associated with marketing year prices. As the total consumption is higher than supply in Turkey, ending stocks decrease and producer prices increase. Since Turkey met the increasing demand of the textile sector through imports, it increased its cotton stocks after 1997/98. The major reason for the increase in stocks was that foreign cotton prices were lower than the domestic cotton prices.

The general framework used by Labys (1973) while relating ending stocks with prices is the equilibrium model of a competitive market with

stocks. For commodities produced annually, such as cotton, supply is a function of the previous year's price. Demand is a function of today's and previous year's prices. A stock is a function of other factors (storage cost, etc.) and price. Equilibrium price (market clearing price) is set at the price where the supply equals to demand and stocks. In equilibrium, prices can be determined from the inverse of the stocks function. This provides a price determination equation, with prices negatively related to stocks.

Westcott and Hoffman (1999) state that the factors affecting supply and demand are generally explained by the stock-to-use ratio. Stocks are employed to make adjustments against the shocks in supply and demand. Stocks decrease in the face of undesired production shocks and the accompanying higher prices. When the production increases and prices fall, stocks will increase. The aggregate use, which consists of the domestic consumption and exports, is generally more stable and tends to change gradually in time. Thus, supply and demand factors are determined simultaneously with prices. In their study, Westcott and Hoffman (1999) estimated the corn and wheat price models by using the stock-to-use ratio and variables representing the changes in the political regime. Among other studies, Van Meir *et al*. (1983) and Baker & Menzei (1988) analyzed the relations between the stock-to-use ratio and prices.

Goodwin *et al*. (2005) expresses that price adjusts to the realization of the supply and changes in the total use. There is a potential for simultaneity between total use and prices. Stocks and total use are jointly determined with prices. In the reduced model where the price is a dependent variable, the presence of the stock-to-use variable may lead to simultaneity biases.

It is necessary to examine the effect of political changes and other conditions in the market to grasp the factors playing a role in the determination of cotton prices. Thus, this study briefly defines the factors that are deemed to be relevant with price determination in the cotton

market in Turkey and estimates the vector autoregressive model of the cotton price determinants.

2. Materials and Methods
2.1. Empirical Model
Since the stock-to-use ratio and price variables are interrelated as confirmed by previous studies, this study utilizes Vector Autoregressive (VAR) model based on simultaneous equations system. VAR is generally used to estimate interrelated time series. This model developed by Sims (1980) is appropriate to analyze the joint linear dynamics in a system. Moreover, simultaneous equations system eliminates the bias problem. Each endogenous variable in the system within the VAR model are regressed with its own lagged or past values and lagged values of all other endogenous variables in the model. The mathematical representation of a VAR is $y_t = A_1 \, y_{t-1} + \cdots + A_p y_{t-p} + BX_t + \varepsilon_t$ here y_t is a k vector of endogenous variables, x_t is a d vector of exogenous variables, $A_1, \dots A_p$ and B are vectors of coefficients to be estimated and ε_t is a vector of error terms that may be contemporaneously correlated but are uncorrelated with their own lagged values uncorrelated with all the right-hand side variables.

Domestic stock-to-use ratio and stock-to-use ratio of the two competitive countries (USA and Greece) in Turkey's cotton market, which reflect the impact of supply and demand factors, have an effect on the determination of cotton market prices. It is expected that cotton price is inversely related to the stock-to-use ratio of two competitive countries. As long as the domestic cotton price is high, the stock-to-use ratio of the two competitive countries decreases due to imports. Liberalization policies in the domestic cotton market have made the cotton supply dependent to foreign sources. Thus, domestic cotton stock-to-use ratio and stock-to-use ratio of the two competitive countries are expected to have an

inverse relationship. It is expected that the change in the government support policy and the oil crisis in 1973 had an effect on the determination of the cotton price (Table 1).

Table 1. Definitions of the variables in the VAR model

LnP_t	Average real price in the cotton production season in year t in logarithmic form
$LnKU_t$	Domestic cotton stock-to-use ratio in year t in logarithmic form
$LnCKCU_t$	Stock-to-use ratio of the two competitive countries in year t in logarithmic form
DP	Dummy variable equals to 1 in years when the government support policy was changed (1993, 1998-2010) and to 0 in the remaining years
D_{73}	Dummy variable equals to 1 in the year when the world oil crisis broke out and to 0 in the remaining years

2.2. Data and Unit Root Tests

The variables in the VAR model consist of the annual data for the period between 1960 and 2010 and they are shown in Figure 1 below. Cotton stock-to-use ratio of the countries was obtained from USDA Cotton and Wool Yearbook Report (2010). Cotton prices were compiled from the publications of the Turkish Statistical Institute (TUIK, 2012). Changes in the political regime were identified making use of the Annual Cotton Report of the Ministry of Industry and Trade (2010). Validity of the VAR analysis depends on the stationary of the time series. Therefore, stationary information is needed for the variables in the VAR model. For stationary, Augmented Dickey-Fuller Test (Dickey and Fuller, 1979) (ADF) and LM unit root test were carried out. ADF unit root test demonstrated that $LnKU_t$ and $LnCKCU_t$ variables are stationary, whereas the cotton market price is not. In some cases, when structural changes are not taken into account, a variable may seem difference-stationary, whereas when structural changes are taken into account, it may be level-stationary. Thus, LM unit root test with single and double breaking points was carried out, which was developed by Lee and Strazicich (2001,2003) and in which structural breaks are determined endogenously. This unit root test indicated that LnP_t variable underwent a structural change in 1973 and was stationary. The oil crisis of 1973 led to the increase in the cotton prices (Figure 1).

Figure 1. VAR model time series

3. Results and Discussion
3.1. Granger Causality Tests

In an attempt to determine the direction of short-term dynamic relation between the variables in the cotton pricing model, Granger (1969) causality test was conducted. Results of the Granger causality test may be used to determine the direction of the cause-effect relationship, that is, the sequence of the variables in the VAR model. Testing the Granger causality in a VAR framework comes down to a joint test for coefficients to be equal to zero. F or Wald test is applied to determine whether the coefficients are significant or not.

Results of the Granger causality test are given in Table 2. In this table, a represents significance level of 10%. According to the results of the causality test, there exists a forward unidirectional causality between the cotton price and stock-to-use ratio of the two competitive countries and domestic stock-to-use ratio. In addition, there exists a unidirectional causality from stock-to-use ratio of the two competitive countries and domestic stock-to-use ratio. Cotton price and domestic stock-to-use ratio have an indirect causality relationship.

On the grounds that domestic cotton prices are higher than foreign cotton prices and imports are permitted, stock-to-use ratio of the two competitive countries is affected. The stock-to-use ratio of the two competitive countries has a causal effect on the domestic stock-to-use ratio because of the imports.

Table 2. Pairwise Granger causality tests (1 lag and 50 observations)

Null Hypothesis:	F-Statistic	Prob.
$LnCKCU_t$ does not Granger Cause LnP_t	2.48	0.12
LnP_t does not Granger Cause $LnCKCU_t$	3.74	0.06[a]
$LnKU_t$ does not Granger Cause LnP_t	1.24	0.27
LnP_t does not Granger Cause $LnKU_t$	5.11	0.03[a]
$LnKU_t$ does not Granger Cause $LnCKCU_t$	0.11	0.75
$LnCKCU_t$ does not Granger Cause $LnKU_t$	3.00	0.08[a]

`* a denotes significance at a 10 per cent level`

3.2. VAR Estimation

Prior to estimating a VAR model, one needs to determine an appropriate number of lags. There are numerous information criteria employed to determine the number of lags. Akaike information criterion, Schwarz information criterion and final prediction error are among the most commonly used ones Enders (2010). All information criteria indicate that optimum number of lags for VAR model is 1.

In addition to the individual unit root test for LnP_t, $LnKU_t$ and $LnCKCU_t$ variables, VAR should be tested for stationarity as well. If VAR is not stationary, some results such as impulse-response standard errors would not be valid. Following Lütkepohl and Reimers (1992), the inverse roots of the characteristics AR polynomial should have modulus less than one and lie inside the unity circle. The AR roots in this case are all less than one; thus the estimated VAR is stable. The sequence of variables is important in the estimation of the VAR model. In line with the results of Granger causality test, cotton price (LnP_t) was determined as the exogenous variable. VAR model can be estimated in the order LnP_t, $LnCKCU_t$ and $LnKU_t$. Apart from these variables, the dummy variables that represent the structural break caused by the oil crisis of 1973 (D_{1973}), and the years when the government support policy was changed were included in the VAR model.

. Table 3. VAR estimates

Variables	LnP_{t-1}	$LnCKCU_{t-1}$	$LnKU_{t-1}$	D_{1973}	DP	R^2
LnP_t	0.74(8.76)	-0.13(-2.58)	0.11(2.16)	0.60(2.86)	0.01(0.02)	0.82
$LnCKCU_t$	-0.41(-2.22)	0.67(5.97)	0.31(2.79)	-0.06(-0.14)	-0.14(-0.86)	0.38
$LnKU_t$	0.21(0.93)	0.32(2.29)	0.63(4.49)	0.98(1.71)	0.31(1.58)	0.11

* values inside the brackets represent t statistics
.

Table 3 shows the variable coefficients and significant levels of the estimated VAR model without intercept. When the VAR model was estimated, the dummy variable DP was found to be insignificant. Domestic stock-to-use ratio is not affected by the cotton prices of the previous

year. The world oil crisis had an effect on the cotton price and domestic stock-to-use ratio, but had no effect on the stock-to-use ratio of the two competitive countries.

3.3. Impulse Response Functions

Impulse-response function enables us to see the impact of a one standard deviation shock in the innovations of all endogenous variables in the VAR model on the present and future values of each variable in the system. Due to the nature of dynamic VAR model, a shock given to a variable will directly affect not only that variable, but also all other variables in the VAR model. In obtaining impulse-response functions, Choleski decomposition is used to orthogonalize the innovations. The impulse responses are sensitive to the ordering of variables. Figure 2 indicates the combined response of the variables in the system against a one standard deviation shock in the innovation. It is observed that impulse-response coefficients do not converge to zero in 25 years, but tail off and become zero after a long time. This demonstrates that the estimated model is stable and there exists causality between the variables in the system in the long-term.

Cotton price reacts to a shock in the stock-to-use ratio of the two competitive countries and domestic stock-to-use ratio. While the impact of a shock in the domestic stock-to-use ratio is positive up to the eleventh year, it becomes negative subsequently. The impact of the shock brings forth the maximum response in the cotton prices three years after the shock, and afterwards it diminishes over time. The impact of a shock in the stock-to-use ratio of the two competitive countries brings forth the maximum response in the cotton prices three years after the shock, and subsequently diminishes over time and disappears in the long-term.

The stock-to-use ratio of the two competitive countries reacts to a shock in the domestic stock-to-use ratio and cotton price. The impact of the shock in the domestic stock-to-use ratio brings forth the maximum response in the stock-to-use ratio of the two competitive countries three years after the shock, and subsequently the positive impact of the shock diminishes over time. The shock impact of 0.08% change in the cotton price brings forth the minimum response in the stock-to-use ratio of the two competitive countries eight years after the shock, and subsequently the negative impact of the shock diminishes over time and disappears.
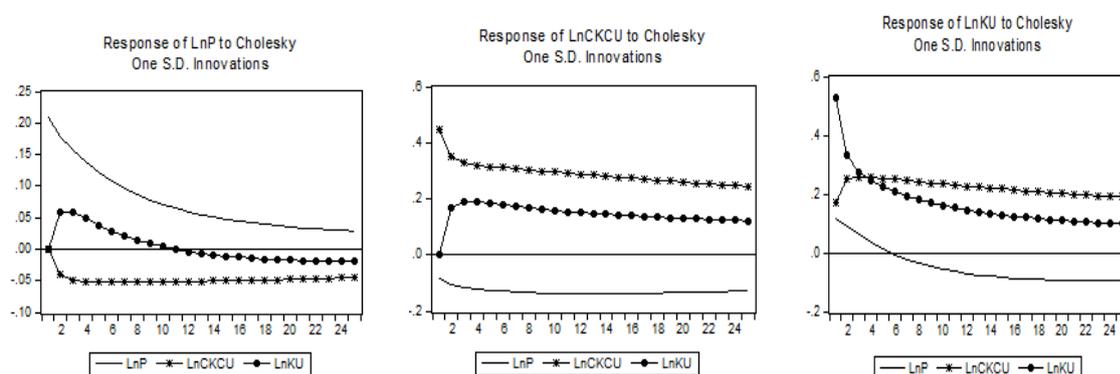
Figure 2. Impulse-response functions

Domestic stock-to-use ratio reacts to a shock in the cotton prices. The impact of the shock is positive up to the sixth year, and subsequently becomes negative. The shock impact of 0.11% change in the cotton prices brings forth the minimum response in the domestic stock-to-use ratio 20 years after the shock, and subsequently the negative impact of the shock diminishes and

disappears in the long-term. The shock impact of 0.17% change in the stock-to-use ratio of the two competitive countries brings forth the maximum response in the domestic stock-to-use ratio 3 years after the shock. The positive impact of the shock diminished after the third year.

3.4. Variance Decompositions

One of the alternative ways of evaluating the estimator qualities of the VAR model is forecast error variance decomposition. With forecast error variance decomposition, relative importance of random shocks can be seen better. Like the results of impulse-response functions, the results of variance decomposition as well are sensitive to the sequence of the variables in the system. A similar sequence was used in the variance decomposition analysis as well. Figure 3 shows the forecast error variance decompositions for the period of 25 years.

Majority of the forecast error variance of cotton price and stock-to-use ratio of the two competitive countries is explained by the innovations they have. While cotton price is affected by the innovations in the stock-to-use ratio of the two competitive countries by 21% in the 25th year, domestic stock-to-use ratio is affected by a lower percentage. 68% of the forecast error variance of stock-to-use ratio of the two competitive countries can be explained by itself and this percentage continues to diminish after the 23rd year. In the 23rd year, 13% of its variance can be explained by the innovations in the cotton price, whereas 17% bythose in the domestic stock-to-use ratio. Forecast error variance of domestic stock-to-use ratio is substantially explained by the innovations in the stock-to-use ratio of the two competitive countries.
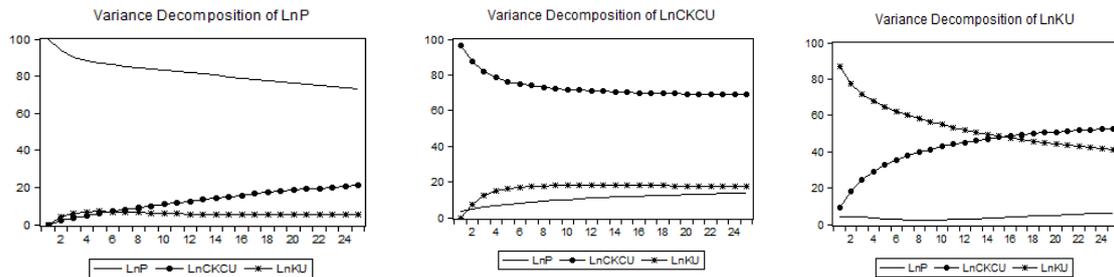
Figure 3. Forecast error variance decompositions

4. Conclusions

In this study, the impacts of the market supply and demand factors and government support programs on the determination of cotton prices since the planned development period of Turkey are estimated through the use of a dynamic vector autoregressive model. Until 1999, base price for cotton in Turkey was set by the government, based on the production costs. Base price led to an increase in the cotton supply, thus in the cotton stocks as the direct price support was in use. In this period, the government dominated the whole process from industrial processing to marketing of cotton

purchased from the producers. As from 2000, cotton production support policy was amended, and indirect price support, in other words, difference payment system was adopted. Thus, it was ensured that the cotton price was determined according to the supply and demand in the domestic cotton market. The dummy variable representing this change in the government support policy was found to be insignificant in the estimation of the VAR model. In other words, this change in the government support policy has no significant impact on the cotton price. The stationary test indicates that the cotton price had a structural

change in 1973. The estimation of the VAR model revealed that the oil crisis of 1973 had a significant impact on the cotton price. In the dynamic VAR model, stock-to-use ratio of the two competitive countries has a negative impact on the cotton price. Furthermore, there exists a forward unidirectional causality from the cotton price and stock-to-use ratio of the two competitive countries and domestic stock-to-use ratio. Cotton price and domestic stock-to-use ratio have an indirect causality relationship. In addition, forecast error variance decomposition and impulse-response function results are supportive of the causality relationship between the variables.

The fact that the domestic cotton prices are higher than the foreign cotton prices due to the cost of cotton production, and the achievement of full liberalization in the foreign trade of cotton as from the second half of 1980s indicate that the stock-to-use ratio of the two competitive countries plays a role in the determination of the domestic cotton price.

References

Baker, A. and Menzie, K., 1988. Drought Effects on Corn Price Forecasts. Feed Situation and Outlook Report, fds-307, USDA, Economic Research Service, 25-28 pp.

Dickey, D. A. and Fuller, A. W., 1979. Distribution of the Estimators for Autoregressive Time Series with a Unit Root. Journal of the American Statistical Association, 74(366): 427–431.

Enders, W., 2010. Applied Econometric Time Series, 3rd Ed. Hoboken, NJ: John Wiley, 544 pp.

FAO., 2012. Agricultural Statistics. Food, Agriculture and Organization.

Goodwin, B.K., Schnepf, R., Dohlman, E., 2005. Modelling Soybean Prices in a Changing Policy Environment. Applied Economics, 37: 253-263.

Granger, C. W. J., 1969. Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. Econometrica, 37(3): 424-438.

Hamilton, J. D., 1994. Time Series Analysis. Princeton, NJ: Princeton University Press, 445 pp.

Labys, W.C., 1973. Dynamic Commodity Models: Specification, Estimation and Simulation, Lexington, MA : Heath Lexington Books. 351 pp.

Lee, J. and Strazicich, M. C., 2003. Minimum Lagrange Multiplier Unit Root Test with Two

Structural Breaks. Review of Economics and Statistics, 85(4): 1082–1089.

Lee, J. and Strazicich, M.C., 2001. Break Point Estimation and Spurious Rejections with Endogenous Unit Root Tests. Oxford Bulletin of Economics and Statistics, 63(5):535–558.

Lütkepohl, H. and Reimers, H. E., 1992. Impulse Response Analysis of Co-integrated Systems. Journal of Economics Dynamics and Control, 16(1):53–78.

MIT., 2010. Annual Cotton Report of the Ministry of Industry and Trade. Turkey, 12 pp.

Sims, C. A., 1980. Macroeconomics and Reality. Econometrica, 48(1): 1-46.

TUIK., 2012. Textile Sector Statistics. Turkish Statistical Institute, 56 pp.

USDA., 2010. Cotton and Wool Yearbook Reports. United State Department of Agriculture, 8 pp.

Van Meir, L. W., 1983. Relationships among Ending Stocks, Prices, and Loan Rates for Corn, Feed Outlook and Situation Report, FdS-290, U.S. Department of Agricultural Economics Research Service, 9-13 pp.

Westcott, P. C. and Hoffman, L. A., 1999. Price Determination for Corn and Wheat. Economic Research Service Technical Bulletin No. 1878, July,Washington, D.C., 21 pp.