ZKÜ Sosyal Bilimler Dergisi, Cilt 5, Sayı 10, 2009, ss. 77–96
ZKU Journal of Social Sciences, Volume 5, Number 10, 2009, pp. 77–96

ESTIMATION OF HAZELNUT EXPORT OF TURKEY AND FORECAST ACCURACIES

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ABSTRACT

In this study, the hazelnut export of Turkey is explained and then forecasted by the simple econometric cause-effect and the autoregressive moving average cause-effect (ARMAX) techniques. The hazelnut export quantity can be explained by the foreign exchange rate, and thus the hazelnut export revenue can be explained by hazelnut export quantity as the price theory states. The hazelnut export demand elasticity with respect to the foreign exchange rate is found inelastic while the elasticity of the hazelnut export revenues with respect to quantity is found elastic. The forecasts indicate that both the hazelnut export quantity and revenue of Turkey are expected to rise in the future. The ARMAX type technique is found outperforming the simple econometric cause-effect technique for the 1998-2001 in-sample prediction. However, based on MAPE criterion there existed inconsistency between simple econometric and ARMAX type techniques in outperforming each other in one to four steps ahead out-of-sample forecasting.

Keywords: *Hazelnut Export, Forecasting, Accuracy Comparison.*

TÜRKİYE'NİN İÇ FINDIK İHRACATI TAHMİNİ VE ÖNGÖRÜ DOĞRULUĞU

ÖZET

Bu çalışmada Türkiye'nin iç fındık ihracatı basit ekonometrik ve otoregresif hareketli ortalamalar sebep-sonuç teknikleri kullanılarak (ARMAX) açıklanmış ve bu tekniklere dayanılarak öngörü yapılmıştır. İç fındık ihracatı miktarları yabancı döviz kuruyla, fiyat teorisi çerçevesinde de iç fındık ihracat gelirleri ihracat miktarlarıyla açıklanabilmektedir. Tabii logaritma tabanına göre kurulmuş modellerden iç fındık ihracatının dolar döviz kuru esnekliği inelastik, ihracat gelirlerinin iç fındık ihracatı miktar esnekliği elastik bulunmuştur. Bu modellere bağlı olarak yapılan öngörülerde iç fındık ihracatı ve gelirlerinin artış göstereceği öngörülmüştür. Dönem içi öngörü doğruluğu kıyaslamasında ARMAX tekniğinin basit ekonometrik-sebep sonuç tekniğine üstünlük sağladığı, yani daha doğru öngörüde bulunduğuna ulaşılmıştır. Fakat bir ila dört dönem ileriye dönük öngörü doğruluk kıyaslamasında, MAPE (Ortalama Mutlak Yüzde Hata) ölçütüne göre tekniklerin doğruluk sıralamasında basit ekonometrik ile ARMAX tipi teknikleri arasında tutarsızlık görülmüştür.

Anahtar Kelimeler: *İç Fındık İhracatı, Öngörü, Doğruluk Kıyaslaması.*

1. INTRODUCTION

This study aims to explain the hazelnut export quantity and the hazelnut export revenue, and forecasts them until 2010 and compares the forecast accuracies of the simple econometric and the ARMAX (Autoregressive Moving Average Cause Effect) techniques on the quantity and revenue series for in and out-of sample periods. The finding may be valuable for the governments, politicians, producers and hazelnut exporters to foresee their future and define new strategies in the hazelnut sector. On the other hand, the accuracy comparision of these techniques contributes to the forecasting literature in choosing the most accurate technique among alternatives. **Li et al. (2005:98)** points out that none of the advanced econometric models outperforms AR(I)MAX models by referring some studies for tourism. Therefore, AR(I)MAX type forecast should be of interest to fill the gap in further studies in addition to its application to tourism. There has not been such approach applying to hazelnut export series up to now to be able to compare the results of the techniques with erlier studies.

Hazelnut is one of the most important agricultural export products for the economy of Turkey. Hazelnut is an interior good for many agri-based industrial products that are either exported or consumed domestically. Moreover; many producers know that Turkish hazelnut is highly competitive in the world markets. The European Union is known as the largest international market for Turkish hazelnut. According to the report of the Office of Agriculture under the Turkish Treasury (2004) Turkey exports about 80%-90% of domestic hazelnut production and supplies 80% of the world hazelnut export. According to the Hazelnut Cooperation Organization (Fiskobirlik, 2009) the hazelnut export share of Turkey to the European Union is about 80 % by 2008.

A large number of people in northern Turkey survive by producing hazelnut, and the country increases considerably its foreign currency reserves via hazelnut exporting. Producers attempt to produce more hazelnut as they earn more by exporting them. On the other hand, the producers can distribute their productive lands to different crops and reduce social land cost over hazelnut production once they see the future of the market. By having forecast knowledge, domestic producers decide to continue producing hazelnut at market expansion or stop producing hazelnut and use the land for other purposes at low market shares. Therefore, estimating the pattern of hazelnut production and the revenues based on the hazelnut exports is important for producers. In other words, Turkey can manage hazelnut land productively either by increasing hazelnut production if its production forecast is under that of required one or reduce its production If its production forecast is over the demand for Turkish hazelnut. On the other hand, over production by opening new areas may not only reduce productivity per heap but may also reduce the hazelnut export price. Both cases are undesirable.

In considering the accuracies of the simple econometric and a complicated ARMAX technique, the forecast accuracies of the techniques are compared for sample prediction, 1998-2001, and out-of sample prediction, 2002-2005, to show their accuracy performances on each other.

The article is arranged as follows: Section two discusses data and variables, section three discusses model specification, section four presents the estimated hazelnut export quantity and revenue models and statistical criterions, section five discusses whether structural break exists or not by postulating Chow Structural Break Test, section six discusses forecast accuracies of the simple econometric and ARMAX techniques, and main conclusions are given in section seven.

2. DATA AND VARIABLES

All models will be estimated for the period of 1978-2001 because recorded data are not available before that period. It is well known that Turkey's trade liberalization started in 1980. Within the period the exchange rate changes affected the hazelnut export and revenues. Therefore, the use of the foreign exchange rate data is found reasonable to explain hazelnut export and estimate hazelnut export exchange rate elasticity to decide whether domestic currency devalutions for each good including hazelnut export at the same level is needed to increase hazelnut export revenues.

The variables that will be used in model estimations are symbolized as follows:
EXC=Yearly average Turkish Liras per United States Dollar, $\Delta EXC=EXC_t-EXC_{t-1}$, LEXC=Natural logarithmical values of EXC.
XFQ=Hazelnut export (Ton), LXFQ = Natural logarithmical values of XFQ.
XFUSD=Hazelnut export revenue (USD), LXFUSD=Natural logarithmical values of XFUSD.
e=Estimated error term; moving average factor, ERROR.
t-j: Subscription used to show dynamic level of a variable in a model, such as e_{t-1}, e_{t-2}, or $LXFQ_{t-1}$.
PE=Absolute percentage error, SPE= Sum of PE_i, NUM=Number of observation, MAPE=Mean absolute percentage error, which are used for forecast accuracy comparions.

Exchange rate data are obtained from *International Financial Statistics Yearbook*, IMF, the hazelnut export quantities and the export revenues are obtained from *Hazelnut Cooperation Organization*[1].

The SAS (Statistical Analysis Software) is applied to derive correlogram and estimate statistics and models[2]. We used various SAS user guides books such as ETS User's Guide (1988) and Der and Everitt (2002) application book for the estimations and data analyzes.

3. MODEL SPECIFICATION

From micro economic theory one knows that revenues (R) is a function of quantities (Q) sold at a market price (P). In other words, the hazelnut expenditures is a function of the quantities bought by other countries, assuming internationally fully competitive market exists. The difference between the export revenue and buying cost is the profit[3].

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[1] http://fiskobirlik.org.tr/istatis.htm, Fiskobirlik (Fındık Tarım Satış Kooperatifleri Birliği), Turkey.

[2] SAS, Version 9.1.3.

[3] The profit function of an hazelnut exporter firm or a country is $\Pi(Q)=TR(Q)-TC(Q)$, where Q is symbolized as XFQ, and TR (Q) is symbolized as XFUSD in estimated models.

In the economic context, one should firstly be aware of an exchange rate effect on exporting hazelnut as one of the main agricultural product of Turkey. For this reason, the use of the United States Dollar price in terms of Turkish Liras (USD/TL) is thought to be a more rational specification instead of hazelnut export price which is not available for entire period. Hence the hazelnut export quantity needs to be written as a function of exchange rate; XFQ=f(EXC). Secondly; one needs to assume that both exporter and importer country has full information about foreign exchange rates. Thirdly, it is assumed that the price of hazelnut is defined at international market. After one forecasts this price, one can forecast both the hazelnut export quantity and the hazelnut export revenue for a country. Fourthly, the hazelnut export revenue is assumed to be an implicit function of the foreign exchange rate[4]. Therefore, forecasting the hazelnut export quantity and the hazelnut export revenues will help a country in forecasting hazelnut export profits when buying costs are known, helping economic agents to define new strategies.

One also needs to forecast the foreign exchange rate values to use them as explanatory variable in forecasting the hazelnut export quantity. The relation between LXFQ and LEXC is indicated by natural logarithmic values in Figure 1[5]. There exists a strong positive statistical association between the hazelnut export quantity and the TL per USD at the current levels[6]. This association is expected to be significant and co-integrated and fit the economic theory. It shall match the expectations from the export oriented development policies, because Turkey has followed persistent devaluing exchange rate policies for the recent decades, or for the sample period.

Figure 1: Correlation of LXFQ and LEXC

Lag	Covariance	Correlation	0 1 2 3 4 5 6 7 8 9 1
-6	0.356561	0.39557	********
-5	0.418516	0.46430	*********
-4	0.506131	0.56150	***********
-3	0.532834	0.59112	************
-2	0.594531	0.65957	*************
-1	0.658904	0.73099	***************
0	0.768164	0.85220	*****************
1	0.661539	0.73391	***************
2	0.593312	0.65822	*************
3	0.445632	0.49438	**********
4	0.357439	0.39654	********
5	0.260144	0.28860	******
6	0.199130	0.22091	****

4 One should recall that the foreign exchange rate is traditionally defined as the ratio of domestic price indices over foreign price indices under Purchasing Power Parity theory of exchange rate. Indeed, Turkish Liras per USD rate may reflect the trade price of hazelnut, as the USD is an international reserve currency. However, such type definition of foreign exchange rate can be tested to hold..

5 The ccross correlation function between XFQ and EXC is not provided here to save place.

6 In view of demand side or in view of USD per Turkish liras Figure 1 would show negative relationship between two variables, which would be symmetric of Figue 1.

Toforecast USD values to be used as input series for the hazelnut export quantity the first order autoregressive model is appropriately fitted to the first order differentiated TL per USD series based on the Box-Jenkins methodology. Based upon this methodolgy, the nine periods ahead out-of sample of the TL per USD values are forecasted. These forecast values are used to forecast the hazelnut export quantities for the period of 2002-2010, and then forecasted hazelnut export quantities are used to forecast the hazelnut export revenues for the same period.

Figure 2: Correlation of LXFUSD and LXFQ

Lag	Covariance	Correlation	0 1 2 3 4 5 6 7 8 9 1
-6	0.018474	0.17381	|***
-5	0.030620	0.28808	|******
-4	0.057417	0.54020	|***********
-3	0.055453	0.52172	|**********
-2	0.071649	0.67411	|*************
-1	0.066822	0.62869	|*************
0	0.087554	0.82375	|****************
1	0.064274	0.60471	|************
2	0.072383	0.68101	|**************
3	0.070917	0.66721	|*************
4	0.059419	0.55904	|***********
5	0.042101	0.39610	|********
6	0.028527	0.26839	|*****

Two models are specified to explain the hazelnut export revenues based on the economic theory and statistical associations shown in Figure 1 and Figure 2. Figure 2 indicates a positive strong statistical association between the hazelnut export revenue and the hazelnut export quantity in terms of natural logarithm values7. Thus, a statistical reasoning exists for modeling in addition to economic relationship.

Following the econometric cause-effect model specification based on economic theory supported by statistical association, one may estimate a form of "the autoregressive (integrated) moving average econometric cause-effect (AR(I)MAX)" models if there exists room for it, based on the Box-Jenkins (1970) approach. The AR(I)MAX models forecast more accurately than the simple econometric cause-effect models (Akal, 2002). Recently researchers have applied AR(I)MAX type models more often than earlier times. Because this technique obtains many possible systematical effects which, if a researcher has their data, have to be accounted for via an autoregressive and/or moving average dynamical filters within a model (Akal, 2004). Narayan and Prasad (2004) applied ARMAX model for the first time in the international trade, departing from the simple ARMA and other cause-effect regression techniques, to foresee Fiji's exports and imports and thus trade balance. They also argue that theoretical basis allow researchers to set ARMAX models to strengthen forecasts.

Researchers desire to choose a model which yields the smallest root mean square error (RMSE), Akaike's information criterion (AIC) or Schwartz's information criterion (SBC) and a model which does not indicate overparameterization among estimates for a

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[7] It is also derived a cross correlation function between XFUSD and XFQ. However, we preferred not to present it here to save place. But Fifure 1 presents similar relation for these variables.

model fitting well to a series. However, researchers must reach insignificant error distribution (white noise), too, but, on the other hand, one should remember that there may be more than one model satisfying errors to be white noise in the Box-Jenkins methodology.

In short, the models are specified appropriately through diagnostic checking and statistical tests. These estimated models will be evaluated intuitively in view of both economic meaning and forecasting accuracies of the techniques in next sections.

4. ESTIMATED MODELS

In this section each series is analyzed under a different heading for simplification, because there are few complicated models estimated, and some important diagnostic tests are presented for each estimated model. The export models are evaluated in terms of economic meaning, and then their forecast values are given with their reliability limits.

4.1. Forecasting American Dollars

In order to forecast the hazelnut export quantities one may apply univariate or multivariate technique. Since the foreign exchange rate has been an important policy instrument for years one can't ignore the effect of the value of U.S. Dollar on the hazelnut export of Turkey, as the changes in the value of the U.S. Dollar covers the changes in the hazelnut import price from Turkey and the development in the foreign exchange rate concerns hazelnut importers.

A multivariate forecasting technique requires the forecasts of input series. Therefore, one should forecast the foreign exchange rate values for 2002-2010 forecast periods. For this purpose, a univariate first order autoregressive integrated (ARI(1)) model is fitted to the stationary first order differencing foreign exchange rate series[8]. Equation one represents the fitted estimated model and its forecast values are found within 95 % lower and upper limits[9].

Model 1: Dependent Series: $EXC_{1978\text{-}2001}$, Mean=53426.21, Standard Deviation=129380, ARIMA(1_1_0): ARI(1):

$$\Delta EXC_t = \underset{(109.54)}{301807.3} + \underset{(3.42)}{.99}\, \Delta EXC_{t-1} \qquad (1)$$

Std Error Estimate = 88850.6751, AIC = 606.693682, SBC =608.96467, $\chi^2_{(0\text{-}6)}$ =1.88, $\chi^2_{(6\text{-}12)}$ =1.93, $\chi^2_{(12\text{-}18)}$ = 1.93, satisfying white noise criterion, R^2 =.8675.

According to Model 1, the current level of TL per USD is explained by the values of the last two periods.

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[8] The first differences series is found stationary based on the Box-Jenkins methodolgy.

[9] Technically we have to realize forecast values of foreign exchange rate even they are forecasted above observed values.

4.2. Forecasting Hazelnut Export Quantities

There are two techniques here. One is the econometric cause-effect X(0_0_0,X) and the other is the ARMAX(p,d,q,X) technique. The reason for applying two different techniques is to evaluate and compare their parameter estimates and forecasts accuracies. The forecasts of these techniques are compared with each other within the sample, considering 1998-2001 years, in terms of the mean absolute percentage error (MAPE) criterion, so that one may have some idea about their out-of sample forecast performances of the techniques[10]. One to four steps ahead forecast based on these techniques are compared in terms of MAPE accuracy criterion for the years of 2002-2006. Out-of sample criterion results are shown in Table 6.

4.2.1. Simple Econometric Cause-Effect Technique

There are two models estimated here. The first is in the form of natural logarithm and the second is in the form of original values. The natural logarithmic form indicated stronger linearity than the second one between the variables. Estimating models based on different forms may help one who wants to show how an autoregressive or moving averages factors cover error effects and influence the accuracy of a model arising from the weak linearity in passing from original values to logarithmic values. Model 2 yields the hazelnut export foreign exchange rate explicitly[11], while Model 3 yields the yearly average changes in the hazelnut export quantity with respect to the foreign exchange rate changes.

Model 2: Dependent Series: $LXFQ_{1978\text{-}2001}$: Mean=11.96065, Standard deviation=0.282776, Var(LEXC)=16.95443, X(0_0_0,LEXC):

$$LXFQ_t = \underset{(129.43)}{11.3364} + \underset{(7.64)}{.0756}\, LEXC_t \qquad (2)$$

Std Error Estimate =0.15453237, AIC=-19.612106, SBC=-17.255998, $\chi^2_{(0\text{-}6)}$ =7.28, $\chi^2_{(6\text{-}12)}$ =16.09, $\chi^2_{(12\text{-}18)}$ =21.20, satisfying white noise criterion, $r_{(NUM1,\ MU)}$ = -.933, R^2 =.72624, DW=2.1787, Chow F= 4.18144 (This ratio indicates that a structural change does not exist).

According to Model 2, the hazelnut export would increase about 0.0756 percent as a result of one percent increase in U.S. Dollar in terms of TL on the average[12]. This elasticity is under unity. The same value is resulted in Model 5. This elasticity coefficient implies a monopoly power of Turkey in the international hazelnut market, especially in the European Union considering hazelnut is not a necessary staple consumption like bread or rice. It shall be considered that there is no substitute of Turkish hazelnut because of their high quality in the world hazelnut market. On the other hand, one must reach a conclusion that having inelastic foreign hazelnut demand with respect to the exchange rate restricts Turkey in increasing its export revenues as a

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[10] Moreover; one can see how the prediction criteria such as standard error of a model, AIC and SBC are consistent with MAPE in Table 6 for the sample period of 1998-2002.

[11] Kulaç (1997:65) found export price elasticity of hazelnut about -0.98, which is close to one enough not to conclude inelastic and thus not to fund hazelnut production.

[12] In view of foreign export demand, the foreign hazelnut demand would decrease about 0.0756 percent as a result of one percentage increase in TL value in terms of USD on the average.

result of reducing hazelnut export prices by devaluing its currency, *Ceteris Paribus*, even the hazelnut export quantity increases. It shall be thought that when the export agencies apply differentiated foreign exchange rates (lower TL per USD) for hazelnut exporting they may increase their profits.

In addition, the original EXC series indicated a linear relationship with the original XFQ series but at a lower level than the logarithmic linearity between LXFQ and LEXC. Here, we would like to present Model 3, which is based on the original values, for the purpose of accuracy comparisons between the econometric cause-effect and the autoregressive moving average econometric cause-effect models, even this model indicates significantly weaker Ljung-Box (1978) statistics for autocorrelation check of residuals or white noise check.

Model 3: Dependent Series: $XFQ_{1978\text{-}2001}$: Mean = 162717, Standard deviation = 44866.64, Var (EXC)= 16.95443, X (0_0_0,EXC):

$$XFQ_t = 151402.5 + .09448\ EXC_t \qquad (3)$$

$$(17.86) \qquad (3.36)$$

Std Error Estimate=38108.652, AIC=576.334214,SBC=578.690322, $\chi^2_{(0\text{-}6)}$=31.71, $\chi^2_{(6\text{-}12)}$ =49.64, $\chi^2_{(12\text{-}18)}$ =74.78, not satisfying white noise criterion, $r_{(NUM1,\ MU)}$ = -.398, R^2=.33868, DW=0.7826, Chow F=26.7964 (no decision about structural change because of not satisfying white noise criterion. See Model 4 for conclusion).

Ignoring the best model criterion and comparing the regressors of Model 3 with Model 4 one may reach at a conclusion that the hazelnut export increases would be between 83.480 and 94.480 kg. as a result of one TL increase per American dollar based on Model 4.

4.2.2. Autoregressive Moving Average Econometric Cause-Effect Technique

Including an AR or MA factor can increase the significance level of white noises in both Model 2 and Model 3. Model 3 necessitated inclusions of both AR and MA filters as a result of diagnostic checking. In other words, the simple cause-effect models can be extended to the ARMAX type models. After diagnostic checking and estimating process, Model 2 was developed to Model 5, and Model 3 was developed to Model 4[13].

Model 4 represents the first order autoregressive and the second order moving average autoregressive econometric cause-effect model (ARMAX model), and Table 1 shows the forecast values of Model 4, which are found within the lower and upper limits.

Model 4: Dependent Series: $XFQ_{\ 1978\text{-}2001}$: Mean = 162717, Standard deviation= 44866.64, Var (EXC)= 4.096E12, ARMAX (1_0_1,2,EXC):

$$XFQ_t = 148289.1 + .08348 EXC_t + .80219 XFQ_{t-1} - .5275 e_{t-1} + .52233 e_{t-2} \qquad (4)$$

$$(6.04) \qquad (2.65) \qquad (4.78) \qquad (-2.43) \qquad (2.45)$$

Std Error Estimate = 26240.6445, AIC=562.519825, SBC= 568.410094, $\chi^2_{(0\text{-}6)}$ = 1.19, $\chi^2_{(6\text{-}12)}$ = 9.23, $\chi^2_{(12\text{-}18)}$ = 14.28, satisfying white noise criterion , $r_{(AR1,\ MA1)}$ =. 449, $r_{(AR1,\ MA2)}$ =. 308, r (AR1,

[13] A forecaster should know that there might be more than one satisfactory model in Box-Jenkins approach.

$_{MU)}$ =. 135, $r_{(MA1, MA2)}$ =-.174, $r_{(MA1, MU)}$ =. 029, $r_{(MA2, MU)}$ =. 031, $r_{(NUM, MU)}$ = -.0348, $r_{(NUM, MA1)}$ = .036, $r_{(NUM; MA2)}$ = -.117, $r_{(NUM, AR1)}$ =-.151, satisfying white noise criterion, R^2 =.70284, DW=1.9719, Chow F=1.30045 (No structural change).

According to Model 4, marginal export tendency with respect to the foreign exchange rate is about 0.08 in the short run, and it is about 0.42 in the long run. The estimated long run export tendency with respect to the foreign exchange rate means that a one TL increase per USD would increase the hazelnut export about 0.42 tons on the average. The average elasticity of the hazelnut export with respect to the foreign exchange rate is about 0.14 for the period, and it is about 0.027 in the short run on the average14. In other words; the hazelnut export foreign exchange rate elasticity based on Model 4 is the same as in Model 5. Model 5 is the natural logarithm form of Model 4. Because both forms yield the same pattern based on the Box-Jenkins methodology. But Model 4 indicated a stronger ARMA part and a weaker cause-effect part than Model 5 indicated. This is the implication of the weaker linear relationship between original series than the linear relation between transformed natural logarithm series. This weakness is undertaken by higher power of AR and MA filter in Model 4 compared to Model 5. And this difference is expected to show up in favor of ARMAX in accuracy comparison with the econometric cause-effect technique in the following sections. Such results would be an indication of the out performance of ARMAX models over the econometric cause-effect model.

In Model 5, the export elasticity with respect to the exchange rate is about 0.074 that is, close to the estimated elasticity in Model 2. This result indicates a stable elasticity estimated Model 2 in passing to Model 5[15]. Table 2 shows the forecast values of Model 5.

Model 5: Dependent Series: $LXFQ_{1978\text{-}2001}$: Mean=11.96065, Standard deviation=0.282776, Var (LEXC)= 14.73851, ARMAX (1_0_1,2,LEXC):

$$LXFQ_t=11.3556+.07375LEXC_t-.65072LXFQ_{t-1}+.66577e_{t-1}+.3851e_{t-2} \quad (5)$$
(109.54) (6.32) (-1.85) (1.91) (1.66)

Std Error Estimate = 0.15260463, AIC = -17.228576, SBC = -11.338306, $\chi^2_{(0\text{-}6)}$ = 3.06, $\chi^2_{(6\text{-}12)}$ =8.37, $\chi^2_{(12\text{-}18)}$ = 11.49, satisfying white noise criterion, $r_{(AR1,MU)}$ = -0.011, $r_{(AR1,MA1)}$ =.788, $r_{(AR1,MA2)}$ = -.33, $r_{(MA1,MA2)}$ =.024, $r_{(MA1,MU)}$ =-.041, $r_{(MA2,MU)}$ = -.01, $r_{(NUM1,AR1)}$ =.034, $r_{(NUM1,MA1)}$ =.053, $r_{(NUM1,MA2)}$ = -.014, $r_{(NUM1,MU)}$ = -.929, satisfying white noise criterion, R^2 =.75576, DW=1.6652, Chow F=2.55432 (No structural change).

The power of coefficients of ARMA part in Model 5 is found to be weaker than their powers in Model 4 whereas the power of cause-effect part is found stronger in Model 5 than in Model 4.

In comparison of ARMAX model with their corresponding econometric cause-effect models, the prediction criterions such as mean root squares error of estimated model, Akaike (1981)'s information criterion (AIC) and Schwartz (1978)'s information criterion (SBC) are found to be smaller in ARMAX type models. Hence, Ljung-Box χ^2

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[14] This would be close to the long run estimated elasticity in Model 5.

[15] Model 2 satisfied white noise criterion in errors but it could be improved further as seen in passing from Model 2 to Model 5 as done.

Table 1: Forecast Values of Model 4

Year	Forecast	Std Error	Lower 95%	Upper 95%
2002	306261.94	26240.6	254831.22	357692.66
2003	356440.57	27212.5	303105.03	409776.11
2004	405879.88	33471.0	340277.93	471481.83
2005	455506.83	36941.9	383102.00	527911.67
2006	505284.31	39012.6	428821.12	581747.50
2007	555182.53	40288.8	476217.95	634147.11
2008	605177.62	41089.1	524644.44	685710.80
2009	655250.40	41596.0	573723.77	736777.04
2010	705385.52	41918.9	623225.94	787545.11

Table 2: Forecast Values of Model 5

Year	Forecast	Std Error	Lower 95%	Upper 95%	FORECAST
2002	12.4112	0.1526	12.1121	12.7103	245542.86
2003	12.4681	0.1526	12.1689	12.1689	259902.22
2004	12.4384	0.1630	12.1189	12.7579	252295.72
2005	12.4817	0.1672	0.1672	12.1539	263463.37
2006	12.4735	0.1690	12.1423	12.8047	261315.91
2007	12.4960	0.1697	12.1634	12.8286	267258.09
2008	12.4964	0.1700	12.1631	12.8296	267364.28
2009	12.5095	0.1701	12.1760	12.8430	270893.06
2010	12.5130	0.1702	12.1794	12.8466	271845.81

autocorrelation test ratios are estimated lower in ARMAX models than corresponding simple econometric cause-effect models, indicating an improvement in the significance level of white noise. In considering the correlation among estimated coefficients of regressors, the overparameterization is avoided as much as possible because over parameterization causes larger forecast errors (Akal, 2002).

4.3. Forecasting Hazelnut Export Revenues

In this section, the degree of the relation between the hazelnut export revenue and the quantity will be researched, and two reliable forecasting models based on two series are determined.

A sale from a product is definitely related to the quantity sold. Therefore, hazelnut export revenues are defined by the quantities sold at market price. We assumed that market prices exist according to international demand and supply for hazelnut. We assumed that exchange rate would take over the effect of this price in explaining hazelnut export sales. Since the exported hazelnut quantity is explained by the foreign exchange rate directly above, now, we can explain or predict hazelnut export revenues by foreign exchange rate implicitly or instrumentally. Therefore, the revenue models can be implied by XFUSD=f (XFQ (EXC)). However, there will be addition of MA part to overtake shocks and improve significance levels of white noises.

The forecast values of the hazelnut export quantity of "Model 5: ARMAX ((1_0_1,2,LEXC)" are used to forecast hazelnut export revenues of Turkey. And the LEXC forecast values are derived from ARI(1) model for ΔEXC series.

4.3.1. Econometric Cause-Effect Technique

The econometric cause-effect models explain the hazelnut export revenues as Model 6 and 7 based on logarithmic and original export revenue series accordingly:

Model 6: Dependent Series: $LXFUSD_{1978\text{-}2001}$: Mean=19.98688, Standard deviation=0.375873, Var (LXFQ)=0.111188, X (0_0_0,LXFQ):

$$LXFUSD_t = \underset{(357.41)}{1.67073}\ LXFQ_t \tag{6}$$

Std Error Estimate= 0.27398192, AIC= 6.94234701,SBC= 8.12040084, $\chi^2_{(0\text{-}6)} = 6.84$, $\chi^2_{(6\text{-}12)} = 9.58$, $\chi^2_{(12\text{-}18)} = 24.23$, satisfying white noise criterion, R^2 =.49081, DW=1.4538, Chow F= 3.4308 (No structural change).

According to Model 6, the hazelnut export revenues with respect to the hazelnut export quantity increases about 1.67 percent as a result of a one percentage increase in the quantity exported. Model 9 also indicates this result. This would mean that the estimated regressor of Model 6 is stable. The hazelnut export revenue can be explained by original values as follows:

Model 7: Dependent Series: $XFUSD_{1978\text{-}2001}$: Mean=5.1315E8, Standard deviation= 1.891E8, Var (XFQ) =3.4457E9, X (0_0_0,XFQ):

$$XFUSD_t = \underset{(22.79)}{3170.6}\ XFQ_t \tag{7}$$

Std Error Estimate=115028454, AIC= 960.000743,SBC= 961.178797, $\chi^2_{(0\text{-}6)} = 6.39$, $\chi^2_{(6\text{-}12)} = 7.62$, $\chi^2_{(12\text{-}18)} = 20.03$, satisfying white noise criterion, R^2 =.64541, DW=1.0995, Chow F=1.78196 (No structural change).

According to Model 7, the average export receipts elasticity with respect to the export quantity is estimated as 1.000537 for the period. And it is estimated as 0.97 in Model 9, which are close to each other.

4.3.2. Moving Average Econometric Cause-Effect Technique

Even the estimated errors of Model 6 and Model 7 of the simple econometric cause-effect technique distributed randomly, the significance level of white noise by including the MA (3) filter in the simple model without causing overparameterization between regressors of input factors and MA filter[16]. As a result, one can see a reduction in AIC and SBC, or in MSE after the inclusion of MA filter in these models. This means that the predictive powers of the simple econometric models are strengthened, and the power of the regressor coefficient of LXFQ in Model 6 strengthens after including the MA filter at lag three or in passing from the simple model to the moving average cause

[16] Partial autocorrelation function (PAC) showed a higher spike at lag three in estimated simple econometric models. These graphs are not presented here to save place.

effect model, or from Model 6 to Model 9. But the power of the estimated coefficient of XFQ decreased in Model 8 compared to Model 7 in equation seven.

By the additions of the moving average factors to Model 6 and Model 7 as a result of diagnostic checking, Model 8 and Model 9 are estimated as follows, and the forecasts of Model 8 and 9 are shown in Table 3 and in Table 4 respectively:

Model 8: Dependent Series: $XFUSD_{1978\text{-}2001}$: Mean=5.1315E8, Standard deviation= 1.891E8, Var (XFQ) =3.4457E9, MAX (0_0_1,XFQ):

$$XFUSD_t = \underset{(16.32)}{3061.9}\ XFQ_t + \underset{(2.39)}{.49013}\ e_{t-1} \qquad (8)$$

Std Error Estimate =105917806, AIC=957.247865, SBC=959.603972, $\chi^2_{(0\text{-}6)}$ = 3.25, $\chi^2_{(6\text{-}12)}$ =4.80, $\chi^2_{(12\text{-}18)}$ =11.56, satisfying white noise criterion , $r_{(NUM1,\ MA1)}$ =. 224, R^2 =. 7106, DW=1.7514, Chow F=1.86512 (No structural change).

Table 3: Forecast Values of Model 8

Year	Forecast	Std Error	Lower 95%	Upper 95%
2002	671189744	105917806	463594658	878784829
2003	795783849	117955996	564594346	1026973352
2004	772493840	117955996	541304337	1003683343
2005	806687581	117955996	575498078	1037877084
2006	800112383	117955996	568922880	1031301886
2007	818306485	117955996	587116982	1049495988
2008	818631619	117955996	587442116	1049821122
2009	829436262	117955996	598246759	1060625765
2010	832353424	117955996	601163921	1063542927

Model 9: Dependent Series:$LXFUSD_{1978\text{-}2001}$: Mean=19.98688, Standard deviation=0.375873,Var (LXFQ)= 0.111188, MAX ((0_0_3,LXFQ):

$$LXFUSD_t = \underset{(693.84)}{1.67027}\ LXFQ_t\ \underset{(2.29)}{-.55237}\ e_{t-3} \qquad (9)$$

Std Error Estimate=.25815656, AIC=6.11164807, SBC=8.46775573, $\chi^2_{(0\text{-}6)}$ = 3.57, $\chi^2_{(6\text{-}12)}$ =7.73, $\chi^2_{(12\text{-}18)}$ = 18.55, satisfying white noise criterion, $r_{(NUM1,\ MA1)}$ =.187, R^2 =. 52914, DW=1.5788, Chow F=.000121336 (No structural change).

Table 4: Forecast Values of Model 9

Year	Forecast	Std Error	Lower 95%	Upper 95%	FORECAST
2002	20.6803	0.2582	20.1743	21.1863	957925797.05
2003	20.8511	0.2582	20.3451	21.3571	1136392351
2004	21.0595	0.2582	20.5536	21.5655	1399731792
2005	20.8478	0.2949	20.2697	21.4258	1132566154.3
2006	20.8341	0.2949	20.2560	21.4121	1117189404.8
2007	20.8716	0.2949	20.2936	21.4497	1159943917
2008	20.8723	0.2949	20.2943	21.4503	1160713805.8
2009	20.8942	0.2949	20.3162	21.4722	1186414662.3
2010	20.9001	0.2949	20.3220	21.4781	1193392356.3

The hazelnut export revenues are explained about 65 percent by hazelnut export quantity based on Model 7, and about 71 percent after the inclusions of the first order moving average filter at lag one. The hazelnut export revenues are explained about 49 percent by hazelnut export quantity based on Model 6, and about 53 percent after the inclusions of moving average filter at lag three as a shock effect in Model 9. According to the forecasts of Model 8 and Model 9, one should expect an increase in the hazelnut export revenues for the first decade of the twenty-first century.

5. TESTING STRUCTURAL CHANGE

To predict Chow F test statistics, one firstly needs to randomize the errors of any model. Except for the estimated errors of Model 3, the estimated errors of other models indicated white noise disturbances[17]. For this purpose, Model 3 is extended to Model 4, which is ARMAX (1_0_1,2,EXC). Model 4 didn't indicate structural change. In other words, the models satisfying randomness in errors did not indicate structural change during the 1978-2001 period[18]. Chow structural change test equations are run for each model for 1978-1989 and 1990-2001 sub periods. The Chow F statistics of the models are given at the end of statistics of the estimated models. This is also expected because trade liberalization and export oriented polices dominated this period. Model 4 indicated a long-run marginal hazelnut export exchange rate tendency equals 0.2. This ratio means that one TL increase per USD would increase hazelnut

[17] Ljung-Box Chi-Square test statistics is given under the estimated models to define randomness of errors.

[18] The estimated models for sub periods are not provided here. They are available upon request from the author. For example for Model 2 we have following estimations for two sub periods to calculate Chow F statistic:

$LXFQ_{t,1878\text{-}89}$= 11.4 + .054525 $LEXC_t$, Σe_{1t}^2=0.22032 or R^2 =0..2357, F= 3.083.
(64) (1.76)

$LXFQ_{t,1990\text{-}01}$= 11.9 + .028173 $LEXC_t$, Σe_{2t}^2=0.15006 or R^2 =0.1964, F= 2.445.
(59) (1.56)

For the entire period Σe_{Bt}^2 equals 0.52537. And Chow $F_{2,20}$=4.18144, which doesn't indicate structural change at %1 (F=5.85) significance levels. See Jan Kmenta (1986:762) for critical F values.

In this section, we will discuss How AR(I)MAX type models perform compared to the econometric cause effect models in terms of MAPE and model selection criteria. We'll compare the techniques for both in and out-of sample predictions. Table 5 shows in-sample MAPE and Table 6 shows out-of sample MAPE comparisons of the techniques. Out-of sample accuracy comparisons are done for the period of 2002-2003 through 2005-2006 hazelnut seasons.

It is obvious that passing from a simple econometric cause-effect model to an autoregressive moving average cause-effect model reduces the values of the estimated errors statistics such as AIC and SBC, etc. Akal (2003) reached at similar results. That would require the choice of the model that estimates the smallest value of these criteria unless there is a violation of the model selection, such as overparameterization, inappropriate autoregressive filter, non-white error distribution, etc. An appropriate model is expected to be consistent in satisfying these criteria simultaneously. However, Box-Jenkins methodology may yield more than one model, as estimated errors are white noises.

All estimated test criteria resulted in consistency in passing from a simple model to a complicated one, meaning that they moved in the same direction in passing from a simple model to its complicated one. For example, in passing from Model 6 to Model 9, the estimated *s*tandard errors declined to 0.25815656 from 0.27398192, AIC declined to 6.11164807 from 6.94234701, SBC declined to 8.12040084 from 8.46775573. And $\chi^2_{(0-6)}$ declined to 3.57 from 6.84, $\chi^2_{(6-12)}$ declined to 7.73 from 9.58 and $\chi^2_{(12-18)}$ declined to 18.55 from 24.23 simultaneously even Model 6 indicated white noise in errors. There is no overparameterization between estimated coefficients referring to LXFQ and e_{t-3} variables. Indeed, as the value of these criteria decline in passing from a simple model to complicated one; we expect a lower MAPE for a sample period.

Model 1 presents foreign exchange rate prediction and MAPE for the period of 1998-2001, including 2001 economic crisis. It is seen that while MAPE is indicating a declining trend it suddenly increased to 16 percent in 2001 because foreign exchange rates were underestimated more than expected because of the unpredicted exchange rate crisis in 2001. The exchange rate point percentage error in 2001 increased to 32 percent from 7.7 percent in 2000.

According to MAPE criterion, comparing Model 5 with Model 2, Model 5 is a better predictor than Model 2 as seen in Table 5. Both models indicate a declining MAPE. This result is consistent with the expectations based on the model selection criterions. However, Table 6 indicates that Model 2 outperforms Model 5 for out-of sample forecasting, but, their accuracies approach each other at the extend of forecast period. This implies that ARMAX will be outperforming simple econometric technique after four-year advanced forecasts.

On the other hand, in comparing of Model 3 with Model 4, the simple econometric model does a better prediction than the complicated one, but the simple econometric model has an increasing MAPE whereas the complicated one has a declining MAPE in-sample forecast period. Only the estimates of these two models contradict our expectations from an ARMAX model compared to a simple model, because Model 4 is expected to yield lower MAPE based on the lower estimated errors of model selection criteria compared to Model 3. But Model 4 implies decreasing MAPE compared to Model 3 for the 2002-2010 period. This would be expected according to the author. However, four steps ahead forecast comparisons in Table 6 doesn't match this expectation and MAPEs increase in both Model 4 and Model 3 forecasts which oppose to the adverse direction for 1998-2001 in-sample prediction period.

In comparing Model 9 with Model 6, and Model 8 with Model 7; both Model 9 and Model 8 to Model 6 and Model 7; the moving average econometric cause-effect technique do better in-sample prediction than Model 6 and Model 7 of the simple econometric cause-effect technique (see Table 5). This result is consistent with expectations because the simple technique yielded higher model selection criterions in absolute values. Three out of four comparisons of the pairs of the simple econometric cause effect and the moving average econometric cause-effect models match our expectations. The MAPE error criterion is consistent with other model selection criteria. Thus, one may reach at a conclusion that the moving average econometric cause-effect technique as a type of ARMAX outperforms the simple econometric cause effect technique in a sample prediction in term of accuracy. However, such out-performance of ARMAX, or ARX or MAX over the simple cause-effect model shall be expected for the forecast period, 2002-2010. It is highly possible to find similar results for other economic time series.

Table 5: In-Sample Forecast Errors of the Models of the Techniques

YEAR	ERRORS	PE	SPE	NUMBER	MAPE
Model 1: ARIMA (1_1_0): ARI(1): ΔEXC_t= 301807.3 + 0.99 ΔEXC_{t-1}					
1998-1999	38398.98	14.7278	14.7278	1	14.7278
1999-2000	49199.98	11.7483	26.4761	2	13.2381
2000-2001	48376.98	7.7376	34.2138	3	11.4046
2001-2002	397171.99	32.3212	66.5350	4	16.6337
Model 2: X(0_0_0,LEXC): $LXFQ_t$= 11.3364 + 0.0756 $LEXC_t$					
1998-1999	-41466.30	23.8699	23.8699	1	23.8699
1999-2000	-23613.14	11.8409	35.7108	2	17.8554
2000-2001	-25640.57	12.5533	48.2641	3	16.0880
2001-2002	14039.64	5.4846	53.7488	4	13.4372
Model 5: ARMAX(1_0_1,2,LEXC):$LXFQ_t$=11.356+.07375$LEXC_t$-6507$LXFQ_{t-1}$ +.66577e_{t-1}-3851e_{t-2}					
1998-1999	-32076.14	18.4645	18.4645	1	18.4645
1999-2000	-32786.01	16.4407	34.9052	2	17.4526
2000-2001	-3270.09	1.6010	36.5062	3	12.1687
2001-2002	14660.72	5.7272	42.2334	4	10.5584
Model 3: X(0_0_0,EXC): XFQ_t= 151402.5 + 0.09448 EXC_t					
1998-1999	-2318.13	1.33442	1.3344	1	1.33442
1999-2000	8450.21	4.23739	5.5718	2	2.78591
2000-2001	-6221.18	3.04582	8.6176	3	2.87255
2001-2002	-11521.99	4.50109	13.1187	4	3.27968
Model 4: ARMAX(1_0_1,2,EXC): XFQ_t= 148289.1+.08348EXC_t+.8022 XFQ_{t-1}-.5275e_{t-1}+.52233 e_{t-2}					
1998-1999	-19367.10	11.1486	11.1486	1	11.1486
1999-2000	4405.58	2.2092	13.3578	2	6.6789
2000-2001	3239.06	1.5858	14.9436	3	4.9812
2001-2002	1494.68	0.5839	15.5275	4	3.8819
Model 6: X(0_0_0,LXFQ): $LXFUSD_t$= 1.67073 $LXFQ_t$					
1998-1999	151349364	21.0387	21.039	1	21.0387
1999-2000	-23107539	3.3383	24.377	2	12.1885
2000-2001	-62052242	9.0926	33.470	3	11.1565
2001-2002	-49565845	70.6835	104.153	4	26.0383
Model 9: MAX(0_0_3,LXFQ): $LXFUSD_t$= 1.67027 $LXFQ_t$ -.55237 e_{t-3}					
1998-1999	18589988.85	2.5842	2.5842	1	2.5842
1999-2000	59693244.06	8.6237	11.2079	2	5.6039
2000-2001	-33026246.6	4.8394	16.0472	3	5.3491
2001-2002	-4278405670	67.2677	83.3149	4	20.8287
Model 7: X(0_0_0,XFQ): $XFUSD_t$= 3170.6 XFQ_t					
1998-1999	168592335.4	23.4356	23.4356	1	23.4356
1999-2000	59915338.89	8.6558	32.0915	2	16.0457
2000-2001	34845060.42	5.1059	37.1973	3	12.3991
2001-2002	-175591683	27.6076	64.8049	4	16.2012
Model 8: MAX(0_0_1, XFQ): $XFUSD_t$= 3061.9 XFQ_t +.49013 e_{t-1}					
1998-1999	71221769.36	9.9004	9.9004	1	9.9004
1999-2000	46694140.05	6.7458	16.6462	2	8.3231
2000-2001	34171230.43	5.0071	21.6533	3	7.2178
2001-2002	-164502114	25.8640	47.5173	4	11.8793

Table 6: Out-of Sample Forecast Errors of the Models of the Techniques

YEAR	ACTUAL	FORECAST	ERRORS	PE	SPE	N	MAPE
Model 1: ARIMA (1_1_0): ARI(1): ΔEXC_t= 301807.3 + 0.99 ΔEXC_{t-1}							
2002-2003	1511055	1832435.0	-321380.0	21.269	21.269	1	21.2686
2003-2004	1502995	2436042.9	-933047.9	62.079	83.348	2	41.6739
2004-2005	1429778	3039650.8	-1609872.8	112.596	195.944	3	65.3146
2005-2006	1360210	3643258.7	-2283048.7	167.845	363.789	4	90.9473
Model 2: X(0_0_0,LEXC): $LXFQ_t$= 11.3364 + 0.0756 $LEXC_t$							
2002-2003	255918	249362.50	6555.50	2.562	2.562	1	2.5616
2003-2004	217176	254788.25	-37612.25	17.319	19.880	2	9.9402
2004-2005	194594	259088.04	-64494.04	33.143	53.023	3	17.6744
2005-2006	118816	262660.30	-143844.30	121.065	174.088	4	43.5220
Model5: ARMAX(1_0_1,2,LEXC): $LXFQ_t$=11.356+.07375$LEXC_t$-.65072$LXFQ_{t-1}$+.66577e_{t-1}+.3851e_{t-2}							
2002-2003	255918	245542.86	10375.14	4.054	4.054	1	4.0541
2003-2004	217176	259902.22	-42726.22	19.674	23.728	2	11.8638
2004-2005	194594	252295.72	-57701.72	29.652	53.380	3	17.7933
2005-2006	118816	263463.37	-144647.37	121.741	175.121	4	43.7802
Model 3: X(0_0_0,EXC): XFQ_t= 151402.5 + 0.09448 EXC_t							
2002-2003	255918	324533.8	-68615.8	26.812	26.812	1	26.812
2003-2004	217176	381563.6	-164387.6	75.693	102.505	2	51.252
2004-2005	194594	438593.4	-243999.4	125.389	227.894	3	75.965
2005-2006	118816	495623.2	-376807.2	317.135	545.029	4	136.257
Model 4: ARMAX(1_0_1,2,EXC): XFQ_t= 148289.1+.08348EXC_t+.80219 XFQ_{t-1}-.5275e_{t-1}+.52233e_{t-2}							
2002-2003	255918	306261.9	-50343.9	19.672	19.672	1	19.672
2003-2004	217176	356440.6	-139264.6	64.125	83.797	2	41.899
2004-2005	194594	405879.9	-211285.9	108.578	192.375	3	64.125
2005-2006	118816	455506.8	-336690.8	283.372	475.747	4	118.937
Model 6: X(0_0_0,LXFQ): $LXFUSD_t$= 1.67073 $LXFQ_t$							
2002-2003	593690721	1012643571.3	-418952850.3	70.5675	70.568	1	70.5675
2003-2004	878754034	1113511574.6	-234757540.6	26.7148	97.282	2	48.6412
2004-2005	1554156298	1059600457.4	494555840.6	31.8215	129.104	3	43.0346
2005-2006	1075778854	1139119217.2	-63340363.2	5.8879	134.992	4	33.7479
Model 9: MAX(0_0_3,LXFQ): $LXFUSD_t$= 1.67027 $LXFQ_t$ -.55237 e_{t-3}							
2002-2003	593690721	957925797.05	-364235076.1	61.3510	61.351	1	61.3510
2003-2004	878754034	1136392351.0	-257638317.0	29.3186	90.670	2	45.3348
2004-2005	1554156298	1399731792.0	154424506.0	9.9362	100.606	3	33.5353
2005-2006	1075778854	1132566154.3	-56787300.3	5.2787	105.885	4	26.4711
Model 7: X(0_0_0,XFQ): $XFUSD_t$= 3170.6 XFQ_t							
2002-2003	593690721	778520263.63	-184829542.63	31.1323	31.132	1	31.1323
2003-2004	878754034	824048161.66	54705872.34	6.2254	37.358	2	18.6788
2004-2005	1554156298	799930948.12	754225349.88	48.5296	85.887	3	28.6291
2005-2006	1075778854	835339167.81	240439686.19	22.3503	108.238	4	27.0594
Model 8: MAX(0_0_1, XFQ): $XFUSD_t$= 3061.9 XFQ_t +.49013 e_{t-1}							
2002-2003	593690721	671189744	-77499023	13.0538	13.0538	1	13.0538
2003-2004	878754034	795783849	82970185	9.4418	22.4956	2	11.2478
2004-2005	1554156298	772493840	781662458	50.2950	72.7905	3	24.2635
2005-2006	1075778854	806687581	269091273	25.0136	97.8042	4	24.4510

In comparing Model 5 with Model 4, even two series are more linearly correlated in the natural logarithmic values than the original values, Model 4 did better prediction than Model 5 based on the original hazelnut export quantity and the foreign exchange rate (see Table 5). This result indicates the power of moving average factor in an accurate prediction. Inclusions of MA factor undertakes the effect of errors arising from the weakness of linearity or a mathematical form selection showing a tendency in favor of smaller sample or out-of sample forecast error. This result also indicates the outperforming power of the ARMAX technique over the econometric cause-effect technique.

Surprisingly, the outperformance of ARMAX technique over simple econometric cause-effect technique for in-sample prediction didn't show persistency in four steps ahead out-of sample comparison, which is for 2002-2005 hazelnut seasons only for the pair of Model 5 compared with simple Model 2. But ARMAX type models are expected to recover large forecast errors arising from unexpected shocks quicker than the simple econometric models. For other out-of sample comparisons ARMAX technique outperformed simple technique as seen in Table 6.

7. CONCLUSION

The models which satisfying white noise criterion indicated structural change neither between hazelnut export and exchange rate nor between hazelnut export receipts and hazelnut export quantities.

Yavuz et al. (2005:5-6) found Turkish hazelnut export positvely related to world hazelnut prices, world almond prices and stock level and negatively related to the export fund. Hence, Turkish hazelnut is substitute for world hazelnut and almond, but Turkish hazelnut elasticity with respect to world hazelnut and almond are found inelastic by the authors. They suggest politicians a target price very close to production cost and market price level and a direct income support only to producers to be competetive at international market and to eliminate excees of hazelnut supply. Their findings of inelastic price elasticities support our finding indirectly but lowering export price via devaluations does not impove Turkish hazelnut export revenues.

Foreign importers are concerned with TL per USD when they demand Turkish hazelnut, and the foreign exchange rate can be substituted for the hazelnut export price. Having inelastic foreign exchange rate elasticity of the hazelnut export quantity means that substitution of Turkish hazelnut is low, therefore, Turkey can increase its hazelnut export receipt by asking higher hazelnut export price rather than making it cheaper through devluations of domestic currency. In other words, one percent devaluation yields an increase in the hazelnut export quantity by less than one percent. And one percent increase in the hazelnut export quantity increases the hazelnut export revenue about 1.67 percent. In other words; a one-percentage increase in the hazelnut export revenues requires about 0.598 percentage increase in the export quantity. Indirectly, it means about 7.92 percentage appretiation in USD versus TL. To increase hazelnut export quantity about one percentage requires devaluation more than one percentage, this means decrease in hazelnut export revenue as a result of devaluation.

There existed a consistency between prediction criteria and MAPE criterion in-sample accuracy comparisons. As a result, the ARMAX type models often do better predictions than the simple econometric cause-effect models do on the average. In comparison of the simple econometric-cause-effect with the ARMAX technique, the ARMAX technique outperformed the simple cause-effect technique on the average by

75 percent in terms of MAPE criterion for one to four steps ahead forecasting. Therefore, the forecasts with ARMAX technique may be recommended economic agents in defining a strategy depending on forecasts instead of simple econometric technique. For the season of 2002-2010, we forecast hazelnut export revenues to increase further based on the existence pattern.

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