Econ 301-03 Assignment #5 (Econometrics I, Prof. Hakan Berument)

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Report

on

Analysis of factors affecting the return of Arçelik A. Ş.

The return of Arçelik A. Ş., a big multinational Turkish company producing mainly household appliances, is affected by several factors. The main factor that influences the return of the firm is the return of BIST100 index that includes many important companies traded in the Borsa Istanbul stock market. Two other factors influencing ARCLK return that could be gathered are the percentage change in Lead Futures prices and the August effect. Since lead is one of the metals used widely as an input in the production of household appliances, it affects the profitability of the firm and thus its stock returns. Another factor, August effect, as seen in the sample data has the most explanatory power on ARCLK return among all other months' effects. In order to check and verify the particular effects that are present in such model, the regression analysis and various hypotheses testing[1] have to be done.

Before coming up with conclusions under the standard method (OLS),[2] several regression assumptions must be checked. In order for estimation results to be reliable, the possibilities of having data problems such as heteroskedasticity and autocorrelation should be rejected or otherwise the corrected version should be used. Firstly, heteroskedasticity, the problem of having different variability throughout the data, is tested by White's Heteroskedasticity test, which results in disproving this assumption. Thence, homoskedasticity, the constant dispersion along the data, is assumed. This problem is rather common within cross section data that is not the case in this model. As it is a times series data set, there is more tendency towards another problem – autocorrelation. After conducting the Durbin-Watson test for both positive and negative autocorrelation, it can be seen that there is no positive autocorrelation but the test is inconclusive about the negative one. Even so, there is still a chance of having negative autocorrelation and it can be tested with Breusch-Godfrey test that checks the autoregressive error structure of

[1] All specified hypotheses testing are reported in the Appendix in the same order.
[2] Ordinary Least Squares method

different levels. The test demonstrates the presence of negative autocorrelation that is affected by two previous periods. Under such circumstances the initial estimated OLS output is no longer reliable. Therefore, its corrected version with the White's robust standard errors will be used for further analysis.

The primary concern is to determine whether the overall model truly influences the return of ARCLK equity, i. e. to check if there is any relationship at all between the returns of Arçelik A. Ş. and variables such as the return of BIST100 index, percentage change in Lead Futures prices and the August effect. After performing the hypothesis testing for the significance of the model,[3] it may be seen that having no relationship gets disproved with 5% acceptable error amount. Thus, in this model the above mentioned variables are assumed to have some effects on the ARCLK return.

An important characteristic to check is the mean of the returns of Arçelik A. Ş. when the key variables such as the return of BIST100, the change in lead prices and the August effect are zero.[4] Several tests conducted show that the mean of ARCLK return is not zero without the key variables. The positive return of the firm is even proved. Consequently, with zero return of BIST100, with no change in lead prices and no August effect altogether the average return of Arçelik A. Ş. is assumed to be positive. It means that under neutral and unchanging circumstances the ARCLK equity return is still positive that may worth investing in it to gain profit.

As the primary factor influencing the ARCLK return is the return of BIST100 index that captures the overall financial situation of main Turkish companies, it is useful to determine whether there is any relationship at all between them.[5] After performing the hypothesis testing, it may be seen that having no relationship gets disproved with the given significance level. Another test concludes that BIST100 return affects positively on the ARCLK return. Moreover, to understand whether both of the returns have more or less one-to-one relationships, i. e. for ARCLK equity to have the same increase or decrease in return as BIST100 does, several other tests have to be conducted. First test that equally concentrates on all possibilities failed to reject the basic assumption of having one-to-one relationship between the two returns, while another test based on the idea to prove lower increase in ARCLK return as BIST100 return increases was successful. Hence, these tests draw an assumed conclusion that ARCLK return increases or decreases less in proportion

[3] F-test here, but all subsequent hypotheses are done with t-test.
[4] These are hypotheses testing of β1 and their interpretation.
[5] These are hypotheses testing of β2 and their interpretation.

than BIST100 return does. In other words, the firm is affected by the overall trend of Turkish companies but with a slower pace.

Furthermore, it is important to check the effect of percentage change in Lead Futures prices on the firm return.[6] The hypothesis testing conducted depicts that lead prices indeed affect the return of Arçelik A. Ş. In addition, several other tests conducted to show the one-to-one relationship between the lead prices and the firm's return demonstrate that there is no one-to-one relationship and that lead prices have negative effect on ARCLK return. That is quite expected because an increase in input cost results in lower profitability of the firm. The less profit the firm gains, the fewer dividends it pays to its stocks, thus negatively affecting its price and return.

Finally, checking whether the August effect[7] on ARCLK stock return holds is very essential.[8] After performing the hypothesis testing, it can be seen that it truly affects the return of Arçelik A. Ş. Another test shows that the August effect has negative influence on the firm's return. Having negative effect on the return of the equity, the reason for August month to have some influence may be that the demand for household appliances or Arçelik A. Ş.'s products decreases towards the end of the summer. Therefore, August effect is assumed to negatively impact the firm return.

In a nutshell, according to all hypotheses testing performed after resolving the data problems, the main assumed conclusions drawn are that the overall model and all variables left alone are significant and have explanatory power on the return of Arçelik A. Ş., in particular BIST100 return influences it positively resulting in lower proportion of change in the firm's return, the percentage change in Lead Futures prices and August month both affect negatively on the ARCLK return, and without any of those average return of the firm is assumed to be positive. Having this information, one may apply it for the investment purposes in stock market to gain profits. Keeping track of the abovementioned variables influencing the ARCLK return, buying the stock when it is expected to fall in price according to this model and selling it later on is recommended. For instance, among the simplest ones, the August effect may suggest that the price/return of ARCLK equity tends to fall towards August and thus, buying then and selling later would be profitable. Therefore, the results of this model and hypotheses testing can be analyzed and used in a meaningful way.

[6] These are hypotheses testing of β3 and their interpretation.
[7] It is a binary (dummy) variable.
[8] These are hypotheses testing of β4 and their interpretation.

Appendix

> EViews output of the OLS estimated equation of firm's return (ARCLK share), which is ARCLK Return = $\beta_1 + \beta_2$ BIST100 Return + β_3 ln(LeadFuturesPrices) + β_4 AugustEffect + u, is given below.[9]

Dependent Variable: RETURN_OF_ARCLK
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 11/21/17 Time: 16:08
Sample: 2013M08 2017M09
Included observations: 50
RETURN_OF_ARCLK = C(1) + C(2)*RETURN_OF_BIST_100 + C(3)*LOG(LEAD)+ C(4)*AUG_EFFECT

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	111.1013	55.43005	2.004351	0.0509
C(2)	0.760105	0.151980	5.001346	0.0000
C(3)	-14.39776	7.297879	-1.972870	0.0545
C(4)	-6.053587	2.825093	-2.142792	0.0375

R-squared	0.458709	Mean dependent var	1.668680
Adjusted R-squared	0.423408	S.D. dependent var	7.623437
S.E. of regression	5.788754	Akaike info criterion	6.426330
Sum squared resid	1541.445	Schwarz criterion	6.579292
Log likelihood	-156.6582	Hannan-Quinn criter.	6.484578
F-statistic	12.99403	Durbin-Watson stat	2.528116
Prob(F-statistic)	0.000003		

For the hypotheses testing the significance level (α) is taken as 5%.

> Test for Heteroskedasticity.

Since the presence and the form of heteroskedasticity are unknown, the White's test will be used for testing it.

1. White's heteroskedasticity test.

$\varepsilon^2 = \alpha_1 + \alpha_2$ BIST100Return + α_3 ln(Lead) + α_4 AugustEffect + α_5 BIST100Return^2 + α_6 ln(Lead)^2 + α_7 BIST100Return ln(Lead) + α_8 BIST100Return AugustEffect + α_9 ln(Lead) AugustEffect + v

For the reason that AUG_EFFECT and AUG_EFFECT^2 are same, the latter was omitted to avoid perfect multicollinearity.

H_0: $\alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = \alpha_7 = \alpha_8 = \alpha_9 = 0$.

[9] Monthly observations of time period between August 2013 and September 2017 were collected.

H_A: Not H_0.

Dependent Variable: RESID_SQ
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 12/24/17 Time: 23:53
Sample: 2013M08 2017M09
Included observations: 50
RESID_SQ = C(1) + C(2)*RETURN_OF_BIST_100 +
C(3) *LOG(LEAD) + C(4)*AUG_EFFECT +
C(5)*RETURN_OF_BIST_100^2 + C(6) *LOG(LEAD)^2 +
C(7)*RETURN_OF_BIST_100*LOG(LEAD) +
C(8)*RETURN_OF_BIST_100*AUG_EFFECT +
C(9)*LOG(LEAD)*AUG_EFFECT

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	6428.998	40628.29	0.158239	0.8750
C(2)	107.4186	95.07871	1.129786	0.2651
C(3)	-1575.447	10702.34	-0.147206	0.8837
C(4)	-688.5567	1788.292	-0.385036	0.7022
C(5)	-0.009218	0.229081	-0.040239	0.9681
C(6)	96.50409	704.6863	0.136946	0.8917
C(7)	-13.87938	12.47218	-1.112827	0.2723
C(8)	-3.105310	6.587842	-0.471370	0.6399
C(9)	89.32386	233.6166	0.382352	0.7042

R-squared	0.097170	Mean dependent var	30.82890
Adjusted R-squared	-0.078992	S.D. dependent var	52.31710
S.E. of regression	54.34416	Akaike info criterion	10.99010
Sum squared resid	121084.8	Schwarz criterion	11.33426
Log likelihood	-265.7525	Hannan-Quinn criter.	11.12116
F-statistic	0.551593	Durbin-Watson stat	1.891952
Prob(F-statistic)	0.810505		

$n*R^2 = 50 * 0.097170 = 4.8585$

χ^2-statistics = $\chi^2_{8,0.05} = 15.507$

Since 4.8585 is not > χ^2_8=15.507, fail to reject the null of homoscedasticity.

> Test for Autocorrelation.

2. Durbin-Watson test.

* Test for positive autocorrelation.

H_0: $\rho = 0$.
H_A: $\rho > 0$.

DW = 2.528116

n = 50

k = 3

Table values:

dl = 1.42

du = 1.67

Since DW=2.528116 > du=1.67, fail to reject the null.

* Test for negative autocorrelation.

H_0: $\rho = 0$.
H_A: $\rho < 0$.

DW* = 4 – DW = 1.471884

Since dl=1.42 < DW*=1.47 < du=1.67, the test is inconclusive.

Still there is a chance of having negative autocorrelation that can be checked by regressing the error on its lags.

3. Breusch-Godfrey test.

Several outputs of regressing the error on its p lags:

When p = 1:

Dependent Variable: RESID01
Method: Least Squares
Date: 12/25/17 Time: 01:10
Sample (adjusted): 2013M09 2017M09
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	-0.282721	0.135753	-2.082615	0.0426

R-squared	0.082169	Mean dependent var	0.152419
Adjusted R-squared	0.082169	S.D. dependent var	5.561264
S.E. of regression	5.327887	Akaike info criterion	6.203984
Sum squared resid	1362.546	Schwarz criterion	6.242592
Log likelihood	-150.9976	Hannan-Quinn criter.	6.218632
Durbin-Watson stat	2.195181		

When p = 2:

Dependent Variable: RESID01
Method: Least Squares
Date: 12/23/17 Time: 16:38
Sample (adjusted): 2013M10 2017M09
Included observations: 48 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	-0.381220	0.136608	-2.790607	0.0076
RESID01(-2)	-0.367283	0.134370	-2.733380	0.0089

R-squared	0.204810	Mean dependent var	0.075973
Adjusted R-squared	0.187523	S.D. dependent var	5.594037
S.E. of regression	5.042324	Akaike info criterion	6.114385
Sum squared resid	1169.551	Schwarz criterion	6.192352
Log likelihood	-144.7452	Hannan-Quinn criter.	6.143849
Durbin-Watson stat	2.079299		

When p = 3:

Dependent Variable: RESID01
Method: Least Squares
Date: 12/25/17 Time: 01:13
Sample (adjusted): 2013M11 2017M09
Included observations: 47 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	-0.428703	0.149080	-2.875657	0.0062
RESID01(-2)	-0.395781	0.150193	-2.635144	0.0116
RESID01(-3)	-0.112741	0.148241	-0.760523	**0.4510**

R-squared	0.211494	Mean dependent var	-0.027417
Adjusted R-squared	0.175652	S.D. dependent var	5.607967
S.E. of regression	5.091675	Akaike info criterion	6.154792
Sum squared resid	1140.707	Schwarz criterion	6.272887
Log likelihood	-141.6376	Hannan-Quinn criter.	6.199232
Durbin-Watson stat	2.022887		

Hypotheses testing is given in the table below, $T-p\ R^2 \sim \chi_p^2$ will be tested.

p	R2	T - p	R2 * (T-p)	Table value	Result
1	0,082169	49	4,026281	3,841	Reject the null
2	0,20481	48	9,83088	5,991	Reject the null
3	0,211494	47	9,940218	7,815	Reject the null

As seen the results, all 3 models up to 3rd lag are said to be significant. However, the 3rd lag left alone is not significant as seen in the abovementioned output table. Therefore, to be efficient, it should be omitted and p=2 to be assumed.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	-0.381220	0.136608	-2.790607	0.0076
RESID01(-2)	-0.367283	0.134370	-2.733380	0.0089
R-squared	0.204810			

Having negative coefficients, the residual lags and Breusch-Godfrey test altogether demonstrate the presence of negative autocorrelation in the initial model. Hence, some statistics along with variances and standard errors are wrong in that model. The corrected version should be used (HAC – Newey-West):

Dependent Variable: RETURN_OF_ARCLK
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 12/25/17 Time: 01:51
Sample: 2013M08 2017M09
Included observations: 50
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)
RETURN_OF_ARCLK = C(1) + C(2)*RETURN_OF_BIST_100 + C(3)*LOG(LEAD)+ C(4)*AUG_EFFECT

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	111.1013	30.93511	3.591430	0.0008
C(2)	0.760105	0.136027	5.587904	0.0000
C(3)	-14.39776	4.059210	-3.546938	0.0009
C(4)	-6.053587	2.351964	-2.573843	0.0133

R-squared	0.458709	Mean dependent var	1.668680
Adjusted R-squared	0.423408	S.D. dependent var	7.623437
S.E. of regression	5.788754	Akaike info criterion	6.426330
Sum squared resid	1541.445	Schwarz criterion	6.579292
Log likelihood	-156.6582	Hannan-Quinn criter.	6.484578
F-statistic	12.99403	Durbin-Watson stat	2.528116
Prob(F-statistic)	0.000003	Wald F-statistic	15.32518
Prob(Wald F-statistic)	0.000000		

This estimation output will be used further on.

> Various hypotheses testing for the above estimated equation.

Degrees of freedom (df) = n - k = n - 4 = 46.

* <u>Testing the significance of the overall model</u>:

4. H_0: $\beta_2 = \beta_3 = \beta_4 = 0$.
   H_A: Not H_0.

Model	SSR	n	k	df=n-k
Restricted	2847,722	50	1	49
Unrestricted	1541,445	50	4	46

$$F = \frac{(2847{,}722 - 1541{,}445) / (49 - 46)}{1541{,}445 / 46}$$

$$F = \boxed{12{,}99402876}$$

F-critical = $F_{3, 46, 0.05}$ ~= 2.84.

Since F-statistic=12,994 > F-critical=2.84, the null hypothesis is rejected.

* <u>For</u> β_1:

5. H_0: $\beta_1 = 0$.
   H_A: $\beta_1 \neq 0$.

Test statistic = t = (111.1013 - 0) / 30.93511 = 3.591430.

Critical value = $t_{46, 0.025}$ =~ 2.00.

Since t=3.591430 > t-critical=2.00, the null hypothesis is rejected.

6. H_0: $\beta_1 = 0$.
   H_A: $\beta_1 > 0$.

Test statistic = t = (111.1013 - 0) / 30.93511 = 3.591430.

Critical value = $t_{46, 0.05}$ =~ 1.67.

Since t=3.591430 > t-critical=1.67, the null hypothesis is rejected.

* <u>For</u> β_2:

7. H_0: $\beta_2 = 0$.
   H_A: $\beta_2 \neq 0$.

Test statistic = t = (0.760105 - 0) / 0.136027 = 5.587904.

Critical value = $t_{46, 0.025}$ =~ 2.00.

Since t=5.587904 > t-critical=2.00, the null hypothesis is rejected.

8. H_0: $\beta_2 = 0$.
   H_A: $\beta_2 > 0$.

Test statistic = t = (0.760105 - 0) / 0.136027 = 5.587904.

Critical value = $t_{46,\ 0.05}$ =~ 1.67.

Since t=5.587904 > t-critical=1.67, the null hypothesis is rejected.

9. H_0: $\beta_2 = 1$.
   H_A: $\beta_2 \neq 1$.

Test statistic = t = (0.760105 - 1) / 0.136027 = -1.76358.

Critical value = $t_{46,\ 0.025}$ =~ 2.00.

Since | t |=1.76358 is not > t-critical=2.00, fail to reject the null hypothesis.

10. H_0: $\beta_2 = 1$.
    H_A: $\beta_2 < 1$.

Test statistic = t = (0.760105 - 1) / 0.136027 = -1.76358.

Critical value = $t_{46,\ 0.05}$ =~ 1.67.

Since t= -1.76358 < -t-critical= -1.67, the null hypothesis is rejected.

* <u>For</u> β_3:

11. H_0: $\beta_3 = 0$.
    H_A: $\beta_3 \neq 0$.

Test statistic = t = (-14.39776 - 0) / 4.059210 = -3.546938.

Critical value = $t_{46,\ 0.025}$ =~ 2.00.

Since | t |=3.546938 > t-critical=2.00, the null hypothesis is rejected.

12. H_0: $\beta_3 = 1$.
    H_A: $\beta_3 \neq 1$.

Test statistic = t = (-14.39776 - 1) / 4.059210 = -3.79329.

Critical value = $t_{46,\ 0.025}$ =~ 2.00.

Since | t |=3.79329 > t-critical=2.00, the null hypothesis is rejected.

13. H_0: $\beta_3 = 0$.
    H_A: $\beta_3 < 0$.

Test statistic = t = (-14.39776 - 0) / 4.059210 = -3.546938.

Critical value = $t_{46,\ 0.05}$ =~ 1.67.

Since t-stat= -3.546938 < -t-critical= -1.67, the null hypothesis is rejected.

* For β_4:

14. Checking whether the model with an August effect is the same without it:

$\beta_1 + \beta_2$ BIST100 Return + β_3 ln(LeadFuturesPrices) + β_4*1 + u =
= $\beta_1 + \beta_2$ BIST100 Return + β_3 ln(LeadFuturesPrices) + β_4 *0 + u

$\beta_4 * 1 + u = \beta_4 * 0 + u$

$\beta_4 = 0$

Hypothesis testing:

H_0: $\beta_4 = 0$.
H_A: $\beta_4 \neq 0$.

Test statistic = t = (-6.053587 - 0) / 2.351964 = -2.573843.

Critical value = $t_{46,\ 0.025}$ =~ 2.00.

Since | t |=2.573843 > t-critical=2.00, the null hypothesis is rejected.

15. H_0: $\beta_4 = 0$.
H_A: $\beta_4 < 0$.

Test statistic = t = (-6.053587 - 0) / 2.351964 = -2.573843.

Critical value = $t_{46,\ 0.05}$ =~ 1.67.

Since t-stat= -2.573843 < -t-critical= -1.67, the null hypothesis is rejected.

References.

1. www.investing.com was used for data collection of ARCLK, BIST100 and Lead Futures monthly prices.
2. The EViews program was used to reveal the output of regression analysis.