CHAPTER 4

EMPIRICAL IMPORT DEMAND FUNCTIONS

This chapter will be interpreting the result of the study; we use OLS method to estimate the structure parameters during period 1964 – 2000. The results of estimation by using the Economic View program can be written as follows:

1. *Intermediate products chiefly for consumer goods*

$$Log\ (imt_1) = -2.973090 + 0.061463\ log\ (Exc) + 1.575548\ log\ (GDP)$$
t-stat. (-3.208594) (0.178587) (37.66988)
R-squared = 0.989208 DW = 1.098

$$Log\ (imt_2) = 0.322163 + 1.212578\ log\ (Exc) + 0.371224\ log\ (GDP)$$
t-stat. (0.259996) (2.634707) (6.637158)
R-squared = 0.831128 DW = 1.682

$$Log\ (imt_3) = -0.822796 - 0.800137\ log\ (Exc) + 1.684943 log\ (GDP)$$
t-stat. (-0.426775) (-1.117385) (19.36189)
R-squared = 0.956680 DW = 0.340

$$Log\ (imt_4) = 0.507282 - 0.194395\ log\ (Exc) + 1.072459 log\ (GDP)$$
t-stat. (0.332046) (0.349855) (17.61593)
R-squared = 0.954101 DW = 0.516

$$Log\ (imt_5) = 0.253667 + 0.098198\ log\ (Exc) + 1.045799\ log\ (GDP)$$
t-stat. (0.140893) (0.146845) (12.86855)
R-squared = 0.915268 DW = 0.258

$$Log\ (imt_6) = 1.841976 - 0.212782\ log\ (Exc) + 1.030133\ log\ (GDP)$$
t-stat. (2.611725) (-0.812287) (32.35880)
R-squared = 0.984785 DW = 0.511

$$Log\ (imt_7) = -0.149659 + 0.578458\ log\ (Exc) + 1.208000\ log\ (GDP)$$
t-stat. (-0.308216) (3.207420) (55.11566)
R-squared = 0.995310 DW = 0.889

If we look at value of t-stat from equation 1- 7, we can conclude that the exchange rate variables in the second and seventh equation are highly significant because the computed t are all greater than the critical t-stat (from t-distribution table) which is 1.96 at 95% level of significance. In short, we might say these two model is reliable, however, we still have to check some other problems of the model about autocorrelation because these statistical problems, if present, cause inefficiency in using the regression model to explain results.

Autocorrelation

Autocorrelation is a statistical problem of observations. This problem occurs when the errors associated with observations in a given time period carry over into future time periods, or we may say that the error terms from different time are correlated. Autocorrelation usually occurs in time-series studies, but sometimes it can occur in cross-section studies when the unit of observation has a natural ordering, e.g., by size or geography.[1]

Autocorrelation will not affect the unbiasedness or consistency of the ordinary least-squares regression(OLS) estimators, but it does affect their efficiency. This loss of efficiency will be masked by the fact that the estimates of the standard errors obtained from least-squares regression will be smaller than the true standard errors. In other words, the regression estimators will be unbiased but the standard error of the regression will be biased downward (in case of positive autocorrelation). This will lead to the conclusion that the parameter estimates are more precise than they actually are.

In this part we need to detect autocorrelation by the popular Durbin-Watson Test. The test involves the calculation of a test statistic based on the residuals from OLS procedure. The statistic is defined as

$$DW = \frac{\sum(u_t - u_{t-1})^2}{\sum u_t^2}$$

Durbin-Watson statistic lie in range of 0 to 4, with a value near 2 indicting no autocorrelation. If DW = 0, indicating perfect positive autocorrelation. Therefore, the closer DW is to 0, the greater the evidence of positive autocorrelation. If DW = 4, that is , there is perfect negative autocorrelation. Hence, the closer DW is to 4, the greater

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[1] Damodar N. Gujarati: Basic Econometrics, 3rd edition, McGraw Hill, 1995.

the evidence of negative autocorrelation. As computed DW is usually not exact to 0,2 or 4, we have to follow the decision rules given in the table below.

Table 4.1 Durbin-Watson Test: Decision Rules

Null hypothesis	*Decision*	*If*
No positive autocorrelation	Reject	$0 < d < d_L$
No positive autocorrelation	No decision	$d_U < d < d_L$
No negative correlation	Reject	$4-d_L < d < 4$
No negative correlation	No decision	$4-d_U < d < 4-d_L$
No autocorrelation	Do not reject	$d_U < d < 4-d_U$

According to the results of equation 1-7, when we look at DW test tables we find that for 37 observations and 2 explanatory variables, $d_U = 1.59$ and $d_L = 1.37$ at the 5% level. Only in the second equation has DW value = 1.682 which lie in the no autocorrelation range, other equations we can not reject hypothesis that there are positive autocorrelation.

To improve the models we reestimate the Intermediate imports equation 1-7 exclude the second equation by using the Cochrane-Orcutt procedure.[2] The results are as follow: (For 1st order regressive scheme, AR (1))

$$Log\ (imt_1) = -3.050596 + 0.051439 \log (Exc) + 1.604865 \log (GDP)$$
t-stat. (-2.750632) (0.122569) (2.659767)
R-squared = 0.991314 DW = 1.975

$$Log\ (imt_2) = 0.322163 + 1.212578 \log (Exc) + 0.371224 \log (GDP)$$
t-stat. (0.259996) (2.634707) (6.637158)
R-squared = 0.831128 DW = 1.682

$$Log\ (imt_3) = -0.171945 - 0.534925 \log (Exc) + 1.481693 \log (GDP)$$
t-stat. (-0.075878) (-0.811502) (5.980698)
R-squared = 0.985884 DW = 2.061

$$Log\ (imt_4) = 1.665324 - 0.097530 \log (Exc) + 0.954855 \log (GDP)$$
t-stat. (1.039911) (0.183873) (7.483090)
R-squared = 0.979089 DW = 1.769

[2] Ibid.

$Log\ (imt_5) = -1.173659\ +\ 0.086708\ log\ (Exc)\ +\ 1.242995\ log\ (GDP)$
t-stat. (-0.527039) (0.158972) (5.396868)
R-squared = 0.979470 DW = 1.619

$Log\ (imt_6) = 0.924722\ -\ 0.176783\ log\ (Exc)\ +\ 1.143776\ log\ (GDP)$
t-stat. (0.729054) (-0.603375) (8.568205)
R-squared = 0.992886 DW = 2.207

$Log\ (imt_7) = -0.092366\ +\ 0.515450\ log\ (Exc)\ +\ 1.204434\ log\ (GDP)$
t-stat. (0.151502) (2.284905) (32.78916)
R-squared = 0.996573 DW = 2.135

These 7 equations fit relatively better than does the uncorrected equations. The t-stat are somewhat lower, but they are the correct, efficiently estimated statistics. Note finally that the DW statistics of equation 1-7 are lie in positive autocorrelation zones that are, we reject the null hypothesis at 5% level of significance. These suggest that more complex forms of correlation among the residuals might be present.

By comparing the coefficients of equation after remedy the original regression, we see that all values of coefficients are changed, but their sign are still the same. As the corrected regression is more efficient, interpretation following this model should be better because autocorrelation problem has already been reduced and the way to interpret this model is similar to what we did in the original model as well. Moreover, R^2 corrected model are very close to 1. This means the new regression line is fitter to the data than the old one.

2. Intermediate products chiefly for capital goods

$Log\ (imt_8) = -3.215652\ +\ 0.890291\ log\ (Exc)\ +\ 1.105821\ log\ (GDP)$
t-stat. (-2.779428) (2.071811) (21.17517)
R-squared = 0.970741 DW = 0.609

$Log\ (imt_9) = 2.656099\ -\ 0.353331\ log\ (Exc)\ +\ 1.252051\ log\ (GDP)$
t-stat. (3.754429) (-1.344662) (39.20824)
R-squared = 0.989445 DW = 0.709

$Log\ (imt_{10}) = 3.014167\ -\ 0.632916\ log\ (Exc)\ +\ 1.277539\ log\ (GDP)$
t-stat. (4.379015) (-2.475639) (41.11868)
R-squared = 0.990023 DW = 0.755

$Log\ (imt_{11}) = -0.158715 \ + 0.265586 \log (Exc) \ + 1.197747 \log (GDP)$
t-stat. (-0.160589) (0.723493) (26.84836)
R-squared = 0.979635 DW = 0.554

In the above regression equations, when we use DW (Durbin-Watson) test to check the presence of first-order serial correlation. (37 observations and 2 explanatory variables, $d_U = 1.59$ and $d_L = 1.37$ at the 5% level of significance) we find that the in equation 8-11 has low DW value which lie in the positive autocorelation range. We have to improve the models by using the Cochrane-Orcutt procedure. The results are as follow: (For 1st order regressive scheme, AR (1))

$Log\ (imt_8) = -1.633338 \ + 0.372339 \log (Exc) \ + 1.127841 \log (GDP)$
t-stat. (-1.108936) (0.731761) (10.36526)
R-squared = 0.984245 DW = 1.877

$Log\ (imt_9) = 2.597017 \ - 0.295206 \log (Exc) \ + 1.235028 \log (GDP)$
t-stat. (2.949818) (-0.920458) (20.52537)
R-squared = 0.993372 DW = 1.860

$Log\ (imt_{10}) = 2.708290 \ - 0.502458 \log (Exc) \ + 1.260971 \log (GDP)$
t-stat. (3.078296) (-1.567496) (21.45757)
R-squared = 0.993398 DW = 1.945

$Log\ (imt_{11}) = -0.491986 \ + 0.121696 \log (Exc) \ + 1.177052 \log (GDP)$
t-stat. (0.429505) (0.300801) (13.46777)
R-squared = 0.989781 DW = 1.838

These 4 equations fit relatively better than does the uncorrected equations. The t-stat are somewhat lower, but they are the correct, efficiently estimated statistics. Note finally that the DW statistics of equation 8-11 are lie in positive autocorrelation zones that are, we reject the null hypothesis at 5% level of significance. These suggest that more complex forms of correlation among the residuals might be present.

By comparing the coefficients of equation after remedy the original regression, we see that all values of coefficients are changed, but their sign are still the same. As the corrected regression is more efficient, interpretation following this model should be better because autocorrelation problem has already been reduced and the way to interpret this model is similar to what we did in the original model as well.

Moreover, R^2 corrected model are very close to 1. This means the new regression line is fitter to the data than the old one.

3. Capital Goods

$Log\ (imt_{12}) = 1.482756 - 0.063727\ log\ (Exc) + 1.059469\ log\ (GDP)$
t-stat. (1.725628) (-0.199678) (27.31627)
R-squared = 0.979318 DW = 0.544

$Log\ (imt_{13}) = 9.830086 - 4.319177\ log\ (Exc) + 1.227107\ log\ (GDP)$
t-stat. (0.269324) (-0.323102) (1.028966)
R-squared = 0.297685 DW = 0.777

$Log\ (imt_{14}) = 3.354902 - 0.010279\ log\ (Exc) + 0.403041\ log\ (GDP)$
t-stat. (1.447023) (-0.011936) (3.851245)
R-squared = 0.486402 DW = 0.342

$Log\ (imt_{15}) = 0.227910 - 0.503537\ log\ (Exc) + 1.220770\ log\ (GDP)$
t-stat. (0.101620) (-0.604478) (12.05887)
R-squared = 0.896511 DW = 0.308

$Log\ (imt_{16}) = -3.019799 + 0.893106\ log\ (Exc) + 1.117878\ log\ (GDP)$
t-stat. (-2.418544) (1.925799) (19.83472)
R-squared = 0.966754 DW = 0.637

$Log\ (imt_{17}) = -3.221318 + 0.769205\ log\ (Exc) + 1.109224\ log\ (GDP)$
t-stat. (-2.367685) (1.522174) (18.06198)
R-squared = 0.959465 DW = 0.823

$Log\ (imt_{18}) = -2.282158 + 1.222274\ log\ (Exc) + 1.043195\ log\ (GDP)$
t-stat. (-1.519549) (2.191136) (15.38829)
R-squared = 0.949187 DW = 0.338

$Log\ (imt_{19}) = 4.749526 - 0.812308\ log\ (Exc) + 1.229070\ log\ (GDP)$
t-stat. (6.333435) (-2.916365) (36.30960)
R-squared = 0.986862 DW = 0.859

$Log\ (imt_{20}) = -0.556030 - 0.114090\ log\ (Exc) + 0.931408\ log\ (GDP)$
t-stat. (-0.538543) (-0.297509) (19.98564)
R-squared = 0.961634 DW = 1.273

$Log\ (imt_{21}) = 9.931137 - 2.533342\ log\ (Exc) + 0.851416\ log\ (GDP)$
t-stat. (6.260455) (-4.299646) (11.89062)
R-squared = 0.844446 DW = 0.849

$$Log\ (imt_{22}) = 4.375137 - 0.801524\ log\ (Exc) + 1.266902\ log\ (GDP)$$
t-stat. (5.570419) (-2.747543) (35.73509)
R-squared = 0.986510 DW = 0.810

$$Log\ (imt_{23}) = -0.813185 + 0.190066\ log\ (Exc) + 1.467679\ log\ (GDP)$$
t-stat. (-0.906085) (0.570186) (39.22983)
R-squared = 0.988528 DW = 0.557

$$Log\ (imt_{24}) = -0.289875 - 0.175896\ log\ (Exc) + 1.358901\ log\ (GDP)$$
t-stat. (-0.331125) (-0.552396) (35.11620)
R-squared = 0.987226 DW = 0.300

$$Log\ (imt_{25}) = -4.535671 + 1.182750\ log\ (Exc) + 1.289244\ log\ (GDP)$$
t-stat. (-1.855918) (1.302993) (11.68714)
R-squared = 0.91565 DW = 1.921

$$Log\ (imt_{26}) = -1.599397 + 0.776484\ log\ (Exc) + 0.719521\ log\ (GDP)$$
t-stat. (-0.374718) (0.489793) (3.734626)
R-squared = 0.519853 DW = 1.718

In the above regression equations, when we use DW (Durbin-Watson) test to check the presence of first-order serial correlation. (37 observations and 2 explanatory variables, $d_U = 1.59$ and $d_L = 1.37$ at the 5% level of significance) we find that in the equation 12-26,there have only 25^{th} and 26^{th} equation that have DW value = 1.921, 1.728 which lie in the no autocorrelation.But in the other equations, they have low DW value which lie in the positive autocorelation range. We have to improve the models by using the Cochrane-Orcutt procedure. The results are as follow: (For 1^{st} order regressive scheme, AR (1))

$$Log\ (imt_{12}) = 1.770842 - 0.021171\ log\ (Exc) + 1.001525\ log\ (GDP)$$
t-stat. (1.845199) (-0.061123) (13.09473)
R-squared = 0.990062 DW = 2.191

$$Log\ (imt_{13}) = 3.162318 - 1.772821\ log\ (Exc) + 0.999112\ log\ (GDP)$$
t-stat. (0.303280) (-0.464764) (1.444430)
R-squared = 0.534317 DW = 1.437

$$Log\ (imt_{14}) = -20.96232 + 0.318953\ log\ (Exc) + 2.666930\ log\ (GDP)$$
t-stat. (-1.498050) (0.397246) (2.947016)
R-squared = 0.863346 DW = 2.674

Table 4.1 (continued)

	Exchange rate		Unitary/elastic /inelastic	GDP	
	Coefficient	t-stat		Coefficient	t-stat
16. Glass and other mineral manufactures	+		Unitary	+	*
17. Rubber manufactures	+		Unitary	+	*
18. Metal manufactures	+		Unitary	+	*
19. Non-electrical machinery and parts	-	*	Elastic	+	*
20. For agricultural use	-		Unitary	+	*
21. Tractors	-	*	Elastic	+	*
22. For industrial use	-	*	Elastic	+	*
23. Electrical machinery and parts	+		Unitary	+	*
24. Scientific and optical instruments	-		Unitary	+	*
25. Aircrafts and ships	+		Unitary	+	*
26. Locomotive and rolling stock	+		Unitary	+	*

(= The coefficient is significant at 95% level of confidence.)*

D. Other imports

	Exchange rate		Unitary/elastic /inelastic	GDP	
	Coefficient	t-stat		Coefficient	t-stat
27. Vehicles and parts	-	*	Elastic	+	*
28. Passenger cars	-	*	Elastic	+	
29. Buses and trucks	-	*	Elastic	+	*
30. Chassis and bodies	-	*	Elastic	+	*
31. Tires	-	*	Elastic	+	*
32. Fuel and lubricant	-		Unitary	+	*
33. Coke, briquettes, etc	+		Unitary	+	*
34. Crude oil	+		Unitary	+	*
35. Gasoline	-	*	Elastic	+	*
36. Diesel oil and special fuels	-	*	Elastic	+	*
37. Lubricant, aspna't, etc	-	*	Elastic	+	*
38. Miscellsneous	-		Unitary	+	*

(= The coefficient is significant at 95% level of confidence)*

The result from regressions after improve the model by using the Cochrane-Orcutt procedure is that in the first category; Intermediate products chiefly for consumer goods variables there are 2 equations from 7 equations that exchange rate has negative effect on these variables as expected which are 3^{rd} and 6^{th} and 2 equations that exchange rate was inelastic to intermediate imports which is 2^{nd} and

7^{th} equations. In the second category, Intermediate products chiefly for capital goods variables there are 2 equations from 4 equations that exchange rate has negative effect on these variables as expected which are 9^{th} and 10^{th} equations but exchange rate were unitary to intermediate imports in every equations. In the third category, capital goods variables there are 9 equations from 15 equations that exchange rate has negative effect on these variables as expected which is 12^{th}, 13^{th}, 15^{th}, 18^{th}, 19^{th}, 20^{th}, 21^{st}, 22^{nd} and 24^{th} equations but only 19^{th}, 21^{st} and 22^{nd} equations which exchange rate elastic to intermediate imports, the others are unitary. In the last category, other imports variables there are 10 equations from 12 equations that exchange rate has negative effect on these variables as expected which are 27^{th}, 28^{th}, 29^{th}, 30^{th}, 31^{st}, 32^{nd}, 35^{th}, 36^{th}, 37^{th} and 38^{th} equations. And exchange rate was elastic to intermediate imports in almost every equations exclude in 32^{nd}, 33^{rd}, 34^{th} and 38^{th} equations, which are unitary.

But in every equation GDP has positive effect on the dependent variables as expected that means when GDP change, there will effect to the intermediate products and capital goods in the positive way in every equation.