A FUNCTION FOR THE ARGENTINE EXPORT DEMAND

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Considering the fact that exports can be a driving force of growth, the purpose of the paper is to make an estimation of the Argentine export demand. As the exports are defined as a function of the income of the main trade partners and the relative prices, the income and price elasticities were obtained. Making use of the time-series techniques to detect for non stationarity, an ARDL model was estimated with OLS and 2SLS methods. The main findings are that exports are very sensitive to income but not to prices, suggesting that an impact of a real devaluation would not necessary improve the performance of the exports.

JEL classification: C2, F1

1. Introduction

The increasingly limited access to international financial markets that Argentina faces since it defaulted its external debt by the end of 2001 highlights the exports as an important source of finance for the importation of investments goods, vital for the country's growth process.

This paper offers an estimation of export demand elasticity with respect to the trade partners' income and to relative prices. The higher the income elasticity of the export demand the more significant is the effect of the world's growth. The higher the price elasticity is the greater the impact of a real devaluation over exports.

Section 2 formulates some questions to be answered from the model and lays out the link of the paper with the literature related to the subject. Section 3 presents the sources, definitions of the variables, properties and graphs of the data. Section 4 describes the estimation methods used while the Statistical Model is shown in Section 5. The conclusions are drawn in Section 6.

2. Theory

The purpose of the regression is to answer the following questions:
Do argentine exports react to relative prices and trade partners' income?
Can the country increase its market share through a real devaluation?

Senhadji & Montenegro (1999) and Reinhart (1995) estimated export demand functions for a large number of countries, among which was Argentina. The former authors suggest as price and income long run elasticities for Argentine exports -0.24 and 1.28, respectively, while Reinhart findings are -0.42 and 1.36.

In the literature, there is no consensus on whether real devaluation impact o not on trade balance. While Senhadji & Montenegro and Reinhart, Catao & Falcetti (2002) [1] find that the exchange rate have effect on trade balances, Rose (1990) questions the impact of devaluation on the trade balance. Ahumada (1996) mentions three previous studies for Argentina, where there is no evidence of short nor long run effects of the real exchange rate over the exports[2]. This dissertation adds evidence on this matter.

3. Data

The data comes mainly from the Argentine Institute of Statistics and Census (INDEC) and the IMF International Financial Statistics, although other resources have been used as well (Brazilian Institute of Geography and Statistic, Bureau of Labor Statistics Data, Bloomberg database, Central Banks of Chile and Uruguay).

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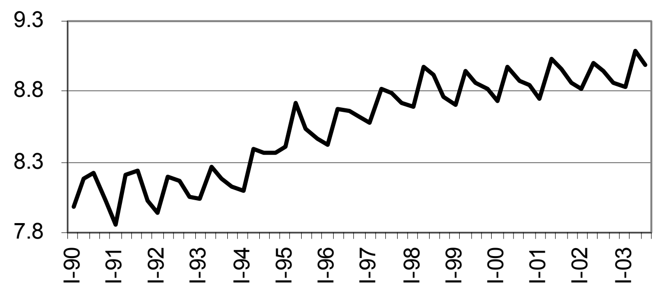
[1] Catao & Falcetti, as well as Ahumada (1996) estimate a supply equation, not a demand function for Argentina's total exports.

[2] These papers are Navajas, F.(1993), *Una Estimacion de la Funcion Agregada de Exportaciones, Argentina 1970-1992.* CEPAL, Buenos Aires; Mallon, R. and Sourrouille (1973), *La Politica Economica en una Sociedad Conflictiva*. El Caso Argentino, Amorrortu, Buenos Aires; Diaz Alejandro, C. (1970), *Ensayos sobre la Historia Economica Argentina*, Amorrortu, Buenos Aires.

The data is quarterly and the sample covers from 01:1990 to 03:2003. The variables are expressed in logarithms, indicated with the letter "l".

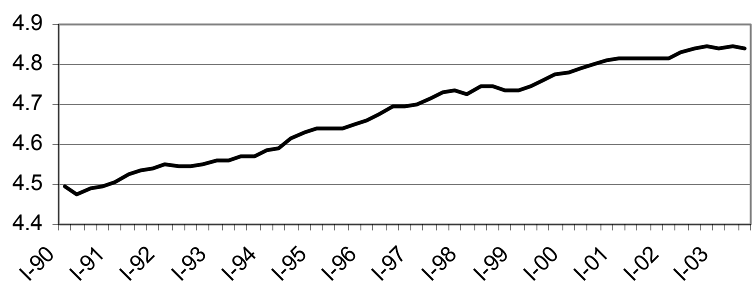
The data of the dependent variable, total exports (l*x*) has a trend, a seasonal component and a structural change at beginning of 1995 (Graph 1). This change can be explained by the effects of the trade liberalization, privatization and deregulation of foreign investment during the first half of the nineties and the implementation of the South American Customs Union (Mercosur). For all these reasons a dummy (*dum95*) was included in the regression, taking the value of 1 from 01:1995 onwards and 0 before, besides seasonal dummies ($s_{(1)}$, $s_{(2)}$,$s_{(3)}$).

Graph 1: lx



L*gdp* is a weighted average of the trade partner's gross domestic product that changes quarterly according to the share in Argentina's total exports.[3] This variable has a trend component but no seasonal component due to the fact that the data of these countries have been seasonally adjusted by the primary sources (Graph 2).

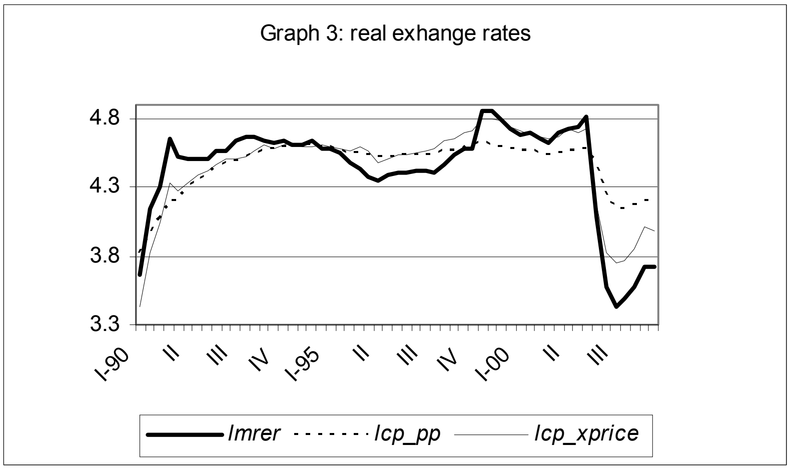
Graph 2: l*gdp*



The choice of the relative price variable was not straightforward. Initially it was considered that in order to capture closely Argentina's competitiveness the most appropriate variable would be a real multilateral exchange rate (l*mrer*), defined as the ratio of the domestic unit labour cost index to the average foreign unit labour cost indices weighted by the share in Argentina's exports and expressed in the same currency. Unfortunately, in the estimation of the exports by Ordinary Least Squares (OLS) this variable never gave the right sign and was

[3] Brazil, United States, Chile, Netherlands, Uruguay, Italy, Spain, Japan and Germany represent nearly 70% of the share in Argentina's total exports.

not statistically significant (the discarded regression is reproduced in the Appendix). Substitutions were made using the ratio between consumer prices, l*cp*, and producer prices, l*pp* (alternatively export prices, l*xprice*) as a proxy between non-tradable and tradable goods, but the results were very similar (Graph 3).



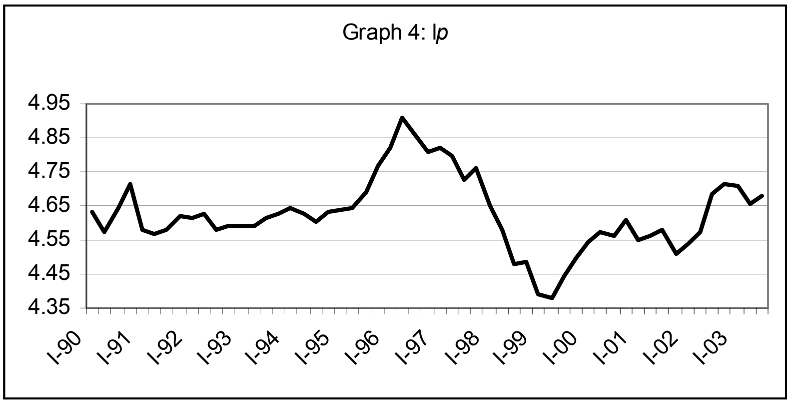
It could be thought that the problem aroused because of the existence of endogeneity on the right hand side of the regression. This gave way to the estimation by Two Stage Least Square, using as instrumental variable Argentina's imports. Nevertheless, the problem with l*mrer* persisted.

A plausible reason for this puzzle (wrong sign and insignificance of l*mrer*) could be due to the existence of structural changes caused by two crises in 04:1990 and 04:2001, the former corresponds to a period of hyperinflation and the latter to the default of Argentina's foreign debt. The breaks have no parallel in the evolution of the exports. These sudden changes in the real exchange rate were followed by disruptions in the economy and the banking system, affecting the credit and increasing the uncertainty.

Although it may not be theoretically the most appropriate choice, the l*mrer* was replaced by a value index containing the prices of the main products exported by Argentina (l*p*)[4] (Graph 4). Additionally, a measure of the real exchange rate volatility (l*varer*)[5] was incorporated to add the effects of price uncertainty (Graph 5).

[4] Wheat, corn, soya, soya oil, sunflower oil, soya pellets, oil. All though this index includes only commodities, it is was preferred to the export unit index from the INDEC, because this one was used to calculate the volume of export. Since Argentina's export are concentrated in a couple of raw materials and lightly processed primary goods, the index used is quite representative.

[5] For his purpose, the variance was calculated with the ratio between consumer and producer prices, since monthly data was available for these series, but not for l*mrer*.



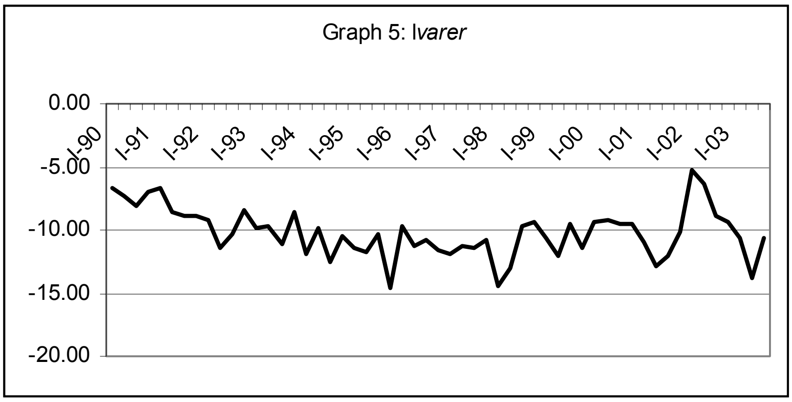


Table 1 shows the correlation of the exports with l*gdp*, l*p* and l*varer*, clearly high for the first variable and particularly low in the case of l*p*. In the Appendix (Section 8) are the scatter diagrams for these variables, where the not very clear relation between l*x* and l*p* is confirmed.

Table 1: Correlation with lx			
	l*gdp*	l*p*	l*varer*
l*x*	0.938116	-0.083610	-0.341411

To find the nature of the relation between the variables the unit-root hypothesis was tested using the Dickey Fuller (DF) or the Augmented DF (ADF) test. The lag length in the ADF regression was selected following the Akaike's (AIC) and the Schwarz's Information Criterion (SIC). In the equation estimated for l*x*, the *dum95* and the seasonal dummies were included. Only in this case, the two Information Criteria suggested different lag length, although the outcomes don't confront.

The results are reported in Table 2. The null hypothesis (H_o) of unit root cannot be rejected for any of the variables. The opposite should be said about l*varer*.

Table 2: Unit root tests				
Variable	**Information Criteria**	**Statistic**	**With trend 5% Critical Value: -3.5**	**Without trend 5% Critical Value: -2.9**
lx	AIC	ADF(4)	-2.02	-1.72
	SIC	DF	-3.25	-1.72
lgdp	AIC, SIC	ADF(1)	-1.42	-1.82
l*p*	AIC, SIC	ADF(4)	-2.67	-2.59
lvarer	AIC, SIC	DF	-4.58	-4.56

Since three of the four variables appear to be non-stationary, the following step was to test for cointegration among l*x*, l*gdp* and l*p*, in order to determine the existence of a long-run relationship between these variables. For this purpose, the Johansen methodology was used (Table 3). The cointegrating equation (CE) and VAR specification assumptions were chosen according to the Information Criteria.

Table 3: Cointegration test

Series: l*x* l*gdp* l*p*

Exogenous series: l*varer, dum95*, $s_{(1)}$, $s_{(2)}$,$s_{(3)}$

AIC				**SIC**			
Test assumption: Linear deterministic trend in the data				Test assumption: No deterministic trend in the data			
Lags interval: 1 to 2				Lags interval: 1 to 1			
Eigenvalue	Likelihood Ratio	5 % Critical Value	H_o: No. of CE(s)	Eigenvalue	Likelihood Ratio	5 % Critical Value	H_o: No. of CE(s)
0.535031	47.75227	29.68	None *	0.587364	59.33167	24.31	None *
0.126410	7.931529	15.41	At most 1	0.197300	12.41662	12.53	At most 1
0.017236	0.904064	3.76	At most 2	0.014397	0.768600	3.84	At most 2

* denotes rejection of the hypothesis at 5% significance level

Normalized Cointegrating Coefficients: 1 Cointegrating Equation

AIC

l*x*	l*gdp*	l*p*	*c* (constant)
1.000000	-2.142347	0.138074	0.877853
	(0.10048)	(0.05862)	

Log likelihood: 397.2894

SIC

l*x*	l*gdp*	l*p*
1.000000	-1.912286	0.176788
	(0.06107)	(0.06324)

Log likelihood: 383.8363

What ever Information Criteria we use, the results of the procedure indicate the existence of at least one cointegrating equation. The H_o of no cointegrating equation has been rejected.

4. Statistical Model

The starting point was an autoregressive dynamic linear regression, ARDL (3,3,3,3), where the variables were lagged three periods. It was estimated by OLS using a general to specific modelling (Hendry, D. and Doornik, J., 1996). The last four observations were separated from the sample for forecasting purposes.

$$lx = f(c, lx_{-j}, lgdp_{-j}, lp_{-j}, lvarer_{-j}, s_j), \qquad j=0,1,2,3$$

The variables in the right hand side of the equation, l*gdp,* l*p* and l*varer*, were initially treated as weakly exogenous, although it is not so clear that l*p* and l*varer* are not jointly determined with l*x*. If this were the case, the OLS estimators will be biased and inconsistent.

Since, the purpose of this dissertation is to estimate a single equation, the export function, and not a system of equations that simultaneously determine a number of endogenous variables, the alternative method was to use the Two-Least Squares (2SLS). The instrument variables incorporated to the model were $lp_{(-1)}$, dlm and $lm_{(-1)}$, where lm denotes Argentina's imports and $dlm = lm - lm_{(-1)}$.

5. Results

The OLS and 2SLS methods yield very similar results. The regression parameters in these differences and levels forms are reproduced in Table 4, followed by the main Diagnostic tests in Table 5.

Table 4: Estimated models
OLS:
$dlx = - 1.46 - 0.62\ lx_{(-1)} + 1.38\ lgdp + 1.81\ d6lgdp - 0.27\ d9lp - 0{,}008\ lvarer +$ (0.43) (0.10) (0.22) (0.48) (0.06) (0.003) $0.12dum95 - 0.03s_{(1)} + 0.23s_{(2)} + 0.05s_{(3)} + \mu_1,$ **[1]** (0.03) (0.02) (0.02) (0.01)
2SLS:
Instrument list: $c\ \ lx_{(-1)}\ \ lgdp\ \ d6lgdp\ \ d9lp_{(-1)}\ \ dlm\ \ lm_{(-1)}\ \ dum95\ \ s_{(1)}\ \ s_{(2)}\ \ s_{(3)}$
$dlx = - 1.67 - 0.71\ lx_{(-1)} + 1.59\ lgdp + 1.81\ d6lgdp - 0.33\ d9lp - 0{,}008\ lvarer +$ (0.51) (0.14) (0.30) (0.50) (0.09) (0.004) $0.14dum95 - 0.04\ s_{(1)} + 0.22\ s_{(2)} + 0.06\ s_{(3)} + \mu_1,$ (0.04) (0.02) (0.03) (0.02)

where $d6lgdp = lgdp - lgdp_{(-2)}$ and $d9lp = lp - lp(-3)$.

The program output of both estimations is attached in the Appendix as well as the graph of residuals, actual and fitted values of the dependent variable.

Table 5: Diagnostic tests		
	OLS	**2SLS**
Observations	48	47
R-squared	0.964927	0.963250
S.E. of regression	0.032162	0.032648
F-statistic (probability)	116.1600 (0.000000)	106.4305 (0.000000)
Durbin-Watson stat.	2.311198	2.045150
Breusch-Godfrey Serial Correlation LM Test (5 lags): statistic**(probability)** :		
F-statistic	0.423625 (**0.828857)**	2.408898 **(0.058085)**
Obs*R-squared	2.895089 (**0.716156)**	1.834548 **(0.871532)**
White Heteroskedasticity Test::		
F-statistic	1.380647 (**0.217009)**	1.507853 **(0.164319)**
Obs*R-squared	17.73001 (**0.219356)**	18.68139 **(0.177484)**
Normality Test:		
Jarque Bera statistic	0.109433 (**0.946754)**	0.019596 **(0.990250)**
Ramsey RESET Test (1 fitted term):		
F-statistic	0.011046 (**0.916866)**	1.758440 **(0.193172)**
Log likelihood ratio	0.014327 (**0.904723)**	
Chow Breakpoint Test: 1995:1		
F-statistic	0.38046 (**0.010536)**	5.206698 **(0.000309)**
Log likelihood ratio	31.09648 (**0.000285)**	
Chow Forecast Test: Forecast from 2002:4 to 2003:3		
F-statistic	0.554998 (**0.696587)**	1.822951 **(0.145124)**
Log likelihood ratio	2.952460 (**0.565812)**	

According to the tests, the residuals (μ_1,μ_2) of both regressions are not autocorrelated, homoscedastic and normally distributed. The stability tests show correct functional form, constant coefficient vectors and small discrepancies between the predicted and actual values. In the Appendix are the Cusum and Cusum of Squares graphs for the OLS estimation. Both suggest parameter constancy.

The sign of the coefficients are the expected by theory: the demand of export goods is a negative function of the export prices and of the real exchange rate volatility and a positive function of foreign gross domestic product.

From the results, it is possible to conclude that the estimates have good statistical properties. The coefficients of d9l*p* and l*varer* although small in the two regressions, are statically significant.

The validity of the instruments was verified with the Sargan test (Table 6). The H_o is that the coefficients of the exogenous and instrumental variables are all zero in a regression where the dependent variable is the residual of the 2SLS estimation (μ_2).

Table 6: Sargan test		
H_o: c(2)=c(3)=c(4)=c(5)= c(6)=c(7)=c(8)=c(9)=c(10)=c(11)=0*		
F-statistic 0.931658	Probability	**0.516479**
Chi-square 9.316581	Probability	**0.502346**
* c(..) are the coefficients of the variables included in the instrument list.		

The H_o can not be rejected. This implies that the errors of the regression are uncorrelated with the instruments.

To check whether l*p* and l*varer* are exogenous, the Wu-Hausman test was conducted (Table 7). The H_o is that the coefficients of the residuals of the two reduced form equations[6] included in the first equation [1] are zero.

Table 7: Wu-Hausman test		
H_o: c(11)=c(12)*		
F-statistic 0.269890	Probability	**0.765038**
Chi-square 0.539781	Probability	**0.763463**
* c(..) are the coefficients of the residuals of the reduced form regressions.		

The non rejection of H_o suggests that it is plausible to consider l*p* and l*varer* as exogenous. This can explain why the results from OLS and 2SLS are not very different.

[6] The two reduced form regressions are estimations of l*p* and l*varer* as a function of the exogenous and instrumental variables.

6. Conclusions

For the reasons mentioned in Section 5 and in order to derive the main conclusions of the regressions, the focus will be made on the OLS estimates (Table 3). As seen in [1], for the short run, the effect of the l*gdp* variable over the exports growth rate is significant: while an increase of 1% in the l*gdp* level raises dl*x* in 1.38%, an increase of 1% in the growth rate of the l*gdp* will raise the exports growth rate in 1.81%.

The effect of *p* is relatively small: a rise in 1% in l*p*'s growth rate produces a decrease of 0.27% in the export's growth rate.

The real exchange rate volatility affects marginally the export's growth rate. A 1% in l*varer* causes only a 0.008% decrease in dl*x*.

The long run solution can be obtained calculating the long run elasticities[7] in equation [1]:

$$lx = -\ 2.36 + 2.24 lgdp - 0.012\ lvarer + 0.19\ dum95 + 0.41\ s$$

The price does not appear in this solution, indicating that the exports are not responsive to prices in the long run.

The long term solution that can be obtained from the unrestricted model ARDL (3,3,3,3)[8] is quite similar.

$$\underset{}{dlx} = \underset{(1.04)}{-\ 1.65} + \underset{(0.17)}{2.16\ lgdp} - \underset{(0.09)}{0.08\ lp} - \underset{(0.005)}{0{,}013\ lvarer} + \underset{(0.04)}{0.21 dum95} - \underset{(0.12)}{0.39 s}$$

All though l*p* appears in the equation, it is not statistically significant.

According to these results, Argentina's exports are very responsive, in the short and long run, to the trade partner's income although not to prices. This suggests that the trade partner's growth contributes in an important way to the rise of Argentina's exports, but on the other hand, Argentina can not increase its market share through a real devaluation. The latter supports the evidence that relative prices have no significant and predictable impact on trade.

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[7] The long run elasticity is defined as the ratio of the short term elasticity divided by one minus the estimated coefficient of the lagged dependent variable. In the long run, for any z, $z = z_{(-1)} = z_{(-2)} = z_{(-3)}$.

[8] This was the starting point of the general to specific modelling.

7. References

Ahumada, H. (1996), “Exportaciones Argentinas: su comportamiento de largo plazo y su dinámica”, *Documentos de Investigación*, Instituto Torcuato Di Tella.

Catao, L. and Falcetti, E. (2002), “Determinants of Argentina’s External Trade”, *Journal of Applied Economics*, Vol. V, No. 1.

Enders, W. (1995), *Applied Econometric Time Series*, Wiley.

Hendry, D. and Doornik, J. (1996), *Empirical Modelling Using PcGive 9.0 for Windows*, International Thomas Business Press.

Reinhart, C., “Devaluation, Relative Prices and International Trade. Evidence from Developing Countries”, *IMF Staff Papers*, Vol. 42, No.2

Rose, A., “Exchange Rates and the Trade Balance: Some Evidence from Developing Countries”, *Economic Letters*, Vol. 34.

Senhadji, A. and Montenegro, C. (1999), “Time Series Analysis of Export Demand Equations: A Cross-Country Analysis”, *IMF Staff Papers*, Vol. 43, No.3

Smith, R. (2003), “Quantitative Methods”, mimeo, Birkbeck College, University of London

Verbeek, M. (2003), *A guide to Modern Econometrics*, Wiley.

8. Appendix

8.1 Discarded output regression with l*mrer*

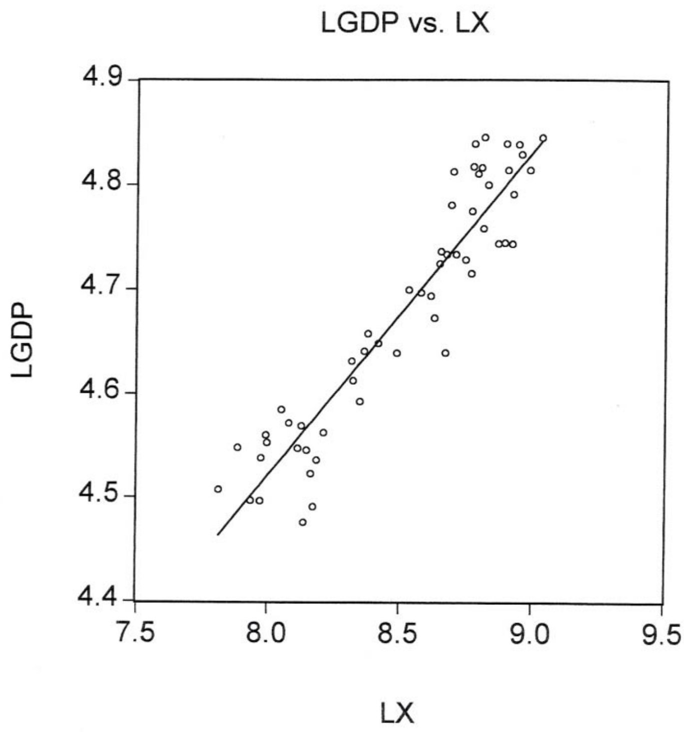
Dependent Variable: DLX
Method: Least Squares
Sample(adjusted): 1990:2 2002:3
Included observations: 50 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.884586	0.667996	-1.324238	0.1929
LX(-1)	-0.471665	0.130985	-3.600895	0.0009
DLMRER	0.065523	0.049968	1.311311	0.1972
LMRER(-1)	0.008451	0.030308	0.278839	0.7818
DLGDP	2.198361	0.920662	2.387805	0.0218
LGDP(-1)	1.007611	0.317702	3.171561	0.0029
DUM95	0.102297	0.039959	2.560064	0.0143
@SEAS(1)	-0.011674	0.025237	-0.462560	0.6462
@SEAS(2)	0.266792	0.030223	8.827590	0.0000
@SEAS(3)	0.064952	0.021881	2.968437	0.0050

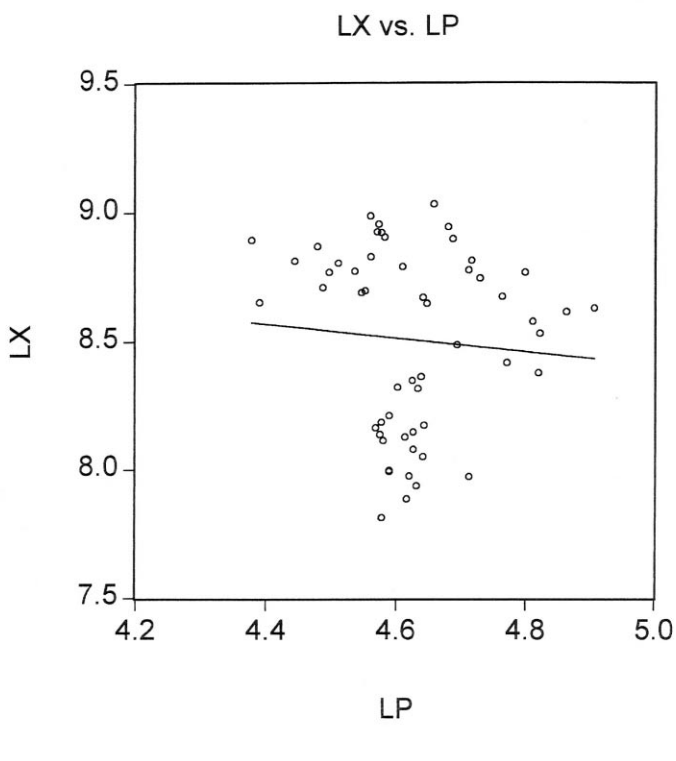
R-squared	0.919122	Mean dependent var	0.019214
Adjusted R-squared	0.900925	S.D. dependent var	0.153522
S.E. of regression	0.048323	Akaike info criterion	-3.044961
Sum squared resid	0.093405	Schwarz criterion	-2.662556
Log likelihood	86.12402	F-statistic	50.50808
Durbin-Watson stat	1.853780	Prob(F-statistic)	0.000000

8.2 Scatter diagrams

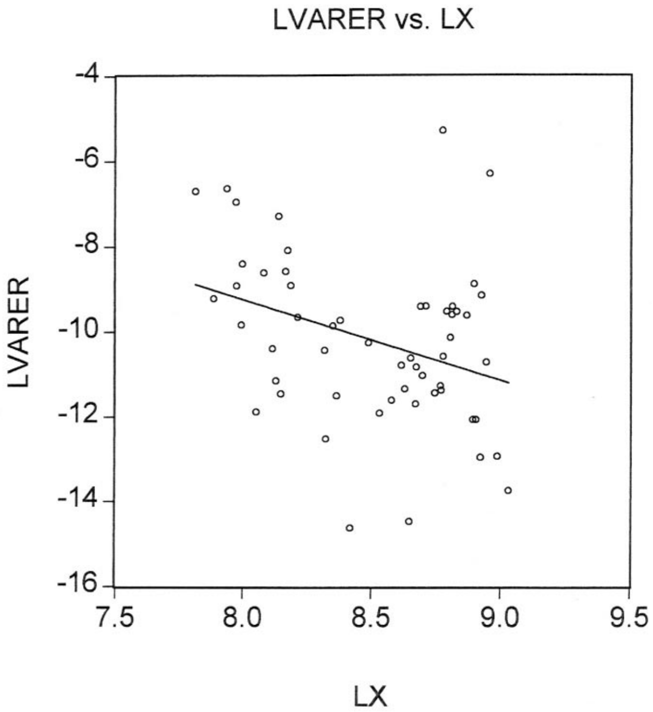
Scatter diagram for exports and l*gdp*



Scatter diagram for exports and l*p*



Scatter diagram for exports and l*varer*



8.3 Output regressions and Residual, Actual and Fitted values

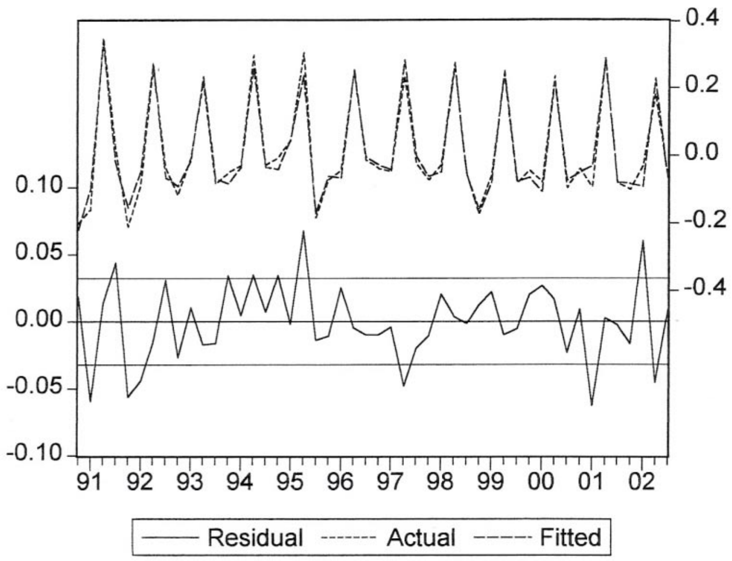
OLS output regression

Dependent Variable: DLX
Method: Least Squares
Sample(adjusted): 1990:4 2002:3
Included observations: 48 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.458575	0.434178	-3.359393	0.0018
LX(-1)	-0.616867	0.098661	-6.252390	0.0000
LGDP	1.381657	0.222205	6.217929	0.0000
D6LGDP	1.810505	0.479946	3.772312	0.0006
D9LP	-0.270189	0.055083	-4.905141	0.0000
LVARER	-0.007675	0.002769	-2.771920	0.0086
DUM95	0.120091	0.030993	3.874797	0.0004
@SEAS(1)	-0.030995	0.018543	-1.671521	0.1028
@SEAS(2)	0.232702	0.023048	10.09625	0.0000
@SEAS(3)	0.049014	0.014268	3.435184	0.0014

R-squared	0.964927	Mean dependent var	0.015096
Adjusted R-squared	0.956620	S.D. dependent var	0.154417
S.E. of regression	0.032162	Akaike info criterion	-3.853020
Sum squared resid	0.039307	Schwarz criterion	-3.463186
Log likelihood	102.4725	F-statistic	116.1600
Durbin-Watson stat	2.311198	Prob(F-statistic)	0.000000

Residual, Actual and Fitted values – OLS model



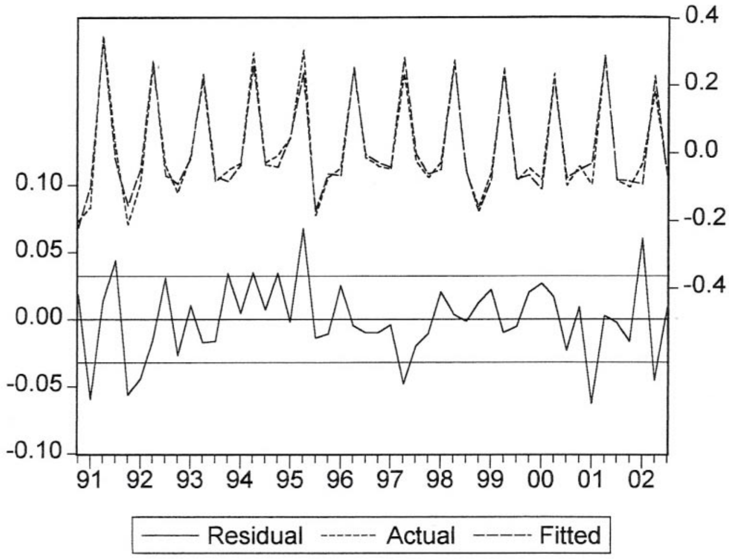
2SLS output regression

Dependent Variable: DLX
Method: Two-Stage Least Squares
Sample(adjusted): 1991:1 2002:3
Included observations: 47 after adjusting endpoints
Instrument list: C LX(-1) LGDP D6LGDP D9LP(-1) DLM LM(-1) DUM95 @SEAS(1) @SEAS(2) @SEAS(3)

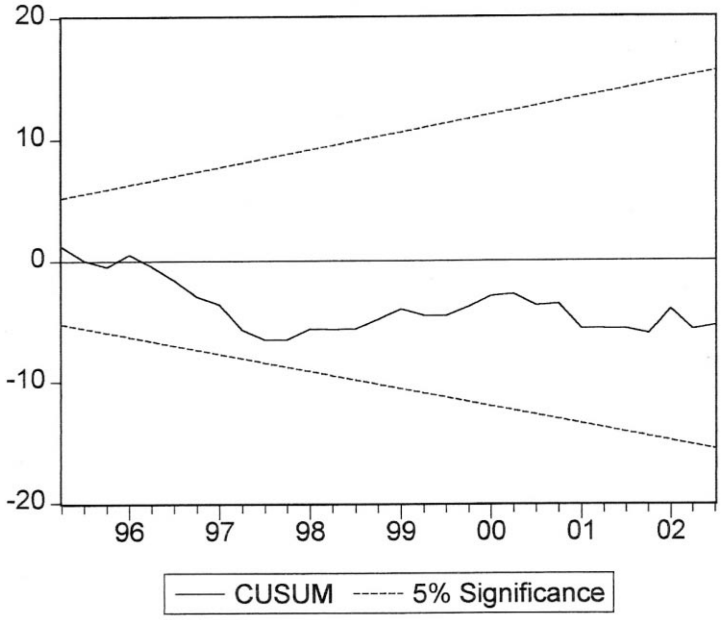
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.674810	0.505331	-3.314285	0.0021
LX(-1)	-0.709280	0.136880	-5.181781	0.0000
LGDP	1.593369	0.304517	5.232447	0.0000
D6LGDP	1.805868	0.498443	3.623019	0.0009
D9LP	-0.331916	0.090906	-3.651193	0.0008
LVARER	-0.007770	0.004365	-1.780017	0.0833
DUM95	0.139779	0.039947	3.499080	0.0012
@SEAS(1)	-0.039752	0.021314	-1.865114	0.0701
@SEAS(2)	0.217855	0.027885	7.812488	0.0000
@SEAS(3)	0.055168	0.015898	3.470032	0.0013

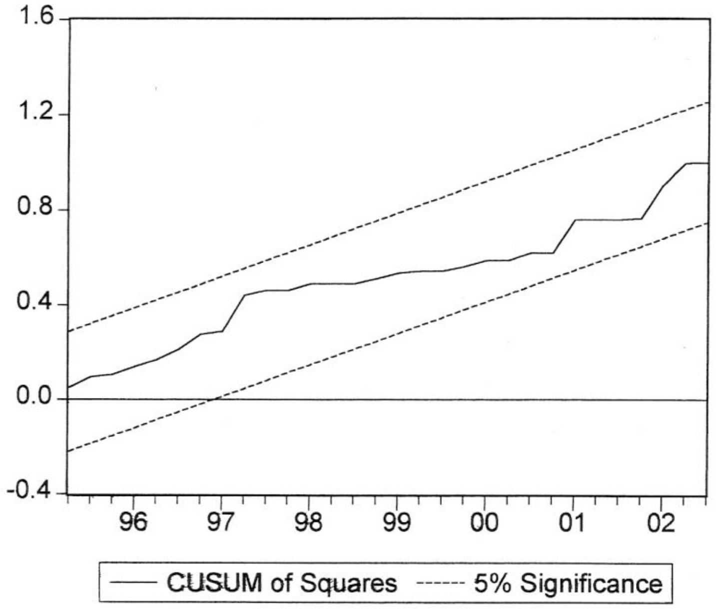
R-squared	0.963250	Mean dependent var	0.019687
Adjusted R-squared	0.954311	S.D. dependent var	0.152738
S.E. of regression	0.032648	Sum squared resid	0.039437
F-statistic	106.4305	Durbin-Watson stat	2.045150
Prob(F-statistic)	0.000000		

Residual, Actual and Fitted values – 2SLS model



8.4 CUSUM and CUSUM of Squares – OLS model




1.6
1.2
0.8
0.4
0.0
-0.4
96
97
98
99
00
01
02
CUSUM of Squares
5% Significance