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Trade-GDP Nexus in Iran: An Application of the Autoregressive Distributed Lag (ARDL) Model

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Trade-GDP Nexus in Iran:
An Application of the Autoregressive Distributed Lag (ARDL) Model

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Abstract

This paper employs annual time series data on Iranian exports, imports and economic growth from 1960 to 2003. Procedures are used to endogenously identify structural breaks in these macroeconomic series and then to incorporate these breaks in unit root tests. An initial finding is that the endogenously determined structural breaks coincide with important phenomena in the Iranian economy, including the Islamic revolution in 1978 and the start of the Iran-Iraq war in 1980. The error correction version of the autoregressive distributed lag procedure is then employed to specify the short and long-term determinants of economic growth in the Iranian economy taking these structural breaks into consideration. The results show that while the effects of gross capital formation and oil exports are important for the expansion of Iranian GDP over the sample period, non-oil exports and human capital are generally less important. The results also show that a deviation from the long-term growth rate in GDP in Iran is corrected between 46 and 60 percent in the following year.

JEL classification numbers: C12, C22, C52.

Key words: structural breaks, unit root tests, autoregressive distributed lag (ARDL) procedures.

I. INTRODUCTION

The Iranian macroeconomy has been subject to numerous and ongoing shocks and regime shifts in recent decades, including the 1974/75 OPEC oil crisis, social and political upheaval associated with the 1979 Islamic Revolution, a destructive eight-year (1980-1988) war with Iraq, the freezing of the country's foreign assets, a volatile international oil market, economic sanctions, and international economic isolation. And determining the correct timing of these structural breaks is clearly of paramount importance in any macroeconomic time-series analysis. Leybourne and Newbold (2003), for example, argue that if structural breaks are not dealt with appropriately, empirical results obtained from the use of, say, cointegration techniques could be spurious and misleading. At the same time, conventional techniques allow the incorporation of only single structural breaks in time series. Accordingly, this paper employs Lumsdaine and Papell’s (1997) procedure (hereafter LP) to examine the unit root hypothesis with two

structural breaks, without imposing predetermined dates for structural breaks. After the timing of major structural breaks are determined endogenously, they are included in autoregressive distributed lag (ARDL) procedure with impulse and/or shift dummy variables.

The reminder of this paper is structured as follows. Section II briefly presents the theoretical underpinnings of the trade-growth nexus. Section III introduces the empirical methodologies used, while Section IV explains and applies the LP unit root procedures as determined by a recursive, rolling or sequential approach. Section V discusses the ARDL and error correction versions of this approach followed by the empirical findings. Finally, Section V presents some concluding remarks and policy implications.

II. TRADE AND ECONOMIC GROWTH: A THEORETICAL OVERVIEW

Competing viewpoints are held on the possible relationships between trade and economic growth. These is possible because expanded trade opportunities can both assist economic growth through growth in exports, and provide obstacles in the form of negative effects on infant industries and difficulties concerning the balance of payments. The literature reflects these two divergent perspectives in both conventional 'welfare gain' models and the newer 'endogenous growth' models. The most important distinction is the alternative focus on the effect of trade on economic growth in general and the export sector of the economy and its externality effects. It is the second approach which forms the basis of the present study.

The traditional case for the beneficial effects of trade on economic growth is based on the theory of comparative advantage. According to Findlay (1984), the Ricardian model shows that a country which specializes in producing commodities that have less comparative cost and then engages in international trade will increase domestic, as well as global, welfare. In addition, international trade will enable developing countries to import capital and intermediate goods, which is necessary for domestic production and GDP growth. The well-known Hecksher-Ohlin model shows similar benefits, but within a two-country model. The keystone of this model is that international trade is one way to improve static productivity, efficiency and international competitiveness. However, neither of these models make it clear whether, or how, international trade determines economic growth in the longer run (Gandolfo, 1994).

Within these earliest approaches, Baghwati argued against the welfare gains of trade. According to Jayme (2001:12), Baghwati believed that national welfare declines as a result of economic growth pushed by technological progress because of the deterioration of the terms of trade after growth, a deterioration which may be sufficient to exceed the favourable effect on welfare due to the economic growth at constant relative product price. In other words, trade liberalization in the presence of distortions can decrease the welfare of the economy. Subsequent approaches to trade and economic growth have examined more closely the effects of openness on growth and include the effects of market structure and product diversification, economies of scale, imperfect competition in the global market, and a number of other factors not considered in traditional 'welfare gain' theory (Helpman and Krugman, 1985.) Moreover, Krugman (1986, 2000) argued that yet more factors, including geographic location, country size and access to information affect trade performance, but these were generally included in static approaches.

By the late 1980s, dynamic endogenous growth theories had emerged (e.g. Lucas 1988; Grossman and Helpman 1990, 1991) and the relationship between trade and growth became a major focus of so-called 'endogenous growth' models. One of the most important insights of this theory is that trade conveys knowledge to the importing country, especially through the technology embedded in the traded product. This knowledge is then used by local manufacturers to increase their competitiveness in domestic and global markets, but if there is a local R&D sector capable of exploiting the knowledge conveyed. Lucas (cited in Long and Wong 1997:45), for example, makes use of "learning by doing" as a channel through which human capital and knowledge of an individual or an economy accumulates. According to previous static models, countries tend to be completely specialized, but in the Lucas dynamic model a country will accumulate only the type of human capital that is specific to the goods produced. This means that when different countries are producing different goods under free trade, they have different growth patterns. Following Lucas, Van and Wan (1997) applied Lucas' concept of "learning by doing" to the issue of technological transfer through international trade, arguing that technological progress, foreign trade and factor accumulation work together to promote economic growth.

As an alternative, Grosman and Helpman (1990) presented a dynamic two-country model of trade and growth with endogenous technological progress. They argued that economic growth cannot be understood without first taking into

consideration the accumulation of knowledge. The basic conclusions were that due to this accumulation of knowledge, research enables innovative designs for new intermediate products and makes further research less costly. New intermediate products allow improvements in the manufacturing process of consumer goods, thus enhancing productivity in final production.

Later, Grossman and Helpman (1991) suggested a different theoretical relation between productivity and the volume of trade through the opportunities it provides to acquire technical information that contribute to a country's general knowledge. Such knowledge transfer takes place in a number of ways: the variety of intermediate products and capital equipment embodying foreign knowledge will increase the productivity of domestic resources; the resultant communication leads to the learning of such things as production techniques and product design; international contacts enable the imitation of foreign technologies and the duplication of products and finally, a country's efficiency can be increased through developing new technology and thus indirectly raising the productivity of the entire economy.

Although proponents of the earlier 'welfare gain of trade' models argued whether trade was beneficial to economic growth or harmful to it, those supporting 'endogenous growth' models took issue instead with the accuracy of the various competing models due to the number of included variables. For example, McCombie and Thirlwall (1999) criticised models like Grossman and Helpman's for neglecting balance of payments constraints, while Pack and Page (1994) show that exports must also be considered because they are important in explaining international differences in productivity growth. This leads to the theoretical considerations underlying the current analysis.

III. UNIT ROOT WITH STRUCTURAL BREAKS

It goes without saying that structural change is of considerable importance in the analysis of macroeconomic time series. Structural change occurs in many time series for any number of reasons, including economic crises, changes in institutional arrangements, policy changes, regime shifts and war. An associated problem is the testing of the null hypothesis of structural stability against the alternative of a one-time structural break. If such structural changes are present in the data generating process, but not allowed for in the specification of an econometric model, results may

be biased towards the erroneous non-rejection of the non-stationarity hypothesis (Perron 1989; Perron 1997; Leybourne and Newbold; 2003).

Conventionally, dating of the potential break is assumed to be known *a priori* in accordance with the underlying asymptotic distribution theory. Test statistics are then constructed by adding dummy variables representing different intercepts and slopes, thereby extending the standard Dickey-Fuller procedure (Perron 1989). However, this standard approach has been criticized, most notably by Christiano (1992), who argued that data-based procedures are typically used to determine the most likely location of a break: evidence of an endogeneity or sample selection problem. This invalidates the distribution theory underlying conventional testing.

In response, a number of studies have developed different methodologies for endogenising dates, including Zivot and Andrews (1992), Perron (1997), Lumsdaine and Papell (1997) and Bai and Perron (2003). These studies have shown that by endogenously determining the time of structural breaks, bias in the usual unit root tests can be reduced. Perron and Vogelsang (1992) and Perron (1997), have proposed a class of test statistics which allows for two different forms of a structural break: namely, the Additive Outlier (AO) model, which is more relevant for series exhibiting a sudden change in the mean (the crash model), and the Innovational Outlier (IO) model, which captures changes in a more gradual manner over time.

With this in mind, Lumsdaine and Papell (1997) (LP) introduced a novel procedure to capture two structural breaks in a series. They found that unit root tests accounting for two structural breaks are more powerful than those which allow for a single break. In support, Ben-David *et al.* argued that "…just as failure to allow one break can cause non-rejection of the unit root null by the Augmented Dickey-Fuller test, failure to allow for two breaks, if they exist, can cause non-rejection of the unit root null by the tests which only incorporate one break" (2003: 304). LP use a modified version of the ADF test, which specifies two endogenous breaks as follows:

$$\Delta x_t = \mu + \beta t + \theta DU1_t + \gamma DT1_t + \omega DU2_t + \psi DT2_t + \alpha x_{t-1} + \sum_{i=1}^{K} c_i \Delta x_{t-i} + e_t \qquad (1)$$

Where $DU1_t$=1 if $t>TB1$ and otherwise zero; $DU2_t$=1 if $t>TB2$ and otherwise zero; $DT1_t = t-TB1$ if $t>TB1$ and otherwise zero; and finally $DT2_t=t-TB2$ if $t>TB2$ and otherwise zero. Two structural breaks are allowed for in both the time trend and the intercept which occur at *TB1* and *TB2*. The breaks in the intercept are shown in equation (1) by $DU1_t$ and $DU2_t$, respectively, whereas the slope changes (or shifts in

the trend) are represented by $DT1_t$ and $DT2_t$. The optimal lag length (k) is based on the general to specific approach suggested by Ng and Perron (1995). Table 1 presents the two most important structural breaks which affected the variables under investigation in this study using the procedure proposed by Lumsdaine and Papell (1997).

The data for the variables under investigation are in constant 1997 prices and have been collected from the Central Bank of Iran and the IFS. LY is a measure of real output (as measured by GDP), LX is total real exports, LXO are oil exports and LXno are non-oil exports, LK is real capital (gross capital formation), LM (total real import) and Lhc is human capital proxies by the number of university-educated, employed workers. The results of the unit root tests in the presence of two structural breaks based on the LP procedure are reported in Table(1).

Table (1) Test for unit roots allowing for two structural breaks

Variable	TB1	TB2	T-statistic for α	K	Result Ho: U-Root
LY	1976	1986	-13.52	7	Reject
LX	1975	1980	-8.10	8	Reject
LXO	1975	1980	-8.06	8	Reject
LXno	1979	1990	-7.14	7	Reject
LK	1979	1984	-8.45	2	Reject
Lhc	1979	1988	-8.91	8	Reject
LM	1975	1995	-6.34	6	

* *Note:* (1) The critical values at 1, 5 and 10 % are –7.34, -6.82 and –6.49, respectively (Lumsdaine and Papell, 1997). (2) * Indicates that the corresponding null is rejected at the 1% level.

The results of unit root tests with two structural breaks in both the intercept and the slope of the trend function show strong evidence against the unit root hypothesis.[1] These results are consistent with Lumasdaine and Papell (1997) and Ben-David et al. (2003). The timing of the breaks for the majority of variables under investigation

[1] It should be noted that, by implementing the conventional ADF and PP unit roots test and also Innovational and additive outlier models (Perron, 1997), we found that for majority of variables under investigation there is not much evidence against the null hypotheses of unit roots in these series.

coincides with either the oil boom in 1975, the Islamic revolution in 1978 or the Iran-Iraq war in the 1980s.

IV. THE ARDL COINTEGRATION APPROACH

A large number of past studies have used the Johansen cointegration technique to determine the long-term relationships between variables of interest. In fact, this remains the technique of choice for many researchers who argue that this is the most accurate method to apply for I(1) variables. Recently, however, a series of studies by Pesaran and Shin (1996;); Pesaran and Pesaran (1997); Pesaran and Smith (1998) and Pesaran et al. (2001) have introduced an alternative cointegration technique known as the 'Autoregressive Distributed Lag (ARDL)' bound test. This technique has a number of advantages over Johansen cointegration techniques. First, the ARDL model is the more statistically significant approach to determine the cointegration relation in small samples (Ghatak and Siddiki 2001), while the Johansen co-integration techniques require large data samples for validity.

A second advantage of the ARDL approach is that while other cointegration techniques require all of the regressors to be integrated of the same order; the ARDL approach can be applied whether the regressors are I(1) and/or I(0). This means that the ARDL approach avoids the pre-testing problems associated with standard cointegration, which requires that the variables be already classified into I(1) or I(0) (Pessaran et al, 2001).

If we are not sure about the unit root properties of the data, then applying the ARDL procedure is the more appropriate model for empirical work.[2] As Bahmani-Oskooee (2004:485) explains, the first step in any cointegration technique is to determine the degree of integration of each variable in the model but this depends on which unit root test one uses and different unit root tests could lead to contradictory results. For example, applying conventional unit root tests such as the Augmented Dickey Fuller and the Phillips-Perron tests, one may incorrectly conclude that a unit root is present in a series that is actually stationary around a one-time structural break (Perron, 1989; 1997) The ARDL approach is useful because it avoids these problems.

[2] In this group of variables, we first considered one structural break based on the Perron (1997) Innovational and Additive outlier models. We could not reject the null hypothesis of a unit root in all cases, but when considering the existence of two breaks we found the reverse and the majority of variables under investigation were found to be stationary.

Yet another difficulty of the Johansen cointegration technique which the ARDL approach avoids concerns the large number of choices which must be made: including decisions such as the number of endogenous and exogenous variables (if any) to be included, the treatment of deterministic elements, as well as the order of VAR and the optimal number of lags to be used. The estimation procedures are very sensitive to the method used to make these choices and decisions (Pesaran and Smith 1998). Finally, with the ARDL approach it is possible that different variables have different optimal numbers of lags, while in Johansen-type models this is not permitted.

According to Pesaran and Pesaran (1997), the ARDL approach requires the following two steps. In the first step, the existence of any long-term relationship among the variables of interest is determined using an F-test. The second step of the analysis is to estimate the coefficients of the long-run relationship and determine their values, followed by the estimation of the short-run elasticity of the variables with the error correction representation of the ARDL model . By applying the ECM version of ARDL, the speed of adjustment to equilibrium will be determined. According to Pesaran and Pesaran (1997), the ARDL model is represented by the following equation:

$$\phi(L,p)y_t = \sum_{i=1}^{k} \beta_i(L,q_i)x_{it} + \delta' w_t + u_t \qquad (2)$$

where

$$\phi(L,p) = 1 - \phi_1 L - \phi_2 L^2 - .....\phi_p L^p$$

and

$$\beta_i(L,q_i) = 1 - \beta_{i1} L - \beta_{i2} L^2 - ..... - \beta_{iqi} L^{qi}, \qquad \text{i=1,2,...,k}$$

In the above equation, y_t is the dependent variable, X_{it} denotes the i dependent variables, L is a lag operator, and W_t is the $S \times 1$ vector of deterministic variables, including intercept terms, dummy variables, time trends and other exogenous variables. The optimum lags are selected in this methodology according to the well-known Akaike Information Criterion (AIC) and the Schwarz Bayesian Criteria (SBC). The long-run coefficients and their asymptotic standard error are then computed for the selected ARDL model. According to Pessaran and Pessaran, as cited in Wilson and Chaudhri (2004:26), "…the long-run elasticity can be estimated by:

$$\hat{\theta}_i = \frac{\hat{\beta}_{i0} + \hat{\beta}_{i1} + ... + \hat{\beta}_{qi}}{1 - \hat{\phi}_1 - \hat{\phi}_2 - ...\hat{\phi}_p} \qquad \forall \text{ i=1,2,…,k} \qquad (3)$$

and the long-run cointegrating relationship is shown as:

$$y_t - \hat{\theta}_0 - \hat{\theta}_1 x_{1t} - \hat{\theta}_2 x_{2t} - ... - \hat{\theta}_k x_{kt} = \varepsilon_t \qquad \forall t = 1,2,\ldots, \text{n} \qquad (4)$$

In this equation, constant term is equal to:

$$\hat{\theta}_0 = \frac{\hat{\beta}_0}{1 - \hat{\phi}_1 - \hat{\varphi}_2 - ....\hat{\varphi}_p} \qquad (5)$$

The ECM version of the selected ARDL model can be obtained by rewriting equation (2) in terms of the lagged levels and first difference of $y_t, x_{1t}, x_{2t}, ..., x_{kt}$ and w_t as follows:[3]

$$\Delta y_t = -\phi(1, \hat{p}) EC_{t-1} + \sum_{i=1}^{k} \beta_{i0} \Delta x_{1t} + \delta' \Delta w_t - \sum_{j=1}^{\hat{p}-1} \varphi * y_{t-j} - \sum_{1=1}^{k} \sum_{j=1}^{\hat{q}_{i-1}} \beta_{ij} * \Delta x_{i,t-j} + u_t \qquad (6)$$

and finally, in the above equation, the error correction term is defined by

$$EC_t = y_t - \sum_{i=1}^{k} \hat{\theta}_i x_{it} - \psi' w_t \qquad (7)$$

In the above equations, $\varphi *, \delta'$ and $\beta_{ij} *$ are the coefficients which is related to the short -run dynamics of the model's convergence to equilibrium, and $\phi(1, \hat{p})$ is the speed of adjustment.

V. EMPIRICAL RESULTS BASED ON THE ARDL APPROACH

Since this study aims to detect the short-run as well as the long-run relationships between exports, economic growth and other variables, we make use of the already well-known though relatively new cointegration techniques of ARDL. Drawing upon the literature on the trade-growth nexus and following Feder (1983), Lucas (1988), Salehi (1992), Van Den Berg (1997), and Ibrahim and MacPhee (2003),

[3] This is based on Pesaran and Pesaran (1997)

we consider the following extended Feder/Salehi-type models in order to identify the relationship between trade and economic growth in an oil-based economy. Similar to the Feder-type model, output in each economic sector is produced with labour and capital factors which are allocated to each sector. In addition, and like Salehi Esfahani, we include total imports as a new factor in the following equations though these have been neglected in most studies of the relationship between exports and economic growth. These models are a kind of production function, which is augmented by the addition of trade factors (exports (X) and imports (M).

Y=F (K, Hc, X, M) (8)

The logarithmic version of the above equations which is applied in the multivariate cointegration technique is shown as follows:

$$Ly_t = \alpha_0 + \alpha_1 Lk_t + \alpha_2 Lhc_t + \alpha_3 Lx_t + \alpha_4 Lm_t + e_t \quad (9)$$

As discussed earlier, the inclusion of exports in the model captures the positive externality effects of exports on economic growth. The externality effects of total exports including the introduction of improved technology; the training of productive labour and the development of more efficient management were introduced first by Feder (1983). Moreover, by helping to prevent shortages of intermediate inputs and by providing better quality inputs, capital and intermediate imports can positively affect productivity. In this procedure, we focus also on the possible effects of disaggregate exports (i.e. separate export categories, such as oil (Xo) and non-oil exports (Xno) on real GDP. Following Pesaran et al. (2001) and Bahmani-Oskooee (2004), the error correction representation of the ARDL model is: [4]

ECM-ARDL model:

$$\Delta \ln y = \alpha_0 + \sum_{j=1}^{n} b_j \Delta \ln y_{t-j} + \sum_{j=0}^{n} c_j \Delta \ln k_{t-j} + \sum_{j=0}^{n} d_j \Delta \ln lhc_{t-j} + \sum_{j=0}^{n} e_j \Delta \ln x_{t-j} + \sum_{j=0}^{n} f_j \Delta \ln m_{t-j}$$
$$+ \delta_1 \ln y_{t-1} + \delta_2 \ln k_{t-1} + \delta_3 \ln lhc_{t-1} + \delta_4 \ln x_{t-1} + \delta_5 \ln m_{t-1} + \varepsilon_{1t} \quad (10)$$

[4] . We also include two impulse and shift dummy variables (D78 and Du80) in this model, which consider the effect of the Islamic revolution in 1978 and Iran-Iraq war beginning in 1980.

The parameters δ_i, i=1,2,3,4,5, function as the long-run multipliers, while the b_j, c_j, d_j, e_j, f_j parameters function as the short-run dynamic coefficients of the underlying ARDL model. As discussed, in the first step we need to capture the usual F-statistic for testing the null hypothesis (of no cointegration) defined by (H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$) among the levels of the included variables in the models. In so doing, equation (10) is estimated without the EC part, then the EC part is added to the already estimated first part of the above equations. Next, F-statistics are calculated to check the null hypothesis (that all coefficients are jointly equal to zero).

At this stage, the calculated F-statistic is compared with the critical value tabulated by Pesaran et al. (2001). These critical values are calculated for different regressors and whether the model contains an intercept and/or a trend. According to Bahmani-Oskooee (2004), these critical values include an upper and a lower band covering all possible classifications of the variable into I(1), I(0) or even fractionally integrated. The null hypothesis of no cointegration is rejected if the calculated F-statistic is bigger than the upper bound. If the computed F-statistic is smaller than the lower bound, then the null hypothesis cannot be rejected. Finally, if it falls in between the lower and the upper bound, then the result is inconclusive. Kremers et al. (cited in Bahmani-Oskooee (2004) argued that in such an inconclusive case an efficient way of establishing cointegration is by applying the ECM version of the ARDL model.

Since all observations are annual and the number of observations is limited, we choose 2 as the maximum order of lag in the ARDL model. The calculated F-statistic for the above model (1) is 2.88. When we consider disaggregate exports, that is to say, when total exports are separated into Oil and Non-oil exports, hereafter model (2), the calculated F-statistic is equal to 2.96 and both of the calculated F-statistics fall between the lower bound and the upper bound at the 5 percent level. This means that our F-statistic results are inconclusive. Following Kremers et al. (cited in Bahmani-Oskooee 2004), in these circumstances the ECM version of the ARDL model is an efficient way of determining the long-run relationship among the variables of interest.[5]

[5] It should be noted that application of the Johansen-Juselius methodology, the Saikkonen and Lutkephol (2000) procedure, as well as the Gregory-Hansen technique, have all confirmed the existence of at least one cointegrating relation between the variables under study. In other words, we

The long-run coefficients of models (1) and (2) are estimated in the second step and the results are reported in Table (2). As discussed, one of the most important issues in applying the ARDL approach is the choice of the order of the distributed lag function. According to Pesaran and Shin (1998), the SBC is generally used in preference to other criteria because it tends to define more parsimonious specifications. In this research, the small data sample is another reason to prefer SBC. The SBC lag specification for equation (1) and (2) are shown in Table 3 in the Appendix. For model (1) they are ARDL (1,0,0,2,1) and for model (2) they are ARDL (1,2,0,2,1,1), where the number represents the lags for each of the variables in the two models. The long-run coefficients of the variables under investigations are shown in the following table.

Table (2) the Long-run coefficients estimating result

Model (1)			Model (2)		
Repressor	*Coefficient*	*T-Ratio [Prob]*	*Repressor*	*Coefficient*	*T-Ratio [Prob]*
LK	.48648	9.3937[.000]	LK	.55518	16.2402[.000]
LHC	.018226	.77174[.446]	LHC	.020568	1.4227[.167]
LX	.38792	9.9294[.000]	LXO	.37254	8.9805[.000]
LM	-.081982	-2.3122[.028]	LXNO	.036846	3.0845[.005]
INTP	1.3487	14.8864[.000]	LM	-.13488	-6.0801[.000]
D78	.10605	3.9410[.000]	INTP	1.2093	12.6528[.000]
DU80	.17623	7.9103[.000]	D78	.097881	5.0622[.000]
			DU80	.18700	10.6545[.000]

Note: The SBC is used to select the optimum values of the ARDL regressions, which is used to calculate the long-run coefficient estimates. D78 and Du80 are the two dummy variables, which consider the effect of the Islamic revolution in 1978, and Iraqi war beginning in 1980.

The long-term coefficients for models (1) and (2) follow the same general pattern. The results of the above table show that in the long-run, physical capital has a very significant effect on GDP and a 1% increase in LK leads to a 0.48 % and 0.55% increase in GDP for model (1) and (2) respectively. A 1% increase in human capital (Lhc) leads to a 0.018% and 0.02% increase in GDP for model (1) and (2). This indicates that human capital does have not an important effect on GDP. In addition, the coefficients of Lhc in both models are not statistically significant. If we consider the effect of total exports on GDP, a 1% increase in total exports leads to a 0.39%

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could not reject the null hypothesis (of at least one cointegrating vector) among the variables under investigation. This result is available upon request.

increase in GDP for model (1). This means that total export has a very significant and important effect on GDP.

Results for model (2) in which we disaggregate total export into oil and non-oil exports, showed that a 1% increase in oil and non-oil exports leads to a 0.37% and 0.036% increase in GDP respectively. It is obvious from this finding that while non-oil exports do not have very important effects on the Iranian economy, crude oil exports are still a major export and the oil sector acts as the major leading sector of the economy. The results also showed that 1% increase in total imports leads to -0.08% decrease in gross domestic product for model (1) and -0.13% for model (2). The coefficient of LM is significant at the 5% level and has the expected sign based on the theory. After estimating the long-term coefficients, we proceed to obtain the error correction representation of equation (10) for both aggregate and disaggregated exports case in model(1) and (2) Table (4) reports the short-run coefficient estimates obtained from the ECM version of the ARDL model.

Table (4) short-run Error correction elasticity estimates

ECM-ARDL (1): dependent variable: *ΔLY*			ECM-ARDL (2): dependent variable: *ΔLY*		
Regressor	*Coefficient*	*T-Ratio [Prob]*	*Regressor*	*Coefficient*	*T-Ratio [Prob]*
ΔLK	.22676	6.2119[.000]	ΔLK	.29332	8.0559[.000]
ΔLHC	.0084954	.75793[.454]	ΔLK1	-.079579	-2.5167[.017]
ΔLX	.21473	10.4553[.000]	ΔLHC	.012371	1.3975[.173]
ΔLX1	-.061448	-2.8851[.007]	ΔLXO	.24592	12.0187[.000]
ΔLM	.0079377	.31483[.755]	ΔLXO1	-.071101	-3.8278[.001]
Constant	.62865	6.2124[.000]	ΔLXNO	-.0047293	-.49338[.625]
D78	.049433	3.4739[.001]	ΔLM	-.01896	-.83805[.409]
DU80	.082146	5.3917[.000]	INTP	.72735	5.0377[.000]
ecm(-1)	-.46613	-7.5571[.000]	D78	.058872	5.0483[.000]
			DU80	.11248	6.2534[.000]
			ecm(-1)	-.60147	-6.3609[.000]
$\bar{R}^2$ = .88543	F(8, 32)	39.8898[.000]	$\bar{R}^2$ = .92822	F(10, 30)	53.1224[.000]

As discussed, the error correction term indicates the speed of adjustment to restore equilibrium in the dynamic model. The ECM coefficient shows how quickly variables converge to equilibrium and it should have a statistically significant

coefficient with a negative sign. According to Bannerjee *et al.* (1998), the highly significant error correction term further confirms the existence of a stable long-run relationship.

Table (4) shows the expected negative sign of ECM is highly significant in both models. This confirms the existence of the cointegration relationship among the variables of these two models yet again. In other words, these coefficients reinforce the existence of a cointegration relationship already shown using the other three methods applied in this research. The coefficients of ECM (-1) are equal to (-0.46) and (-0.60) for models (1) and (2) respectively, and imply that the deviation from the long-term growth rate in GDP is corrected by (0. 46) percent in model (1) and (0.60) percent in model (2) by the coming year. In other words, the highly significant error correction term suggests that more than 0.46 and 0.60 percent of disequilibrium in the previous year corrected in the current year for model (1) and (2) respectively. This findings show that the speed of adjustment is really high especially in model 2.

The forecasting errors and the plots of the graphs of the actual and forecast values for models (1) and (2) are presented in Figure(1). These graphs show that dynamic forecast values for both the level of LY as well as the change in the level of LY are very close to the actual data for both equations.

VI. DIAGNOSTIC AND STABILITY TESTS

Finally, in order to check for the estimated ARDL models, the significance of the variables and other diagnostic tests such as serial correlation, functional form, normality, heteroscedasticity, and structural stability of the model are considered As shown in Table (3) both models generally pass all diagnostic tests in the first stage. The diagnostic test in Table (3) shows that there is no evidence of autocorrelation and the models pass the normality and the test proved that the error is normally distributed. The adjusted R bar shows that around 99% of the variation in GDP is explained by the regressors in both models. Finally, when analysing the stability of the long-run coefficients together with the short-run dynamics, the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUM) are applied.

Following Pesaran and Pesaran cited in Bahmani-Oskooee (2001), the stability of the regression coefficients is evaluated by stability tests and they can show whether or not the regression equation is stable over time. This stability test is appropriate in time series data, especially when we are uncertain about when structural change might have taken place. The null hypothesis is that the coefficient vector is the same in

every period and the alternative is simply that it is not (Bahmani-Oskooee, 2001). CUSUM and CUSUMQ statistics are plotted against the critical bound of 5% significance. According to Bahmani-Oskooee and Wing NG (2002), if the plot of these statistics remains within the critical bound of the 5% significance level, the null hypothesis (i.e. that all coefficients in the error correction model are stable) cannot be rejected. The plot of the cumulative sum of the recursive residual is presented in graph 7.3. As shown, the plot of both the CUSUM and the CUSUMQ residuala are within the boundaries. That is to say that the stability of the parameters has remained within its critical bounds of parameter stability. It is clear from both the graphs presented in Figure (2) that both the CUSUM and the CUSUMQ tests confirm the stability of the long-run coefficients of the GDP function in equations (1) and (2).

Figures (1) Dynamic forecasts for the Level of LY and change in LY, models (1) and (2)

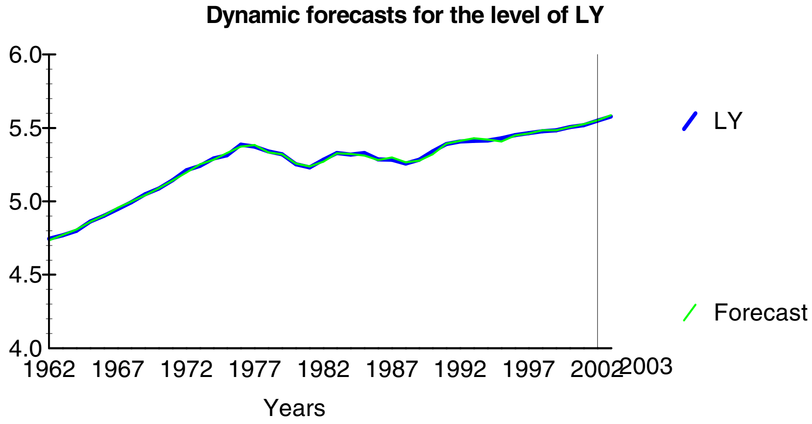
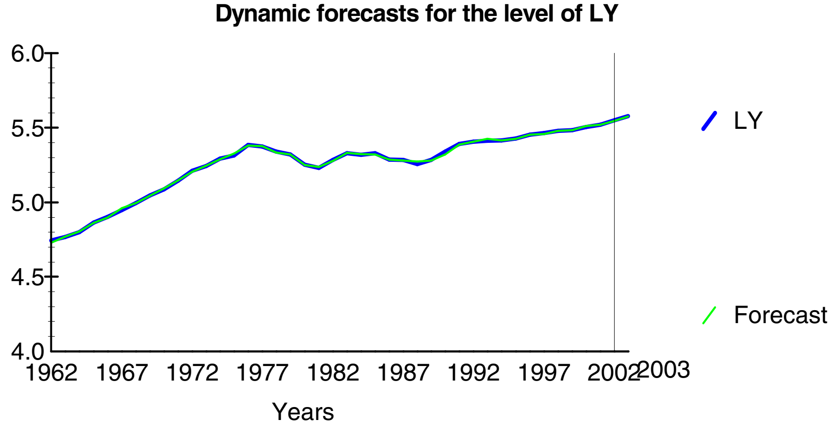
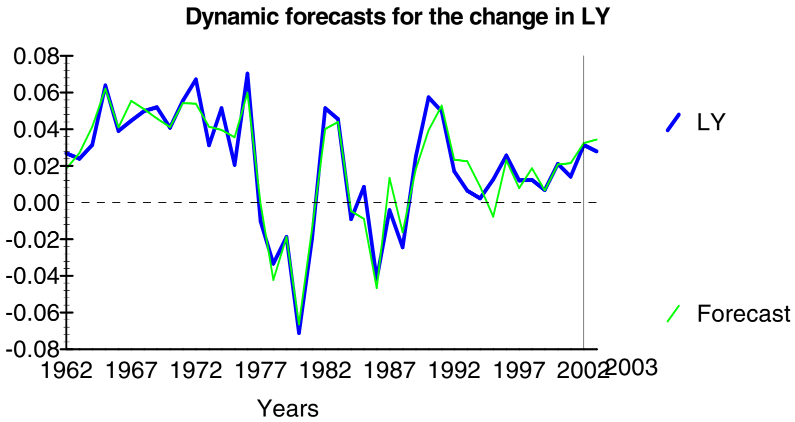
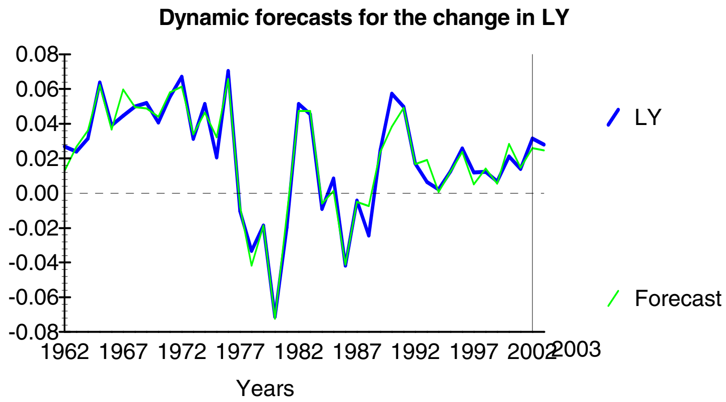
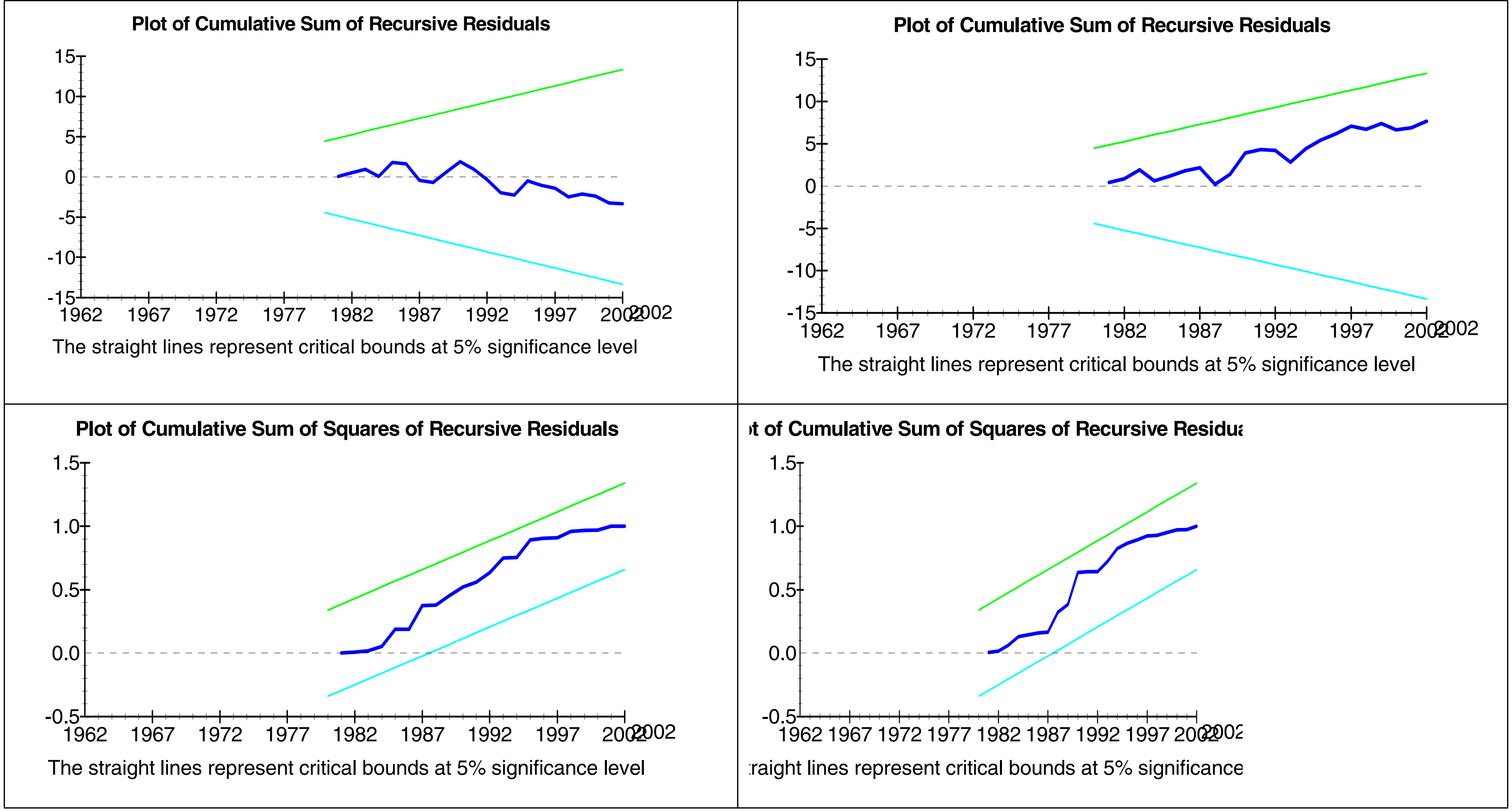
Model (1)	*Model (2)*
	
	

Figure (2) Plots of CUSUM and CUSUMQ statistics for coefficients Stability in model (1) and (2)

Model (1)	Model (2)



VII. SUMMARY AND CONCLUDING REMARKS

This paper uses all available annual time series data (1960-2003) to endogenously determine the two most significant and important structural breaks in the major variables of the trade sector, physical and human capital and GDP in the Iranian economy. The empirical results based on LP (1997) approach provide strong evidence against the null hypotheses of unit roots in the majority of the series under investigation. Moreover, we find that the most significant structural breaks detected over the more than thirty year sample period correspond to regime change associated with the Islamic revolution in 1978 and the Iran-Iraq war in the 1980s. That is, while there may be other events that affected these time series during the sample period, the most important structural breaks are consistent with the revolution and the war. This provides complementary evidence to models employing exogenously imposed structural breaks in the Iranian macroeconomy.

Taking these two structural breaks as given, the second step of this research applies a new cointegration technique (ARDL). The error correction version of the ARDL approach is applied in two cases: first, considering aggregate exports (model 1) and second, separating total exports into Oil and non-Oil exports (model 2). Applying the ECM version of the ARDL model shows that the error correction coefficient, which determines the speed of adjustment, has an expected and highly significant negative sign. The results indicate that deviation from the long-term growth rate in GDP is corrected by approximately 46 and 60 percent in the following year, in model (1) and (2) respectively. The results of the diagnostic and stability tests indicate that both models have generally passed all the diagnostic tests, and there is no evidence of autocorrelation. The error terms are normally distributed. The CUSUM and CUSUMQ stability tests as well showed that the coefficients of the error correction model are stable. Finally, estimation of the long-term coefficients of variables in both models (1) and (2) showed that while the effects of gross capital formation and oil exports are very significant and important in GDP expansion, the non-oil exports and human capital has not the important effects on GDP.

Imports clearly play a statistically significant but small negative effect in gross domestic products in the Iranian economy. And the huge fluctuation of oil prices in international markets has affected the Iranian economy negatively over the last three decades. To counter this, a non-oil export promotion policy was introduced in the

first five-year development plan after the revolution. The empirical findings of this study show that this should be continued even more carefully and emphatically. More specifically, investment in, and expansion of, the petrochemical industry would be one of the other most important policies, which is necessary in the process of export promotion policy in Iran. In addition, to avoid the problem of the effect of huge fluctuation of oil market in Iranian economy and also in order to achieve export diversification in the economy, implementing and introducing the new appropriate exchange rate policy is another important issue that the Iranian government must urgently address. In sum, the following are policy recommendations, which will favour export-led growth in the Iranian economy.

- Reformation of import and export laws and regulations.
- Making production competitive from the viewpoint of price and quality.
- Suitable insurance coverage and guarantees for non-oil exports.
- Increase in the export of manufactured and agricultural products and allocating certain portions of production to exports.

Other policies which were introduced in the five year development plans in order to promote non-oil exports included: the adoption of suitable tax and credit policies for export promotion; the fight against non-official commodity export (smugglings) through controlling borders, and the effective operation of free trade zones for promotion of exports.

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REFERENCES:

Bahmani-Oskooee, M. (2001), "Real and Nominal Effective Exchange Rates of Middle Eastern Countries and Their Trade Performance", Applied Economics, Vol. pp. 103-111.

Bahmani-Oskooee, M.and Nasir, A. (2004). "ARDL approach to test the productivity Bias Hypothesis." Review of Development economics **8**(3), pp. 483-488

Bahmani-Oskooee, M and Wing NG, R.C. (2002). " Long-run Demand for money in

Hong Kong: An application of the ARDL model." International journal of Business and Economics, 2002,Vol.1, No.2, 147-155

Bai, J. and Perron, P. 2 (2003) Critical values for multiple structural change tests, Business and Economics, 2002,Vol.1, No.2, 147-155

Baldwin, R.E (2003) "Openness and Growth: What's the Empirical Relationship?" NBER Working Paper 9578

Bannerjee, A, Dolado , and R. Mestre, 1998. Error-correction mechanism tests for cointegration in single equation framework, Journal of Time Series Analysis, 19, 267-83.

Ben-David, D, Lumsdaine, R. and Papell, D.H. (2003) Unit root, postwar slowdowns and long-run growth: evidence from two structural breaks, *Empirical Economics*, **28**(2), 303-319.

Ben David, and Papell, D.H, (1998) Slowdowns and Meltdowns: post war growth evidence from 74 countries, *Review of Economics and Statistics*, **28**(2), 561-71.

Bhagwati, J. N. (1978). Anatomy and consequences of exchange control regimes. Cambridge, Mass., Ballinger Pub. Co.

Coe, D. T., and Helpman, E. (1995). "International R & D Spillovers." European Economic Review **39(5)**: 859-887.

Salehi Esfahani, H. (1991). "Exports, imports, and economic growth in semi- Economic Review **39(5)**: 859-887.

Feder, G. (1982). "On exports and economic growth." Journal of Development Economics **12**: 59-73.

Findlay, R. (1984). Growth and Development Trade Models. In: R.W. Jones and P. Kenen, eds., Handbook of international economics. Amsterdam.

Gandolfo, G. (1994). International economics I: the pure theory of international trade. Kenen, ed, Handbook of international economics. Amsterdam.

Ghatak S. and Siddiki, J.(2001), The use of ARDL approach in estimating virtual exchange rates in india, journal of applied statistics,11:573-583

Gregory, A.W. and Hansen, B.E. (1996*a*), "Residual-based tests for cointegration in models with regime shifts", *Journal of Econometrics*, 70, pp. 1-2

Grossman, G. M., and Helpman, E. (1990). "Comparative Advantage and Long Run Growth." American Economic Review **80**: 796-815.

Grossman, G. M., and Helpman, E. (1991b). "Trade, Knowledge Spillovers and Growth." European Economic Review **35**: 517-526.

Helpman, E. and P. R. Krugman (1985). Market structure and foreign trade :

increasing returns, imperfect competition, and the international economy. Cambridge, Mass., MIT Press.

Jayme Jr, F. G. (2001). "Notes on Trade and Growth." UFMG Working Paper **166**: 25

Johansen, S. and K. Juselius (1990). "Maximum likelihood estimation and inference in cointegration - with application to the demand for money." Oxford Bulletin of Economics and Statistics **52, .** 169-210.

Krugman, P. R. (1986). Strategic trade policy and the new international economics. Cambridge, Mass., MIT Press.

Krugman, P. R. and M. Obstfeld (2000). International Economics: theory and policy. Reading Mass.; Harlow, Addison-Wesley.

Leybourne, S.J and Newbold, P. (2003) Spurious rejections by cointegration tests induced by structural breaks, *Applied Economics*, **35**(9), 1117-21.

Long, N. and Wong., K (1997). Endogenous Growth and International Trade: A Survey, in Jensen, B and Wong, K(ed). Dynamics, Economic Growth and International Trade, University of Michigan Press.

Lucas, R. E. (1988). "On the Mechanics of Economic development." Journal of Monetary Economics **22(1)**: 3-42.

Lumsdaine, R. L., and Papell, D.H. (1997) Multiple trend breaks and the unit root hypothesis, *Review of Economics and Statistics*, **79**(2), 212-218.

Ibrahim, I. and C. R. Macphee (2003). "Export externalities and economic growth." Trade & Economic Development **12**(3): 257-283.

McCombie, J. and A. Thirlwall. 1999. "Growth in an international context: a Post Keynesian view". In: Deprez, J. and Harvey. *Foundations of International Economics: Post Keynesian Perspectives.* London, Routledge.

Ng, S., and Perron, P. (1995) Unit root tests in ARMA models with data dependent methods for the selection of the truncation lag, *Journal of the American Statistical Association*, **90**(429), 268-281.

Pack, H. (1994). "Endogenous Growth Theory: Intellectual appeal and Empirical Shortcoming." Journal of Economic Perspectives **8(1)**: 55-72.

Perron, P. (1989) The great crash, the oil price shock, and the unit root hypothesis, *Econometrica*, **57**(6), 1361–1401

Perron, P. (1989). "‘‘The Great Crash, the Oil Price Shock, and the Unit Root hypothesis." *Econometrica* 57: 1361–1401.

Perron, P. (1994). *Unit root and structural change in macroeconomic time series.*

Cointegration for the Applied Economist. Rao. B. London, Macmillan.

Perron, P. (1997). " Further evidence on breaking trend functions in macroeconomic variables." *Journal of Econometrics* 80: 355-385

Perron, P. and Vogelsang, T. (1992). "Nonstationarity and Level Shifts with a Application to Purchasing Power Parity,." *Journal of Business and Economic Statistics* 10: 301-320.

Pesaran, M.H. (1995) Planning and macroeconomic stabilisation in Iran, *DAE Working Papers Amalgamated Series No. 9508*, Department of Applied Economics, Cambridge University, Cambridge.

Pesaran, H. M. and Pesaran, B. (1997) *Microfit 4.0* (Oxford University Press).

Pesaran, M. H. a. Smith. (1998). "structural analysis of cointegration VARS." journal of economic surveys **12**(5): 471-505.

Pesaran, M. H., Shin, Y. and R.J. Smith (2001). "Bounds Testing Approaches to the Analysis of Level Relationships." Journal of Applied Econometrics **16**: 289-326.

Saikkonen, P. and Lütkepohl, H. (2000). Testing for the cointegrating rank of a VAR process with structural shifts, *Journal of Business & Economic Statistics* **18** : 451-464.

Van den Berg, H. (1997). "The relationship between international trade and economic growth in Mexico." North American Journal of Economics and Finance 8: 1-

Wilson, E.J and Chaudhri, D.P. (2004). " A Perspective on food policies evolution and poverty in the Indian republic (1950-2001), presented in 33rd conference of Economics , university of Sydney, 27-30 september,2004

Zivot, E., and Andrews, D.W.K. (1992) Further evidence on the great crash, the oil price shock, and the unit root hypothesis, *Journal of Business and Economic Statistics*, **10**(3), 251-7

Appendix:

Table(3): model(1), Autoregressive Distributed Lag Estimates

ARDL(1,0,0,2,1) selected based on Schwarz Bayesian Criterion

****

Dependent variable is LY

41 observations used for estimation from 1962 to 2002

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LY(-1)	.53387	.061681	8.6555[.000]
LK	.22676	.036504	6.2119[.000]
LHC	.0084954	.011209	.75793[.454]
LX	.21473	.020538	10.4553[.000]
LX(-1)	-.095361	.027681	-3.4450[.002]
LX(-2)	.061448	.021299	2.8851[.007]
LM	.0079377	.025213	.31483[.755]
LM(-1)	-.046152	.022091	-2.0892[.045]
INTP	.62865	.10119	6.2124[.000]
D78	.049433	.014230	3.4739[.002]
DU80	.082146	.015236	5.3917[.000]

****

R-Squared	.99813	R-Bar-Squared	.99750
S.E. of Regression	.010708	F-stat. F(10, 30)	1597.8[.000]
Mean of Dependent Variable	5.2553	S.D. of Dependent Variable	.21422
Residual Sum of Squares	.0034399	Equation Log-likelihood	134.2341
Akaike Info. Criterion	123.2341	Schwarz Bayesian Criterion	113.8095
DW-statistic	2.3031	Durbin's h-statistic	-1.0564[.291]

****

Diagnostic Tests

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Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(1)= 1.3254[.250]	F(1, 29)= .96880[.333]
B:Functional Form	CHSQ(1)= 1.0059[.316]	F(1, 29)= .72942[.400]
C:Normality	CHSQ(2)= .83567[.658]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .66907[.413]	F(1, 39)= .64699[.426