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An Application of the Zivot and Andrews Test**

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# Identifying Structural Breaks in the Lebanese Economy 1970-2003: An Application of the Zivot and Andrews Test

by

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## Abstract

During the 1960s and early 1970s the Lebanese economy was characterized by low inflation, high growth, sizeable balance of payments surpluses and small public sector deficits, which made it a highly attractive business centre. During this period the country was described as the Switzerland or Paris of the East. This macroeconomic stability did not last long, however, as the economy subsequently underwent fundamental structural changes during most years after the mid 1970s.

The aim of this paper is to identify the timing of major structural breaks in the Lebanese economy by applying the Zivot and Andrews (ZA) (1992) procedure, using annual time series data spanning the years from 1970 through 2003. The empirical results from the ZA model, which endogenously identifies the most significant structural breaks in each of the macroeconomic variables, clearly show that the null hypothesis of at least one unit root could be rejected for some of the variables under investigation. In other words, some of the variables, which contain a unit root based on the conventional unit root test, become stationary after taking into account the existence of potential structural breaks in the series. The results are statistically significant and the endogenous structural breaks identified using this methodology also coincides with periods of major economic shocks to the Lebanese economy. More specifically, most of the structural changes are associated with: the years of the Civil War in Lebanon, which started in 1975; the post 1982 era which started with the Israeli invasion of Beirut in 1982; the deep recession in 1983-84; and the adverse effects of the 1988-89 currency depreciation on inflation and the real economy.

JEL classification numbers: C12, C22, C52.

**Key words:** structural break, unit root test, and Lebanon economy.

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## **1. Introduction**

Prior to 1975 Lebanon possessed one of the most dynamic economies in the Middle East. Its stable macroeconomic environment, liberal economy, vibrant private sector, traditional role as an intermediary between the developed economies of Europe and the developing countries of the Middle East, and openness to capital and labour mobility made it quite different and unique in the region. Its economic structure was also quite different. While many of the region's economies were heavily reliant upon natural resources (especially oil and gas) and agriculture as the basis for their economic development and taxation revenue, Lebanon, by contrast, possessed few natural resources but enjoyed a strong comparative advantage in the services sector particularly in banking and finance, insurance, and trade-related services. Beirut was the financial centre for the Middle East in the 1960s and early 1970s, having the largest number of representative offices of foreign banks in the Arab world, and was the regional headquarters for many international companies (EIU, 2000). Lebanon's economic stability, characterized by low inflation, high rates of economic growth, sizeable balance of payments surpluses, small budget deficits, and a floating, stable and fully convertible domestic currency, and political stability, made it a highly attractive business centre (Eken et al., 1995).

After 1975, however, the economy experienced a number of traumatic developments that have subsequently had a profound impact on its structure and performance. For example, the Civil War (1975-90) had a severe impact on the Lebanese economy, in terms of declining output and investment, deterioration in public finances, widespread destruction of physical capital stocks and large-scale emigration of high levels of human capital. According to the United Nations (1991) the total damage to physical assets during the civil war was estimated at US\$25 million and Lebanon lost around 200,000 people from its professional and skilled labour force (Eken et al., 1995).

The primary aim of this paper is to identify the timing of major structural breaks to affect the economy by, firstly, applying the conventional Augmented Dickey Fuller (ADF) test and then, secondly, contrasting this with results derived from the Zivert and Andrews (ZA) (1992) procedure using annual time series data spanning the years from 1970 through 2003. It is essential to correctly identify structural breaks in the data for any economy: firstly, to avoid model misspecification and coefficient bias using such data, and, secondly, to ensure that tests for non-stationarity of the data give the correct result. In the context of the Lebanese

economy, which has been subject to considerable economic turbulence for a number of years, the need to correctly identify related structural breaks in economic data, to facilitate a meaningful empirical modelling analysis of its economy, becomes particularly important.

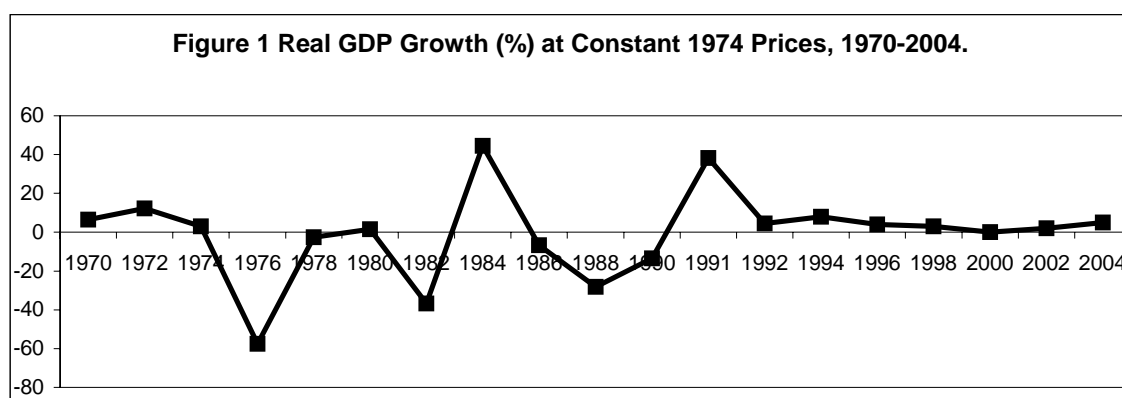
The empirical results from the ZA procedure, which endogenously identifies the most significant structural break in each of the macroeconomic variables, shows that the null hypothesis of at least one unit root could be rejected for some of the variables under investigation. Consequently, some of the variables, which contain a unit root based on the conventional unit root test, become stationary after taking into account the existence of potential structural breaks in the series. The results presented in this paper are statistically significant and the endogenous structural breaks identified using the ZA methodology also coincide with periods of major economic shocks to the Lebanese economy. More specifically, most of the structural changes are associated with: the years of the Civil War in Lebanon, which started in 1975; the post 1982 era which started with the Israeli invasion of Beirut in 1982; the deep recession in 1983-84; and the adverse effects of the 1988-89 currency depreciation on inflation and the real economy.

The structure of the paper is as follows: Section 2 conducts a brief review of economic developments in the Lebanese economy over the period of the early 1960s to 2003. Section 3 uses the ZA method to test the unit root hypothesis assuming one major unknown structural break and reports the timing of such data-dependent structural breaks, which are determined by a recursive, rolling or sequential approach, in each of the variables analyzed in the paper. The results from this approach are compared with those obtained from the conventional ADF test approach, with important differences and implications highlighted. Finally, section 4 presents some concluding remarks.

## **2. An overview of the Lebanese economy**

During the 1960s and early 1970s the Lebanese economy was characterized by low inflation, high rates of growth, large balance of payments surpluses, small public sectors deficits, and a floating, stable and fully convertible domestic currency (Eken et al., 1995). It enjoyed a strong comparative advantage in the services sector, particularly in banking and finance, insurance, and trade related services. This provided the basis for its relatively rapid rate of growth of real output of close to 6 per cent during 1964-74 (Eken et al., 1995). But this stable situation did not last long as the Lebanese economy underwent fundamental structural changes after 1975. During 1975-90 the economy disintegrated as a consequence of its Civil War (1975-1990),

which exacted a heavy toll in human and material terms and resulted in fundamental changes in the economy. Real GDP growth (at 1974 constant prices) was  $-16.14\%$  in 1975 declining to  $-57.14\%$  in 1976 and  $-36.79\%$  in 1982 (See Figure 1). The year 1982 was marked by the Israeli invasion of Lebanon. In addition, GDP growth deteriorated further after 1985 when the central state authority came to an end and gave way to an escalation in violence. This contributed to a substantial decline in economic activity during 1986-90 (Eken et al., 1995).



Source: Plotted by the authors based on data provided by Eken et al. (1995); Eken and Helbling (1999); Ministry of Finance (various years) and Banque du Liban (various years).

Moreover, the flow of goods and factors of production was disrupted as a result of the fragmentation of the country, and there was a loss of professional and entrepreneurial skills through mass emigration during the Civil War period. Emigration was accompanied by capital flight and Lebanon's access to flows of foreign capital was severely curtailed. Concurrently, public finances deteriorated significantly owing to a lack of central government authority, a weak and inefficient tax system, combined with the need to provide a minimum of public services (Saleh and Harvie (2005)). Resulting large fiscal deficits were financed primarily through the banking system. The consequent rapid growth in liquidity compared with economic activity, and the erosion of private sector confidence, led to continuous downward pressure on the Lebanese pound in the foreign exchange market, heightened inflationary pressures, and resulted in high levels of currency substitution. For example, the uncertain political environment and the pickup in inflation led to increased currency substitution in private portfolios and to speculative behaviour. Reflecting these developments, during 1975-82 the LL/US\$ and nominal effective exchange rates depreciated steadily and exchange rate volatility increased significantly. The Lebanese pound depreciated by about

50% against the US dollar during this period, while the nominal effective rate depreciated by about 40% (Eken et al., 1995).

During the second half of the 1980s the macroeconomic situation deteriorated significantly as the domestic conflict escalated, contributing to: accelerating inflation, a weakening in the external position, rapid dollarization of the economy, and downward pressure on the Lebanese pound. With shifting expectations the volatility of the exchange rate escalated sharply during 1983-1990, with the Lebanese pound depreciating by close to 100% vis-à-vis the U.S. dollar in nominal effective terms. The Civil War also had a severe impact on the trade balance as imports rose and exports fell due to the devastation of the industrial sector. For example, exports declined from US\$1,162.7 million in 1975 to US\$582 million in 1986, before increasing to US\$628 million in 1988. A surge in exports after 1986 was caused by a sharp depreciation of the national currency in 1987-88, which resulted in a substantial increase in agricultural and industrial exports. Imports declined in 1976, 1981, 1982, 1985 and 1987 as a result of the Civil War, the Israeli invasion of Lebanon in 1982, and other important factors such as shortages of foreign exchange and a decline in real income, which induced import substitution in the Lebanese market especially in 1987 (Eken and Helbling, 1999).

The outbreak of the Civil War also resulted in considerable volatility in inflation rates, and an overall increase during 1975-90. For example, inflation increased from around 10% in 1975 to close to an imposing 500% in 1987. This volatility could be explained by conjunctural economic policies, mainly monetary policy coupled with ever changing inflationary expectations and a loss of confidence in the domestic currency. The eruption of armed conflict and hostilities, and the resulting deterioration of the political and security situation, had a major adverse on the economy as a whole, but most certainly on the rate of inflation and exchange rate (Chami, 1992).

During the latter part of the Civil War (1985-89) a significant degree of macroeconomic and political instability prevailed. Large budget deficits were monetised for debt reduction purposes, and this contributed to an acceleration in inflation. Moreover, the destruction and loss of capital, both human and physical, were particularly severe during the period, and real GDP declined. All these developments were reflected in a rapid decline of the external value of the Lebanese pound against the major currencies, a sharp increase in

dollarization, and capital outflows. Since 1985 the monetary authorities devoted considerable resources to stop the galloping depreciation of the Lebanese pound.

Measures taken by the central bank that involved constantly intervening in the local foreign exchange market and seeking to increase interest rates on Lebanese pound balances, were aimed at countering speculation against the currency as well as controlling liquidity in the banking system so as to curb the amount of funds available for speculation. Most of these steps were in vain, however, because they did not slow the rate of growth of the monetary base: inflationary pressure intensified and the Lebanese currency continued to depreciate. One year after the conclusion of the Ta'if agreement at the end of 1989, a government of national unity was reinstated and a period of economic normalization and recovery started. Progress was, nevertheless, slow, and political uncertainty and macroeconomic fragility remained significant. Inflation rates remained high and the Lebanese currency depreciated further, particularly in the first three quarters of 1992. It was only in October 1992, after the appointment of Prime Minister Hariri, that reconstruction and stabilization began.

Over the post-war and reconstruction period (starting mainly after 1993) the authorities set out to bring about economic stabilization, together with the task of reconstruction and development of the war-ravaged economy. The year 1993 was marked by favourable macroeconomic developments that included: increasing real GDP, falling inflation, a stable exchange rate, and a strengthening of foreign exchange reserves. Real GDP growth was 7% in 1993 but slowed by the late 1990s, and registered only 0% in 2000 before increasing again to 3% in 2003 (BDL, various years). Declining overall consumption expenditure contributed to the economic slowdown, recovering only slowly thereafter. The decline in economic growth also led to a fall in government receipts that increased the budget deficit, forcing the government to raise borrowing and taxation (EIU, 2000).

An exchange rate based nominal anchor policy, targeting a slight nominal appreciation of the Lebanese pound against the US dollar, has been at the core of the government's stabilization efforts since the early 1990s. The policy has been successful in stabilizing expectations and inflation rates have been rapidly reduced to single digit levels. The overall macroeconomic situation, however, remained difficult with large budget deficits, associated growing public debt, large current account deficits, and occasional episodes of domestic and regional political uncertainties. Under these circumstances, and given the virtual absence of restrictions on capital account transactions, monetary policy has borne a heavy burden, as

high and flexible interest rates have been necessary to ensure the exchange rate peg and to allow for a comfortable cushion of foreign exchange reserves. Hence, to ensure the exchange rate peg, the authorities have set monetary policy parameters, particularly interest rates on primary sales of treasury bills. As stabilization through the exchange rate based nominal anchor policy took hold starting in 1993, however, real interest rates became positive during the 1990s and early 2000s.

Over the post-war period (1991-2003), and as a result of infrastructure rebuilding, acceleration in the growth of government capital expenditure, together with large and expanding current expenditure and the slow recovery of the revenue-generation capacity, resulted in a sizeable increase in fiscal imbalances (Saleh and Harvie (2005)). Consequently, government budget deficits increased from 9.2 per cent of GDP in 1993 to 20.6 per cent in 1996 before declining to around 15 per cent in 2003. This huge increase in the budget deficit led to sustained growth in government debt during the period 1993-2003. In particular, domestic public debt, as a percent of GDP, increased from 44.2 per cent in 1993 to 86.5 per cent and to around 170 per cent in 1997 and 2003 respectively. In nominal terms gross public debt increased from US\$3.7 billion in 1993 to about US\$32 billion in 2003. The external public debt increased from US\$0.3 billion to about US\$15 billion in 2003 as a result of the Paris II conference in 2002, where the government met with international donors to seek bilateral assistance and lower interest rates by restructuring its higher interest rate bearing domestic debt obligations. An aggregate amount of US\$4.3 billion was pledged in 15-year loans at reduced rates to support the government's effort to reduce the public debt (BDL, 2003).

Hence, despite the rising GDP growth rates of the early 1990s (38.2% in 1991), which later fell back to a considerably lower level, the rate of growth in budgetary spending has consistently exceeded this. Government spending as a percentage of GDP rose from 23% in 1993 to 42% in 2000; the deficit ratio (deficit-to-GDP) increased from 9.2% to more than 23% in 2000 before declining to around 15% in 2003 as a result of higher revenues and lower spending (BDL, 2003).

More recently the government has introduced numerous incentives to promote private investment and attract foreign investment (e.g. one stop agency for investors; eased limitations on foreign ownership of land; selective tax incentives; among others) with the aim of stimulating growth and exports to reverse the downturn trend. Overall growth in the



country, more recently, has remained modest: real GDP growth was 2% in 2002 and 3% in 2003, export performance has been encouraging, achieving a growth rate of 25% in 2001, and has been further encouraged by the Association Agreement with the EU concluded in 2002 (BDL, 2003).

### **3. Identifying Lebanon's Significant Structural Breaks**

In this section of the paper, and for purposes of comparison, the conventional ADF (Augmented Dickey Fuller) test and ZA (Zivot-Andrews, 1992) test are now both used to examine the time series properties of data for the Lebanese economy, and to identify structural breaks in this data, covering the period 1970-2003. In doing so this study uses annual data obtained from the following sources: IMF, the International Financial Statistics Yearbook (IFS), (1990-2004); World Bank (various years); Ministry of Finance (various years); Banque du Liban (BDL, various years), and Banque Audi (1999-2003).

#### **ADF test results**

The results from using the ADF test are presented in Table 1. As might be expected the null hypothesis of a unit root for all of the variables under investigation cannot be rejected at the 5 percent significance level. The critical values used in Table 1, however, need to be briefly explained. For a variable to be stationary the ADF t-statistic in absolute value must be larger than the corresponding critical values reported in MacKinnon (1991). From Table 1 it can be seen that the conventional unit root results indicate that all of the variables under investigation contain a unit root, except LRIP. In other words only LRIP is stationary at the 10 per cent significance level. Based upon our discussion in the previous section, however, data for macroeconomic variables in Lebanon are likely to be subject to several structural breaks, and an application of the ADF test to data for such variables is, therefore, likely to be biased towards not rejecting the existence of a unit root (especially with short time spans of data).

**Table 1. Data description and ADF test results**

Symbol	Variable description <sup>1</sup>	ADF <i>t</i> -statistic <sup>2</sup>	Optimal lag length <sup>3</sup>	Inference
<i>LGDP</i>	Gross Domestic product at current prices	-1.667	1	Unit Root
<i>LRGDP</i>	Real GDP	-2.762	0	Unit Root
<i>LCPI</i>	Consumer Price Index	-1.862	1	Unit Root
<i>LRER</i>	Real Exchange Rate	-2.112	1	Unit Root
<i>LMI</i>	Domestic Money Supply	-2.608	0	Unit Root
<i>LRMI</i>	Domestic Real Money Supply	-3.208	0	Unit Root
<i>LCP</i>	Private Consumption in current prices	-1.465	1	Unit Root
<i>LRCP</i>	Real Private Consumption	-2.640	0	Unit Root
<i>LIP</i>	Private Investment in current prices	-1.817	0	Unit Root
<i>LRIP</i>	Real Private Investment	-3.477	0	Stationary <sup>4</sup>
<i>LCG</i>	Government consumption expenditure	-0.947	0	Unit Root
<i>LRCG</i>	Real Government Consumption expenditure	-2.126	0	Unit Root
<i>LX</i>	Exports in current prices (in Lebanese Lira)	-2.898	0	Unit Root
<i>LM</i>	Imports in current prices (in Lebanese Lira)	-2.631	0	Unit Root

Notes: (1) All these variables are in log- linear form and real variables are in constant 1974 prices. (2) Critical *t* values at the 1, 5 and 10 percent levels are  $-4.27$ ,  $-3.55$  and  $-3.21$ , respectively (MacKinnon (1991)). (3) The lag length is determined by means of the Schwartz-Bayesian Criterion (SBC). (4) Based on the MacKinnon critical values, the corresponding null hypothesis is rejected at the 10% significance level.

Consequently, when the true data generating process of a broken linear trend is stationary the conventional unit root tests have little power. Failing to account for at least a one time structural break in the trend function, could bias the usual unit root results towards their non-rejection of the null (Perron 1989; 1997). Therefore, usage of well known tests such as the ADF test could lead to incorrectly identifying that there is a unit root in a series, whereas in actual fact this series can be stationary around a one-time structural break (ZA, 1992).

Perron (1989) applied the new procedure by assuming or visually detecting a particular year as the starting point for the structural break. The assumption of a known break, however, is subject to certain criticisms, as one could select a particular date which complies with his or her results by resorting to pre-testing and data-mining. Moreover, a particular event could occur in year  $t$  but its gradual effects might not eventuate until subsequent years.

Christiano (1992) also criticised the conventional ADF approach arguing that data-based procedures should be used to determine the most likely location of a break, and that this invalidates the distribution theory underlying conventional testing. In response to this and criticisms of Perron's (1989) assumed timing break approach, a number of recent studies have developed different methodologies for endogenising the timing of structural breaks involving estimation in an iterative process, including Zivot and Andrews (ZA, 1992), Perron and Vogelsang (1992), Perron (1997), Lumsdaine and Papell (1997) and Bai and Perron (2003). These studies have shown that by endogenously determining the timing of structural breaks bias in the usual unit root tests can be reduced. According to Zivot and Andrews (1992), the use of endogenously determined structural breaks may also lead to the rejection, or at least the weakening, of the unit root hypothesis in some cases.

Hence there is a significant and important difference between the ZA method and Perron's (1989) test, where the former estimates the timing break while in the latter an assumption about the timing break is made. In addition, with the Perron test the null hypothesis states that the variable under investigation contains a unit-root with a drift that excludes any structural break. With the alternative ZA method the null hypothesis states that the series is a trend stationary process, with a one-time break in the trend variable occurring at an unknown point in time. The latter approach is, therefore, more general allowing for shifts in the level or the growth rate of the series. The ZA method runs a regression for every possible break date sequentially. By endogenously determining the timing of structural breaks ZA argue that the results of the unit root hypothesis suggested by earlier conventional tests such as the ADF test may be reversed. The ZA method is now applied to the data for Lebanon and the results compared with the ADF test results presented in Table 1.

## ZA test results

With the ZA test the  $TB$  (time of the break) is chosen to minimize the one-sided  $t$ -statistic of  $\alpha=1$  in equations 2 to 4 below. In other words a break point is selected which is the least favorable to the null hypothesis. The ZA model endogenises one structural break in a series (such as  $y_t$ ) as follows:

$$H0: \quad y_t = \mu + y_{t-1} + e_t \quad (1)$$

H1:

Model A

$$\Delta y_t = \mu + \beta t + \theta DU1_t + \alpha y_{t-1} + \sum_{j=1}^k c_j \Delta y_{t-j} + \varepsilon_t \quad (2)$$

Model B

$$\Delta y_t = \mu + \beta t + \gamma DT1_t + \alpha y_{t-1} + \sum_{j=1}^k c_j \Delta y_{t-j} + \varepsilon_t \quad (3)$$

Model C

$$\Delta y_t = \mu + \beta t + \theta DU1_t + \gamma DT1_t + \alpha y_{t-1} + \sum_{j=1}^k c_j \Delta y_{t-j} + \varepsilon_t \quad (4)$$

Model A allows for a one-time change in the intercept. Model B is used to test for stationarity of the series around a broken trend, and, finally, Model C accommodates the possibility of a change in the intercept as well as a broken trend.  $DU_t$  is a sustained dummy variable capturing a shift in the intercept, and  $DT_t$  is another dummy variable representing a shift in the trend occurring at time  $TB$ . The alternative hypothesis is that the series,  $y_t$ , is I(0) with one structural break.  $TB$  is the break date, and  $DU_t=1$  if  $t > TB$ , and zero otherwise,  $DT_t$  is equal to  $(t-TB)$  if  $(t > TB)$  and zero otherwise. The null is rejected if the  $\alpha$  coefficient is statistically significant.

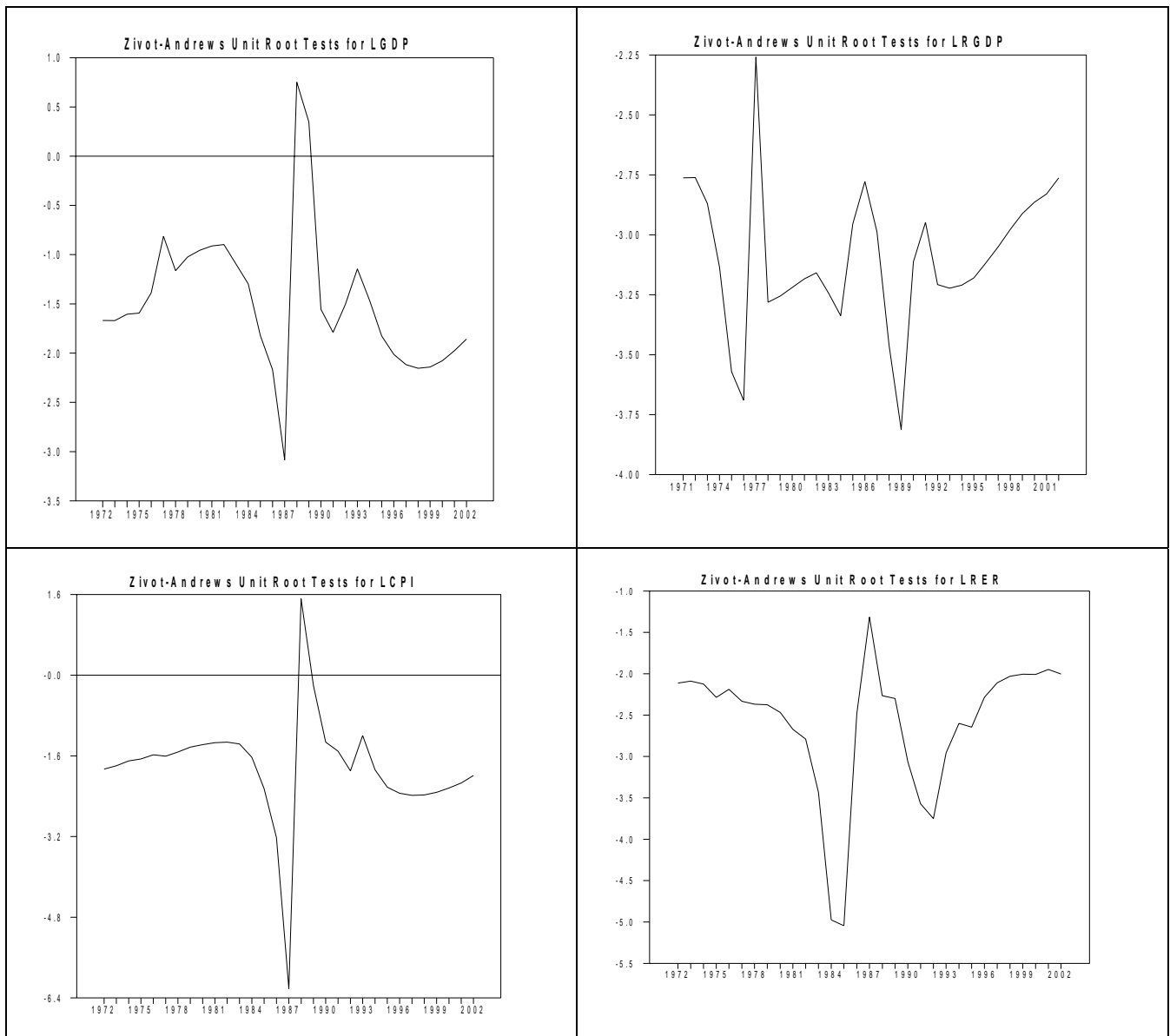
More specifically, the ZA test asserts that the  $TB$  is endogenously determined by estimating the above three-equations (A, B and C) sequentially. This is done sequentially in order to allow for  $TB$  to be in any particular year with the exception of the first and last years. The optimal lag length is determined on the basis of the Schwartz-Bayesian Criterion (SBC) and the most significant  $t$  ratio, and is known as the general to specific approach. Using the ZA procedure the timing of the structural changes (impacting on both the intercept and the

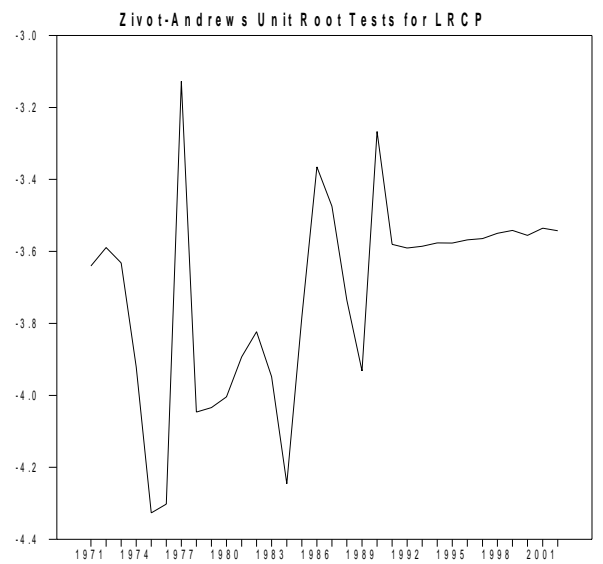
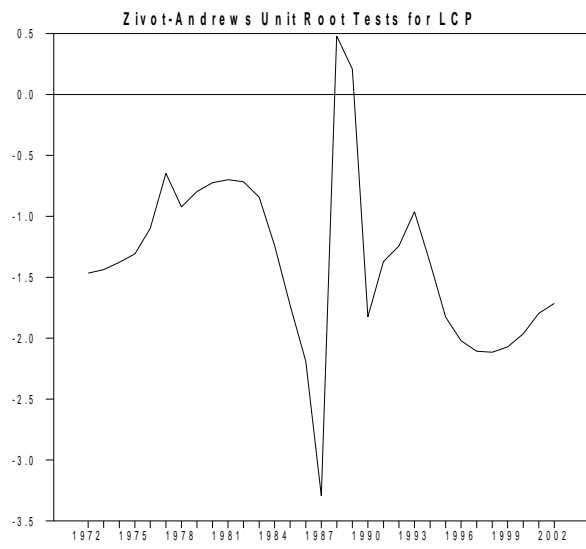
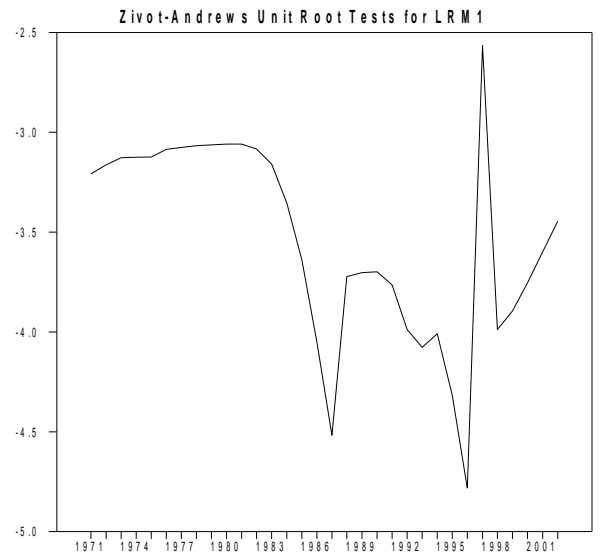
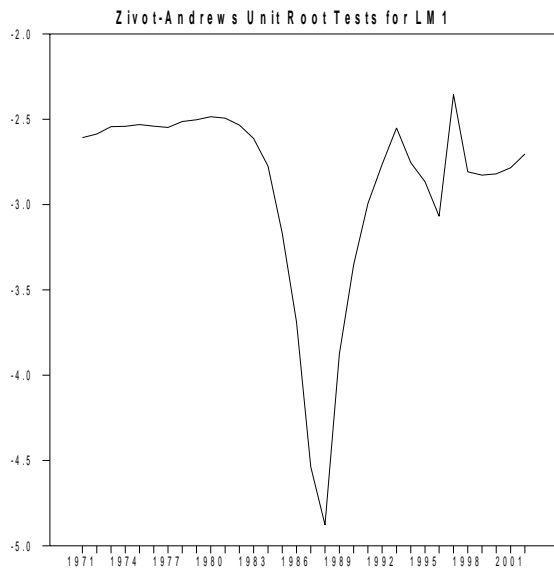
slope of each series) for each of the variables under investigation is detected based on the most significant  $t$  ratio for  $\hat{\alpha}$ , that is  $t_{\hat{\alpha}}$ . Model C is adopted for the purpose of this paper and the results subsequently reported, since this is the most comprehensive of the three models capturing breaks in both the intercept as well as the trend.

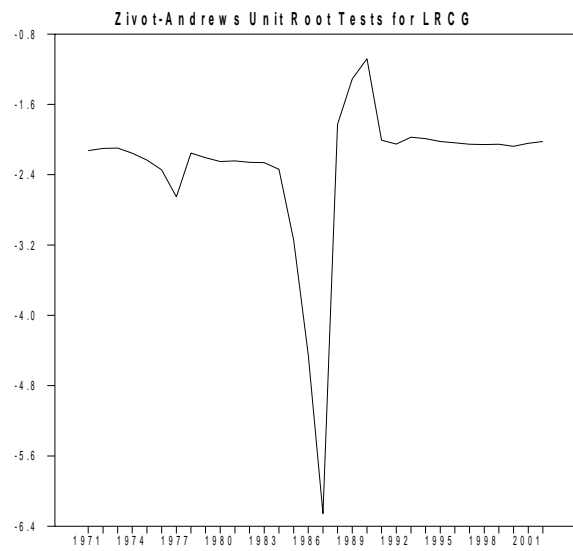
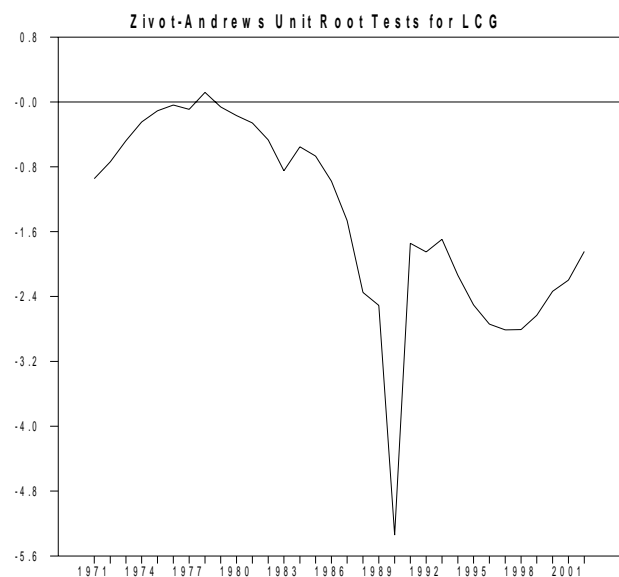
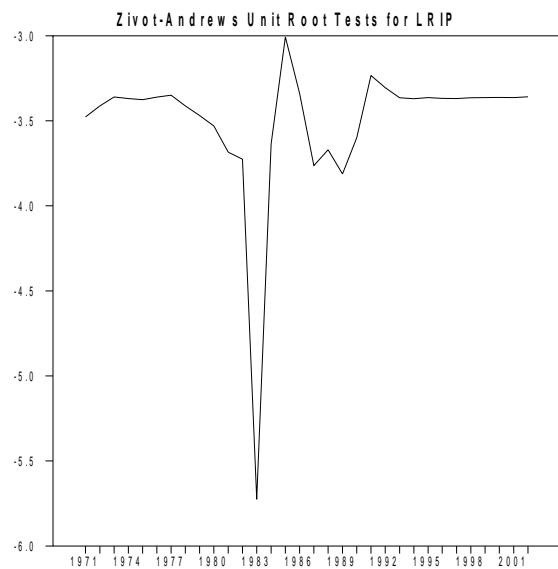
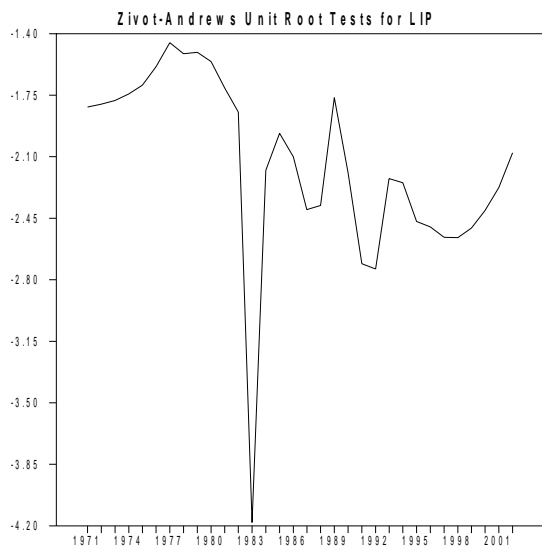
Figure 2 shows the plots of the estimated  $\hat{t}_{\alpha}$  within the trimming region using the ZA procedure. The lowest value for  $\hat{t}_{\alpha}$  in each graph determines the  $TB$ . The estimated coefficients for equation (4) together with the corresponding  $TBs$  for each of the variables under investigation are presented in Table 2. As can be seen from these results, (a) the estimated coefficients for  $\mu$  and  $\theta$  are all statistically significant, supporting the view that at least one structural shift in the intercept has occurred during the sample period for all of the variables under investigation; (b) the trend variable is significant in 9 out of 14 cases; indicating the series exhibit an upward or downward trend; (c) the estimated coefficients for  $\gamma$  are statistically significant for 10 out of 14 variables (the only 4 exceptions being  $Ln(GDP)$ ,  $Ln(MI)$ ,  $Ln(RCP)$  and  $Ln(RIP)$ , implying that at least one significant structural shift in the trend has occurred in at least 10 of the variables under investigation

As discussed earlier, empirical results based on the conventional ADF unit root test indicate that none of the variables under investigation is stationary at the 5 percent or better significance level (see Table 1). The ZA methodology, however, produces mixed results, as the presence of the most significant structural breaks in the data make some of the variables under investigation stationary. These empirical results are consistent with the original ZA (1992) findings as they too found that some of the variables found to be non stationary using the ADF test now become stationary. In the context of the present study these stationary variables are:  $Ln(CPI)$ ,  $Ln(RIP)$ ,  $Ln(CG)$ , and  $Ln(RCG)$ . The corresponding timing of the structural break (TB) for each variable is also shown in Table 2. More interestingly, we observe that the timing of the structural breaks for the variables:  $Ln(GDP)$ ,  $Ln(CPI)$ ,  $Ln(MI)$  and  $Ln(CP)$  occurred in the years 1987 and 1988, which are also the years when the country experienced a significant degree of macroeconomic and political instability. Large budget deficits were monetised and inflation was accelerating. Hence, the country experienced not only double-digit but also triple-digit inflation, reaching approximately 500% in 1987 (Eken et al. 1995).

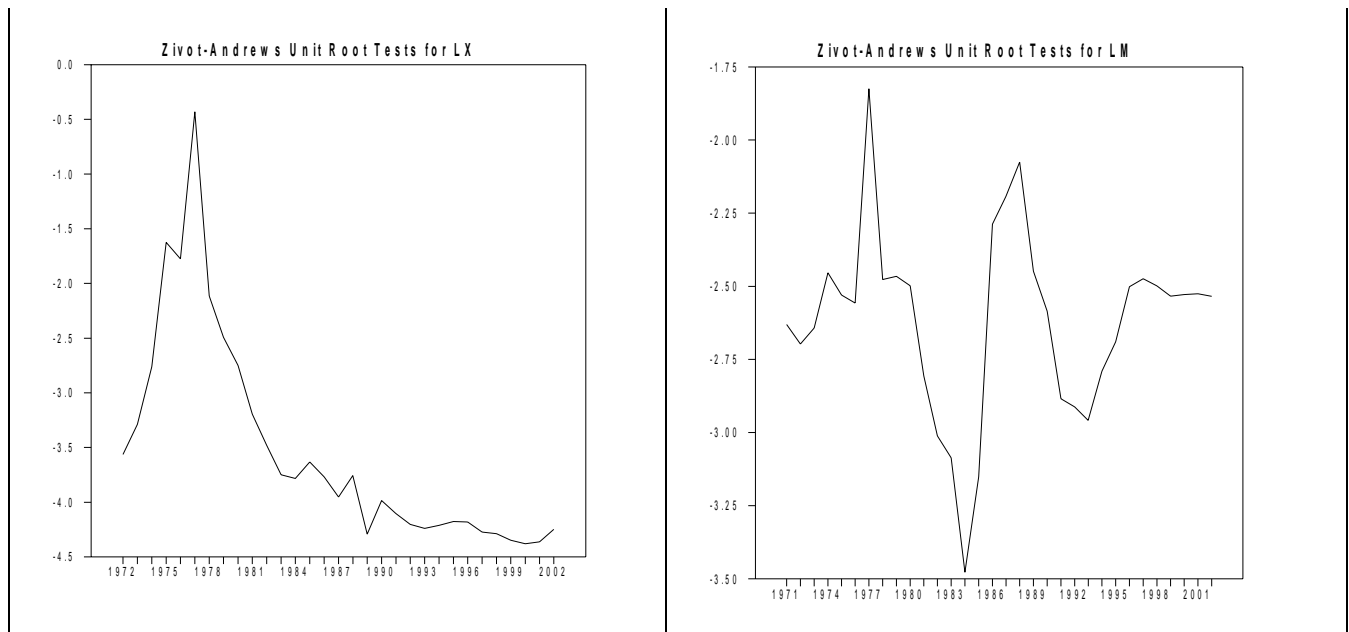
**Figure 2. Plots of the estimated timing of structural breaks by ZA procedure allowing for a break in both intercept and trend (model C)**











Source: Authors' calculations based on the ZA procedure (model C).

Note: the numbers on the vertical axis are  $\hat{t}_\alpha$  ratios. The minimum t-ratio determines  $TB$ .

Moreover, the structural break for  $Ln(CPI)$  that occurred in 1987 can also be attributed to the domestic conflict which escalated during the second half of the 1980s, leading to: an acceleration in inflation, a weakening in the external position and rapid dollarization of the economy, and significant downward pressure on the Lebanese pound which depreciated sharply during 1987-1988.

The structural break for the variable  $Ln(MI)$  occurred in the year 1988, and coincided with the policy of money creation by the authorities as the primary method of budget financing. This led to inflation which increased from 18.1% in 1984 to 487.1% and 155% in 1987 and 1988 respectively (Eken et al. 1995). M1 – domestic currency denominated liquidity – grew at an average rate above 45% during the period 1982-1988. In addition, the average exchange rate depreciated from LL6.51 per US\$ in 1984 to 409.23 per US\$ in 1987 (BDL, various years).

**Table 2. The Zivot-Andrews test results: break in both intercept and trend**

(Model C) 
$$\Delta y_t = \mu + \beta t + \theta DU1_t + \gamma DT1_t + \alpha y_{t-1} + \sum_{i=1}^k c_i \Delta y_{t-i} + \varepsilon_t$$

Variable	TB1	$\mu$	$\beta$	$\theta$	$\gamma$	$\alpha$	k	Unit root results
<i>LGDP</i>	1987	2.331 (2.78)	0.0765 (3.32)	1.335 (3.62)	-0.047 (-1.38)	-0.312 (-3.08)	1	Unit root
<i>LRGDP</i>	1989	5.361 (3.78)	-0.006 (-0.58)	-0.3312 (-1.98)	0.0386 (2.14)	-0.615 (-3.81)	0	Unit root
<i>LCPI</i>	1987	0.966 (5.03)	0.0725 (5.96)	1.498 (7.15)	-0.076 (-4.54)	-0.277 (-6.22)	1	Stationary
<i>LRER</i>	1985	2.37 (5.07)	0.006 (0.94)	-0.324 (-3.43)	0.031 (3.42)	-0.501 (-5.04)	1	Unit root
<i>LMI</i>	1988	6.104 (4.79)	0.161 (4.32)	1.898 (3.91)	-0.032 (-0.94)	-0.860 (-4.87)	0	Unit root
<i>LRMI</i>	1996	6.891 (4.78)	-0.080 (-4.09)	-1.075 (-2.31)	0.287 (3.31)	-0.786 (-4.78)	0	Unit root
<i>LCP</i>	1987	2.092 (2.96)	0.081 (3.57)	1.398 (4.04)	-0.071 (-2.32)	-0.291 (-3.29)	1	Unit root
<i>LRCP</i>	1975	6.264 (4.33)	0.046 (0.53)	-0.354 (-1.97)	-0.039 (-0.451)	-0.738 (-4.32)	1	Unit root
<i>LIP</i>	1983	3.087 (4.23)	-0.021 (-0.53)	2.197 (5.82)	0.097 (1.87)	-0.408 (-4.18)	0	Unit root
<i>LRIP</i>	1983	6.135 (5.75)	-0.117 (-2.77)	1.681 (4.54)	0.0546 (1.21)	-0.786 (-5.72)	0	Stationary
<i>LCG</i>	1990	2.041 (5.25)	0.146 (5.82)	1.196 (5.52)	-0.133 (-7.45)	-0.415 (-5.34)	0	Stationary
<i>LRCG</i>	1987	4.765 (6.17)	0.102 (4.61)	-1.702 (-5.92)	-0.051 (-2.13)	-0.815 (-6.25)	0	Stationary
<i>LX</i>	1993	3.471 (4.51)	-0.005 (-1.03)	-0.087 (-0.32)	0.167 (1.98)	-0.516 (-4.37)	1	Unit root
<i>LM</i>	1984	3.603 (3.66)	0.0567 (2.08)	-0.485 (-2.31)	-0.0102 (-0.456)	-0.527 (-3.47)	0	Unit root

Notes: (a) Critical values at the 1 and 5 percent levels are -5.57 and -5.08, respectively (Zivot and Andrews, 1992).

The structural break for the variable  $CP$  was determined using both log level in current prices ( $Ln(CP)$ ) and also at 1974 constant prices ( $Ln(RCP)$ ). As shown in Table 2, when we determine the timing of the break using current prices the structural break occurs in 1975 while with constant prices the year of the break changes to 1987. The structural break occurring in 1975 coincided with the outbreak of the Civil War which resulted in a sharp decline in real GDP growth by  $-16.1\%$  in 1975 and  $-57.1\%$  in 1976 (Eken, et al., 1995). The break in 1987 could be attributed to the escalation of the domestic conflict in this year and the adverse economic outcomes mentioned previously during 1987-88.

The structural break for the variable  $Ln(IP)$  and  $Ln(RIP)$  was determined in both log level in current prices and also at 1974 constant prices. As shown in Table 2 the results for both indicate that the break occurred during 1983, a year following the Israeli invasion in 1982 marking a major turning point for the economy, massive destruction of the country's infrastructure, huge damage to all sectors in the economy, loss of human resources, together with the presence of various military apparatus in the country which had a severe impact on the economy. Hostilities erupted again in 1983 and the government lost control of most of the capital, Beirut, the year after this. Hence 1983 coincided with massive fiscal deficits, which reached acute levels of 24% of total expenditure; and there was also massive spending on weapons and munitions for the army alone which accounted for US\$800 million (Al-Khalil, 1991).

The structural break for the variable  $Ln(CG)$  and  $Ln(RCG)$  was determined in both log level current prices and 1974 constant prices. As shown in Table 2 the results for both indicate that the breaks occurred in 1987 for the variable  $Ln(RCG)$  and 1990 for the variable  $Ln(CG)$ . The structural break for the variable  $Ln(RCG)$  occurring in 1987 coincides with the deterioration in the macroeconomic situation and the escalation in the domestic conflict at this time and mentioned previously (Eken et al., 1995). The structural break for the variable  $Ln(CG)$  occurring in 1990 coincides with an intensification of fighting in both industrial and prosperous areas of Lebanon, and with a dramatic decline in output and exports. The hostilities in this year (the third period of the Civil War) resulted in a significant outflow of capital and a massive wave of emigration. Out of a population of three million, 250,000 people are estimated to have left the country between March 1989 and May 1990. The productive sectors such as agriculture and industry were severely affected and their exports declined by more than 50% during 1990 (Al-Khalil, 1991).

The structural break for the variable  $Ln(X)$  occurred in 1993, coinciding with expansionary fiscal policy in order to rebuild the country and to restore macroeconomic stability in the war-ravaged economy. The acceleration of government participation in the reconstruction and rehabilitation process was exceptionally large during this year as the government began to increase reconstruction expenditures and social services. Total government expenditure increased from 2,219 billion LL in 1992 to 3,017 billion LL in 1993 and capital expenditure also increased from 146 billion LL in 1992 to 393 billion LL in 1993 with the government's aim of rebuilding the country and stimulating the economy. The year 1993 was characterized by high economic growth (7%), declining inflation and a sharp decline in exchange rate volatility (Eken et al., 1995).

The structural break for the variable  $Ln(M)$  occurred during 1984, coinciding with the government losing its control of most of the capital (Beirut) as a result of hostilities which erupted again in 1983. The post-1982 period was extremely severe for the Lebanese economy, as indicated earlier, as a result of the Israeli invasion in 1982, massive destruction of the country's infrastructure and the huge damage to almost all sectors of the Lebanese economy. In addition, the post-1982 period was also associated with the recession in the Gulf countries due to a declining oil price and preferences in these countries for the employment of cheaper non-Arab labour. All of these severely affected exports and had a negative impact on remittances from the Gulf countries during 1984 (Al-Khalil, 1991).

#### **4. Summary and conclusions**

This paper has identified the timing, and explanation, of major breaks in key macroeconomic variables for the Lebanese economy, utilizing annual time series data covering the period 1970-2003. To achieve the objective of the paper the Zivot and Andrews approach was adopted, allowing the data to determine, endogenously, the single most important structural breaks in each series.

According to the empirical results presented in Table 1 the conventional unit root test (ADF test) provides insufficient evidence against the unit root null hypothesis for almost all of the variables under investigation. After accounting for the most significant structural breaks in the data impacting on both the intercept and trend the results from the ZA test

presented in Table 2, however, indicated that the null hypothesis of at least one unit root is rejected for four of the variables under investigation at the 10 per cent level or better.

Most of the endogenously determined structural changes are associated with: the years of the Civil War in Lebanon, which started in 1975, the post 1982 era which started with the Israeli invasion of Beirut in 1982, the deep economic recession of 1983-84, and the adverse effects of the 1988-89 currency depreciation on inflation and the real economy of Lebanon.

The study has shed some light on the issue of structural breaks in the data and as such provides complementary evidence and useful results for future studies using macroeconomic variables in Lebanon and elsewhere. Since testing for non-stationarity with multiple structural breaks may yield conflicting results to conventional as well as ZA unit root tests, future work could usefully further concentrate on a clearer refinement of this issue.

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