Cointegration, Causality and Wagner's Law: A test for Northern Cyprus, 1977-1996[1]

Peter M. Jackson
Professor of Economics
Director of Management Centre
Leicester University, Leicester, LE1 7RH United Kingdom
pmj1@le.ac.uk

Meryem Duygun Fethi
PhD Candidate
Management Centre
mdf2@le.ac.uk

Sami Fethi
Research Student
Economics Department
sf19@le.ac.uk

Abstract

The purpose of this study is to analyse public expenditure growth in Northern Cyprus during the period 1977-1996. We test the validity of Wagner's Law that there is a long-run tendency for public expenditure to grow relative to national income. This implies that public expenditure can be treated as an outcome, or an endogenous factor, not a cause of growth in national income. Conversely, Keynesian proposition treats public expenditure as an exogenous factor, which could be utilised as a policy instrument. In the former approach, the causality runs from national income to public expenditure whereas in the latter proposition, causality runs from public expenditure to national income. Utilising recent advances in cointegration and causality techniques, in the case of Northern Cyprus economy, we find that there is a mixed evidence in support of Wagner's Law.

Keywords: Wagner's Law, Cointegration, Causality, Northern Cyprus

[1] We thank to Professor Clive Fraser for his helpful comments.
The earlier version of this paper was presented at the Second International Congress on Cyprus Studies; Eastern Mediterranean University, Gazimagusa, Turkish Republic of Northern Cyprus, 24-27 November, 1998.

1. Introduction

Small island economies (SIEs) are characterised by absolutely small public sectors compared with the public sectors in the larger nations. However, due to insufficient private sector incentives, the public sectors are usually ascribed strong social and economic roles. In most SIEs, the public sector is the major employer and aims to act as an instrument to encourage the development process. This results in significant expansion of the sector where the public expenditures are mainly spent on the salaries or pensions of public sector employees whilst the budget receipts of the governments depend only on a narrow tax base. A significant source of budget receipts for many SIEs is inevitably external grants which come in the form of foreign aid (McKee and Tisdell, 1990).

The growth in the size of public sector has received considerable attention for several decades. In particular, the relationship between public expenditure and national income has been tested empirically for various countries using both time-series and cross-sectional data sets within the context of 'Wagner's Law'. Wagner's Law was proposed by German political economist, Wagner (1883). Among the several interpretations, the most popular interpretation of the Law states that the increase in economic activities cause an increase in government activities, which in turn raises public expenditure.

In this study, we aim to utilise Wagner's Law to empirically analyse public expenditure growth in a small island, Cyprus, in particular Northern Cyprus where the role of government as a major actor to encourage economic development and growth has always been significant. Relying on the proposition by Wagner, we will investigate whether there is a long-run tendency for public expenditure to grow. The main motivation behind this study is that such analysis has not been attempted before.

The paper is laid out as follows. Section 2 discusses the public expenditure pattern of Northern Cyprus. Section 3 briefly explains the theoretical analysis of public expenditure growth with special emphasis on Wagner's Law. In section 4, data and empirical methodology are explained. The empirical results derived from estimation are covered in section 5. Section 6 provides some conclusions.

2. An Overview of Public Expenditure Behaviour in TRNC

In the immediate aftermath of the war in 1974, which led to the bizonality of Cyprus, Turkish Cypriot administration in the North faced the challenge of reorganising the necessary physical and social infrastructure. There was an urgent need on the part of government to rehabilitate the refugee population since the post-war risks coupled with the political uncertainties and the lack of capital accumulation in the private sector hindered potential private investments.

Therefore the government became the largest employer. Though there were no statistics kept in the early years of Turkish Cypriot administration, in 1977 public expenditure as a percentage of GDP was 31.4 %. That period was characterised by intensive state involvement in the economy.

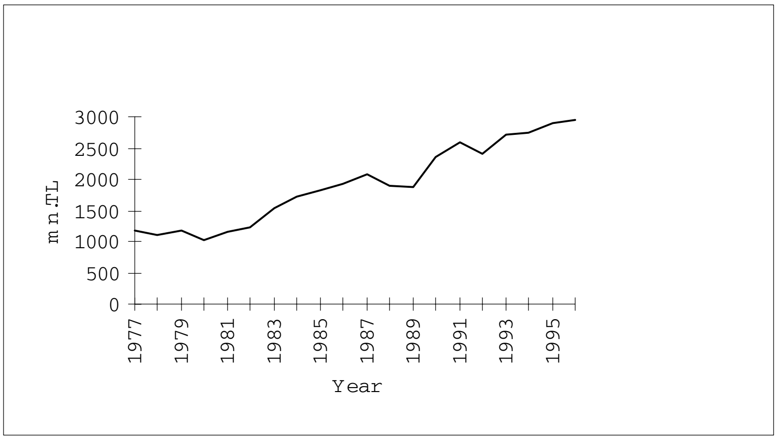

Figure 1. Overall government spending in TRNC.

Figure 1 reveals the time path of overall public expenditure at constant prices. Total government expenditure in 1977 was 1186.1 million TL. Over the period under study, the total public expenditure path in TRNC always lies above 24 percent of GDP. In the period 1978-82, with the exception of the year 1980, the trend is relatively stable in the range between 27 and 29% of GDP. The substantial fall to 1019.5 million TL in 1980 corresponds to 24% and coincides with the military take-over in Turkey in 1980 (which may have resulted in the disruption of aid transfers from Turkey).

The total government expenditure increases to 1536.2 million TL in 1983 and jumps to 1732.2 million TL in 1984, which coincides with the year, 1983, when the declaration of Turkish Republic of Northern Cyprus (TRNC) as an independent state occurred. Over the same period, due to the second oil crisis (1979-1982/83), most OECD countries also experienced a similar rise in their government spending. There is an increasing trend in the TRNC's government expenditure between 1982 and 1987; however, the ratio fell considerably to 31.4% and 28.6% in 1988 and 1989 respectively. This is in conjunction with the Economic Stability Protocol signed between Turkey and the TRNC which aimed to decrease state intervention and provide more incentives for the private sector.

Having the characteristics of a small island, TRNC economy is highly exposed to external shocks. In 1991, the TRNC GDP fell by 4.3% in real terms because of the severe effects of the Gulf War and the collapse of the multinational company, PPI. Further, in 1994, due to the economic crisis in Turkey, GDP fell by 4.1% (EIU, 1996/97). On the other hand, the share of public expenditure in GDP rose sharply to 34.1% and 39.5% in 1990 and 1991 respectively. The share in 1992 fell to the 1990 level, but resumed its increase in the following years. In 1996, the total public expenditure was 2942.3 million TL, equivalent to 39% of GDP.

3. Wagner's Law

One of the frequently quoted stylised facts of public sector economics is that of "Wagner's Law". Stated simply, it proposes that there is a long-run tendency for public expenditure to grow relative to some national income aggregate such as GDP. A number of time series empirical studies have in the past found support for Wagner's Law. These, however, might not be reliable because they did not employ cointegration tests to establish stationarity in the relevant variables [See for example, Peacock and Wiseman (1961), Musgrave (1969), Bird (1971) and Beck (1982)].

A number of explanations lie at the foundations of Wagner's law. First, as a country industrialises, public sector activity, it is asserted, is substituted for private activities. This reflects the need for public protection as society becomes more complex through urbanisation. Commerce and the increasing complexity of contracts require supporting publicly funded legal system. Second, a number of public services are income elastic. For example, education and cultural activities, Wagner argued, fall into this category - as do health services. Third, the importance of natural monopolies, especially infrastructure services, increase as the economy grows.

It follows from the above discussion that public expenditure in Wagner's Law can be treated as an outcome, or an endogenous factor, not a cause of growth in national income. Conversely, there is another approach which is associated with Keynes. Here, public expenditure is seen as an exogenous factor which can be used as a policy instrument. The former requires the causality to run from national income to public expenditure whereas in the latter from expenditure to national income. The Keynesian proposition on public expenditure is supported by developing countries which strongly base their economic growth on the growth in their public sector.

This study aims to examine the causal relationship between public expenditure and GDP for the TRNC economy where the role of government as a major actor to encourage economic development has always been significant. In addition, we utilise recent advances in econometrics to overcome the problems which arise from the non-stationary time series data.

4. Empirical Methodology

Using annual data[1] for the TRNC over the period 1977-1996, we investigate the evidence of Wagner's Law using appropriate estimation methods. The most popular formulation of Wagner's Law is given in the following equations, (1a) and (1b) where we included a dummy variable for the year, 1988:

$$LGE_t = c_0 + c_1 LGDP_t + c_2 DU88 + u_t \qquad (1a)$$

$$LGENT_t = b_0 + b_1 LGDP_t + b_2 DU88 + v_t \qquad (1b)$$

where

GE_t = Real government expenditure expressed in million TL.

GDP_t = Real gross domestic product expressed in million TL.

$GENT_t$ = Non-transfer real government expenditure expressed in million TL[2].

DU88 = Dummy variable for 1988 to capture the effects of the relevant year.

u_t and v_t are serially uncorrelated random disturbance terms, and L denotes the natural logarithm.

Firstly, we examine the stationarity properties of the TRNC data using the Augmented Dickey-Fuller (ADF). Then, we proceed for the order of integration to investigate whether the time series are 'Difference Stationary Process' (DSP), against the alternative 'Trend Stationary Process' (TSP), using Dickey-Fuller LR joint test (or F-test) [See Dickey and Fuller, 1979, 1981].

Secondly, with respect to the series, we observe a potential break in 1988 – the Economic Protocol effect. Any kind of structural break may cause unreliable results obtained in the first step. Therefore, we utilise the additive outlier model (AOM) Perron tests for unit roots to check the validity of the break. In other words, we test whether the order of integration is changed by the potential structural break. Omitting this phenomenon may create 'spurious unit roots'. This test can be regarded as an improvement in time series procedure (See Perron, 1990).

Thirdly, on the basis of the results obtained in the first two stages, if the data are I(1) we test the equations (1a) and (1b) by utilising Engle-Granger (1987), Johansen, (1988) and Johansen and Juselius (1990) methods. Cointegration analysis by

Engle-Granger (1987) provides only one cointegrating vector whereas the Johansen full Information Maximum Likelihood (ML) method provides all the cointegration vectors. In addition to this, we check the robustness of the cointegrating estimates by employing Saikkonen's method which provides asymptotically efficient estimates (See Saikkonen, 1991).

Furthermore, for the short run relationship between government expenditure and gross domestic product, we utilise an Error Correction Mechanism (ECM) by Ordinary Least Squares (OLS), and derive this ECM using the residuals from the estimated cointegrating regression for both equations (1a) and (1b) respectively.[3]

Thus,

$$\Delta LGE_t = \alpha_0 + \alpha_1 u_{t-1} + \sum_{i=0}^{m} a_i \Delta LDP_{t-i} + \sum_{k=0}^{n} b_i \Delta LGE_{t-k} + \sum_{j=0}^{n} g_i \Delta LDU_{t-j} + e_t \qquad (2a)$$

where

u_{t-1} is the lagged estimated residual from equation (1a);

LGE, LGDP, and DU are as defined in equation (1a);

and

$$\Delta LGENT_t = c_0 + c_1 v_{t-1} + \sum_{i=0}^{m} a_i \Delta LDP_{t-i} + \sum_{k=0}^{r} b_i \Delta LGE_{t-k} + \sum_{j=0}^{n} g_i \Delta DU_{t-j} + e_t \qquad (2b)$$

where all variables are as defined in equation (1a) and (1b) and Δ denotes the first differences. The estimated error correction term should be negative and statistically significant in the short-run equations (2a) and (2b). With respect to the Granger Representation Theorem (GRT), negative and statistical significant error correction coefficients are necessary conditions for the relevant variables in question to be cointegrated. This provides further evidence and confirmation for the static long-run and the dynamic short-run components.

Moreover, we use Akaike's Minimum Final Prediction Error (FPE) Criterion with Hsiao's synthesis to choose the optimal lag lengths both in log-levels and log-differences (See Giles et al, 1993)[4]. Akaike's Minimum FPE is formulated as follows:

$$FPE(m) = \frac{T+K}{T-K}\,\frac{SSR(m)}{T} \qquad (3)$$

where T is the sample size, and k=m+1 if Lx and Ly are not cointegrated; k=m+2 if they are cointegrated [Error correction term should then be added to the equation]; SSR(m) is the sum of the squared residuals. When $m=m^*$ in equation (4a), we change n to find out the value $n=n^*$ as to minimise FPE(m^*, n) in which $k= m^* + n+2$ (in the cointegrated case). If FPE$(m^*,n^*) <$ FPE$(m^*) \rightarrow$ Y Granger-Causes X. The values of m and n are related with equation (4a). We then adopt Granger-Causality test to determine the direction of the causality between the relevant variables. From the GRT, we know that causality should exist in at least one direction in the I(1) variables. In the light of GRT, we construct the vector autoregressive (VAR) model in terms of the levels and the first differences of the variables under consideration. We utilise error correction term for both equations to capture short-run dynamics.

We test Granger-Causality between the relevant variables such as X and Y to estimate the following VAR model:

$$DLX_t = \alpha + \sum_{i=1}^{m} b_i DLX_{t-i} + \sum_{j=1}^{n} g_i DLY_{t-j} + u_t \qquad (4a)$$

$$DLY_t = c + \sum_{i=1}^{q} d_i DLY_{t-i} + \sum_{j=1}^{r} e_i DLX_{t-j} + v_t \qquad (4b)$$

where DLX_t = Ln (X_t) - Ln (X_{t-1}) and u_t and v_t are serially uncorrelated random disturbances with zero mean. In all cases, Granger-Causality tests are associated with tests on the significance of the g's and the e's conditional on the optimal lag lengths, m, n, q, and r. We test to see if Y Granger-causes X by using the hypothesis as follows:

$H_o: g_1 = g_2 = g_3 = \ldots g_n = 0$ is rejected against the alternative,

H_1: not H_o.

Similarly, we test if X Granger-causes Y by testing the hypothesis as below:

$H_0^*: e_1 = e_2 = e_3 \ldots e_r = 0$ is rejected against the alternative

H_1^*: not H_0^*.

Finally, having applied Final Prediction Error (FPE), we employ Wald and Sim's LR tests to determine the direction of causality under OLS estimation.

5. Empirical Results

All our empirical tests have been carried out by Microfit 4.0 (Pesaran and Pesaran, 1997). Initially we investigate the stationary properties of the data using the Augmented Dickey-Fuller (ADF) test. The purpose of 'augmenting' the Dickey-Fuller (DF) regression is to achieve white noise errors. When the order of augmentation is zero, the ADF test works in the form of DF test. The ADF test is widely regarded as one of the most efficient test for integration level. In practise, it is regarded as the most favourite test among the practitioners. Therefore, we formulate the ADF regression for the time series X_t as follows;

$$\Delta X_t = g X_{t-1} + \sum_{j=1}^{p} b_j \Delta X_{t-j} + \varepsilon_t \qquad (5)$$

where ε_t represents a sequence of uncorrelated stationary error terms with zero mean and constant variance[5]. Having determined the appropriate value of p, we test $H_0 : g = 0$ versus $H_1 : g < 0$. Rejection of H_0 implies that X_t is I(0) while acceptance implies that it is integrated of order (1). In other words, the series X_t is stationary if $|g| < 1$ (See Charemza and Deadman, 1992; 124-131) and not stationary if $|g| = 1$ (See Perman, 1991).

This sequential testing results are shown in Table 1. The visual inspection of the variables in hand confirms the view that the variables in question-LGE, LGENT, and LGDP-are all non-stationary in levels but stationary in first differences. In other words, the ADF test results for unit roots confirm that all variables are integrated of order one, I(1) in levels but integrated of order zero in first differences (i.e. stationary in first differences). This situation is denoted as LGE~I(1), LGENT~I(1), and LGDP~I(1).

The next step is to examine the type of trend (i.e. stochastic or deterministic) in time series data. We then employ Dickey-Fuller LR joint test (or F-test) to check the relevant series if they are DSP or TSP (See Dickey and Fuller, 1981). We test the null hypothesis of DSP, i.e. $b_i = 0$ and $a_i = 1$, against the alternative of TSP by using the following equation:

$$\Delta X_t = b_o + b_1 t + a_1 X_{t-1} + \sum_{i=1}^{n} a_2 \Delta X_{t-i} + e_t \qquad (6)$$

where e_t is a zero mean, serially uncorrelated and mutually independent disturbance term. b_o, b_1, a_1, and a_2 are all parameters estimated by OLS regression and t is a time trend.

As a result, the null hypothesis of DSP cannot be rejected for all variables in consideration. Thus the variables in question are said to DSP. Table 2 indicates that the test statistics, i.e. 1.85, 3.22, and 3.50 seem to be appropriate to allow us to claim that we have a DSP process. In other words, stationarity is achieved by successive differencing (See Nelson and Plosser, 1982).

As regards to real government expenditure (LGE) and non-transfer real government expenditure (LGENT) for the period 1977-1996, we observe a decline after 1987. This may be capturing a structural break on both LGE and LGENT for the TRNC. We then employ the Additive Outlier Perron Test for unit roots with structural break (See Perron, 1990, Perron and Vogelsang, 1992)[6]. The results presented in Table 3 suggest that there seems to be no 'spurious root' resulting from structural breaks which occurred in 1988. We employ the following equations for structural break. This is the AOM version of the Perron integration level test and it is carried out in two-steps (See Perron, 1990).

$$\Delta X_t = \sum_{i=0}^{k} f_i (DUTB)_{t-i} + g X_{t-1} + \sum_{i=1}^{k} a_i \Delta X_{t-i} + e_t \qquad (7)$$

where

$(DUTB)_t = 1$ if $t = T_b + 1$ and 0 otherwise

T_b is the break year,

DUTB is dummy variable for the break year, and e_t is an error term.

We can conclude that the effects of exogenous break are insignificant and there is no spurious unit root created by exogenous breaks in the examined series. The next step is to test for cointegration between LGE, LGENT and LGDP, which are all I(1). We estimate the EG static long-run regression by OLS to investigate whether the residuals are stationary or not. A sufficient condition for a joint cointegration among the variables in a long-run regression is that the error u_t and v_t should be stationary. The residual based ADF test statistics for u_t and v_t ensure that we reject the null of no cointegration at 5% significance level. Indeed, if LGE~I(1), LGENT~I(1) and LGDP~I(1) are cointegrated, u_t and v_t should be I(0) [See equations (8a) and 8b and Table 5]. The following is the estimation results of the cointegration regression for equations (1a) and equations (1b) by OLS:

$$LGE_t = -8.41 + 1.86\,LGDP_t - 0.27\,DU88 \qquad (8a)$$

(-4.55) (8.48) (-2.57)

$R^2 = 0.93$ $\bar{R}^2 = 0.92$ CRDW =1.94 ADF* = -4.55 CV = -4.19 SER = 0.095

Diagnostic Tests

χ^2_{SERCOR}=0.082 (Prob=0.92) χ^2_{NORM}=0.50 (Prob=0.76) $F_{HET}(1,16)$=0.068 (Prob=0.79)

* No augmentation is necessary to be sufficient to secure lack of autocorrelation of error terms.

$$LGENT_t = -5.26 + 1.44\,LGDP_t - 0.20\,DU88 \qquad (8b)$$

(-2.93) (6.78) (-1.97)

$R^2 = 0.89$ $\bar{R}^2 = 0.88$ CRDW = 1.79 ADF*= -4.35 CV =-4.19 SER = 0.096

Diagnostic Tests

χ^2_{SERCOR} = 0.035 (Prob=0.85) χ^2_{NORM} = 0.49 (Prob=0.78) $F_{HET}(4,91)$=0.513

* No augmentation is necessary to be sufficient to secure lack of autocorrelation of error terms.

Notes: t-statistics are in parentheses and all diagnostics pass at 5% level of significance for both equations above.

Table 5 indicates that there is evidence of a long-run relationship between real GDP and real government expenditure and non-transfer real government expenditure. For the long-run impact, the coefficients of the income variable in both equations are found to be positive and significantly different from one (i.e. the coefficient of LGDP exceed unity such as 1.86 and 1.44 respectively). At this stage, we cannot conclude that our findings are likely to support Wagner's law for TRNC case before employing the Granger-Causality testing procedure. However, Wagner's hypothesis suggests that the causal flow runs from income (GDP) to government expenditure whilst Keynesian proposition indicates an opposite causal flow.

It is important to note that the estimated t-values in parentheses in equations (8a) and (8b) have only a descriptive role to play since the variables are non-stationary. High R^2 suggests that (for both equations 8a and 8b) our long-run OLS estimators are not substantially biased. Since CRDW > R^2, the joint cointegration is ensured (Banarjee et al, 1993).

In the relevant equations, we use dummy variable for 1988 in order to take into account the structural break in the relevant year. The dummy used for 1988 may capture the effects of the subsequent Economic Protocols signed in the late 1980s between the TRNC and Turkey. However the sign of the dummy may be capturing the adverse effects of the circumstances on government expenditure.

To test if there is a single cointegration vector or not, we employ a maximum likelihood (ML) test (Johansen and Juselius, 1990). Table 4 confirms the unique cointegrating vector among the relevant variables. The two equations are estimated without a constant term, with restricted intercepts and no trends. Both provide in favour of cointegration. In this table, trace and maximum eigen value statistics[7] support the null hypothesis of a 'unique cointegration vector'.

On the basis of the results, the long-run relationship between government expenditure and GDP is found by using the ML approach. This confirms earlier findings but without evidence of causality, nothing can be said whether Wagner's or Keynes' hypotheses are valid. Nevertheless, the long-run OLS is still biased if the explanatory variables are assumed not to be weakly exogenous. To remedy this, Engle and Granger (1987) argue that a simple way to check 'weak exogeneity' of explanatory variables is to estimate an Error Correction Model (ECM). Thus we test the statistical significance of the EC terms using a traditional t-test. If the result of such a t-test is significant then the explanatory variable can no longer be treated as 'weakly exogenous'. Our calculation shows that LGDP in equations (1a) and (1b) is weakly exogenous. These results are not reported, but available on request.

To test whether our OLS results are robust or not, we utilise the asymptotically efficient OLS estimator of Saikkonen. This estimator is obtained from the OLS estimator by a time domain correction (Saikkonen, 1991). We also employ Engle and Yoo (1991) three-step correction method to obtain unbiased long-run and statistically valid standard errors for our parameters. Due to non-normality of the distribution, EG estimates the static cointegrating regression which may be substantially biased. All the long-run multivariate estimates are reported in Tables 6 and 7 for both equations (1a) and (1b). These results reveal our original static OLS estimates for the relevant variables, that is measures based on the EG method, are robust.

Due to the static structure of the cointegrating regression and the small sample size, the estimates of the static cointegrating regression parameters are said to be 'super consistent' (See Stock, 1987). To remedy this problem, some econometricians consider the lagged and difference terms. Thus, we employ ECM to test for short run adjustment towards long-run equilibrium, and to explore the relationship between government expenditure and GDP (if any) in the short-run. The results of the parsimonious dynamic model, using the error terms from the OLS regression are, as follows:

$$\Delta LGE_t = 0.036 - 0.78u_{t-1} + 1.06\Delta LGDP_t - 0.21\Delta DU88 \quad (9a)$$

(1.35) (-3.26) (2.69) (-2.20)

$R^2 = 0.53$ $\bar{R}^2 = 0.44$ SER = 0.032

Diagnostic Tests

χ^2_{SERCOR}=3.84 (Prob=0.05) χ^2_{NORM}=2.40 (Prob=0.3) F_{HET}(1,17)=0.46 (Prob=0.50)

$$\Delta LGENT_t = 0.035 - 0.87u_{t-1} + 0.88\,\Delta LGDP_t - 0.20\Delta DU88 \quad (9b)$$

(1.45) (-4.26) (2.61) (-2.62)

$R^2 = 0.51$ $\bar{R}^2 = 0.46$ SER= 0.031

Diagnostic Tests

χ^2_{SERCOR}=3.74 (Prob=0.05) χ^2_{NORM}=0.86 (Prob=0.35) F_{HET}(1,17)=0.057 (0.45)

Notes: t-statistics are in parentheses and all diagnostics pass at 5% level of significance.

For both equations, the Error Correction term is negative and significant at the one percent level and the magnitudes of the corresponding coefficients show that almost 90% and 80% of any disequilibrium in the long-run relationship between variables are corrected after one year. In other words, output adjust its equilibrium level quickly and the error correction terms provide further evidence that the variables in the equilibrium regression are cointegrated. All contemporaneous values are also significant, which supports the previous findings[8].

Having established that real government expenditure and real GDP are cointegrated with the inclusion of the relevant dummy, we use the concept of the GRT. This theorem tells us that causality must exist at least in one direction, in the I(1) variables. The causality issue is a very crucial point in the context of bivariate analysis, i.e. Wagner's Law. It is important to mention that if there is evidence of Granger causality from government expenditure to GDP and not vice versa, the Law would be under suspicion. To investigate this, we first use the Final Prediction Error Criteria to determine the optimal lag-length for the relevant variables in the VAR models.

Table 8 shows the optimal lag lengths for the relevant variables and also FPE(m^*) and FPE (m^*,n^*) values are reported where these values suggest that there is unidirectional causality from real government expenditure and nontransfer real government expenditure to the real GDP. It is worth noting that there is a reverse causality according to Wagner's Law at log-differences. This finding supports the Keynesian proposition rather than Wagner's proposition.

To obtain the results which are reported in Table 9, we follow the formal Granger-Causality testing procedure. We then employ Wald and Sims' test statistics to obtain the usual asymptotic χ^2 distribution. The Wald test refers to a test of zero restriction on the independent variables in equations of 4a and 4b. We then use a simple logarithmic transformation which converts Wald statistics into LR test statistics in order to obtain results for Sims' LR test. This transformation is also asymptotically χ^2 (See Giles et al 1993:202, Sims, 1980:17).

As can be seen, the evidence of causality is from real government expenditure (LGE) and nontransfer real government expenditure (LGENT) to real GDP. This also shows that Keynesian proposition plays a crucial role for the TRNC economy. We also take the earlier evidence of cointegration between LGE, LGENT and LGDP into account at log-levels data. Table 10 shows the results that if a pair of variables are cointegrated, causality should exist at least in one direction. However, the evidence in Table 11 is mixed. The FPE results show that there is bi-directional causality between LGE and LGDP at log-level and there is no support for this on the basis of the Wald test and LR tests. However, there is unidirectional causality from LGDP to LGENT at log-difference on the basis of the FPE and this situation is supported by Wald and Sims' LR tests. Table 11 provides a summary for this study where the notation $\rightarrow$ denotes unidirectional causality; and $\leftrightarrow$ indicates bi-directional causality.

6. Conclusion

The long-run relationship between real government expenditure and real gross domestic product was tested using aggregate time series TRNC data for the period 1977-1996. Given the small sample size, our results are indicative rather than definitive. Initially, the data series were found to be non-stationary in levels, but stationary in differences. Secondly, the models were found to be cointegrated. Cointegration is essential for the valid test of Wagner's Law. At this point, we included a dummy variable to capture the effects of the Economic Protocol which had occurred in 1988. Thirdly, we employed the Johansen Maximum Likelihood estimation to confirm the uniqueness of the cointegration vector among the variables under study. Finally, we used the FPE Criteria and formal Granger Causality testing procedure to determine the direction of causality. We may draw some conclusions from these tests that there is uni-directional causality (or reverse causality according to Wagner's Law) from LGE and LGENT to LGDP at log difference which supports the Keynesian proposition. On the other hand, at the log levels, there is a unidirectional causality from LGDP to LGENT which supports the proposition of Wagner's Law for TRNC over the period 1977-1996.

End Notes

1. The data are provided by the State Panning Organisation, Nicosia, TRNC, 1996.
2. GENT is computed by deducting total transfer expenditures from the total government expenditure. Bird (1971), Musgrave & Musgrave (1988) favour the inclusion of transfers into government expenditure. However, Brown & Jackson (1990) argue that excluding transfer payments is useful when examining the growth of public expenditure.
3. Note that we use Hendry's general-to-specific modelling strategy (See Miller, 1991).
4. We follow Giles et al (1993) faithfully to determine the lag lengths on the basis of Akaike's Minimum Final Prediction Error.
5. The 'ADF' command in Microfit includes the intercept term in the ADF equation. Therefore the corresponding critical values should take the intercept term into account. (Pesaran and Pesaran, 1997)
6. Perron (1990) suggests two types of models for testing unit roots with structural break, the Additive Outlier Model (AOM) and the Innovational Outlier Model (IOM) respectively. The AOM is recommended for 'sudden' structural changes whilst the IOM is applied for 'gradual' structural changes. In an economy, it is believed that 'sudden' is more appropriate than 'gradual'. Therefore we prefer to use the AOM in the case of TRNC.
7. Reimers (1992) finds that the Johansen procedure over-rejects when the null-hypothesis is true in the case of small samples. Thus he suggests that (T-P) version is the corrected statistics for the small samples and this can be corrected by using $(T-P) \log (1-\lambda_i)$ rather than $T \log (1-\lambda_i)$. In this test, p=nk takes account of the number of estimated parameters and T is the number of usable observations.
8. In this study, we first estimate short-run ECM with one lags of each variable and eliminate those lags with insignificant parameter estimates. Secondly, we re-estimate simpler models to find out the most suitable model. In addition to this, we apply the instrumental variable (IV) method to ensure our OLS short-run estimates are not jeopardised by the presence of some contemporaneous effects.

References

Banerjee, A., Dolado, J., Galbraith, J.W. and Hendry, D.F. (1993) Cointegration, Error-Correction and the Econometric Analysis of Non-Stationary Data, Oxford University Press, Oxford.

Beck, M. (1982) 'Towards a theory of public sector growth', Public Finance, 37, 163-77.

Bird, R.M. (1971) 'Wagner's law: a pooled time-series, cross section comparisons, National Tax Journal, 38, 209-218.

Brown, C.V. and Jackson, P.M. (1990) Public Sector Economics, 4th edition, Basil Blackwell, Oxford.

Charemza, W.W. and Deadman, D.F. (1992) New directions in econometric practice. Edward Elgar, England.

Charemza, W.W. and Deadman, D.F. (1997), New directions in econometric practice. Edward Elgar, England.

Country profile, Cyprus, Economist Intelligence Unit (EIU), various years.

Dickey, D.A. and Fuller, W.A. (1979) 'Distribution of the estimators for autoregressive time-series with a unit-root', Journal of the American Statistical Association, 79, 355-367.

Dickey, D.A. and Fuller, W.A. (1981) 'Likelihood Ratio Statistics for Autoregressive time series with a unit root', Econometrica, 49, 1057-72.

Economic and Social Indicators, State Planning Organisation (SPO), Nicosia, TRNC, various years.

Engle, R.F. and Granger, C.W.J. (1987) 'Cointegration and error correction: representation estimation and testing', Econometrica, 55, 251-76.

Giles, D.A., Giles, J.A. and McCann, E. (1993) 'Causality, unit roots, and export-led growth: the New Zealand', Journal of International Trade and Economic Development, 1, 195-218.

Johansen, S. and Juselius, K. (1990) 'Maximum likelihood estimation and inference on cointegration with application to the demand for money', Oxford Bulletin of Economics and Statistics, 52, 169-21.

Mackinnon, J.G. (1991) 'Critical values for integration and cointegration tests', in Long-run Economic Relationships: Readings in Cointegration. R.F. Engle and C.W.J. Granger (eds.). Oxford University Press, New York, 267-276.

McKee, D.L and Tisdell, C. (1990) Developmental Issues in Small Island Economies, Praeger Publishers, New York.

Miller, S.M. (1991) 'Monetary dynamics: An application of cointegration and EC Modelling', Journal of Money, Credit and Banking, 23, 139-154.

Musgrave, R.A. (1969) Fiscal Systems, Yale University Press, New Haven.

Nelson, C.R. & Plosser, C.I. (1982) 'Trends and random walks in macroeconomic time series: Some evidence and implication', Journal of Monetary Economics, 10, 139-162.

Osterwald-Lenum, M. (1992) 'A note with quantiles of the asymptotic distribution of the ML cointegration rank tests statistics', Oxford Bulletin of Economic and Statistics, 54, 461-472.

Peacock, A.T. and Wiseman, J. (1961) The Growth of Public Expenditure in the United Kingdom, Princeton University Press, Princeton.

Perman, R. (1991) 'Cointegration: An Introduction to the Literature', Journal of Economic Studies, 18, 3, 3-30.

Perron, P. (1990) 'Testing for a unit root in a time-series with a changing mean', Journal of Business and Economic Statistics, 8, 153-162.

Perron, P. and Vogelsang, T.J. (1992) 'Testing for a unit root in a time series with a changing mean: corrections and extensions', Journal of Business and Economic Statistics, 10, 467-70.

Peseran, H. and Peseran, B. (1997) Microfit 4.0: An Interactive Econometric Software Package (User Manual), Oxford University Press, Oxford.

Reimers, H.E. (1992) 'Comparisons of tests for mutivariate cointegration', Statistical Papers, 33, 335-359.

Rybinski, K. (1994) 'Extended Tabulations for Perron Additive Outlier test', University of Gdansk, mimeo.

Saikkonen, P. (1991) 'Asymptotically efficient estimation of cointegration regressions', Econometric Theory, 7, 1-21.

Sims, C.A. (1980) 'Macroeconomics and reality', Econometrica, 48, 1-48.

Stock, J.H. (1987) 'Asymptotic properties of least squares estimators of cointegrating vectors', Econometrica, 56, 1035-56.

Appendix

Table 1. ADF (Augmented Dickey-Fuller) Test for Unit Roots

Variable	Test statistics		Critical Values			
	Level	1st difference	Charemza and Deadman		Mackinnon	
			5%	10%	5%	10%
$LGDP_t$	-1.89	-4.75	-2.18	-1.76	-3.03	-2.66
LGE_t	-2.84	-4.81	"	"	"	"
$LGENT_t$	-3.34	-5.34	"	"	"	"

The corresponding critical values for 20 number of observations at 5% and 10% significance levels are obtained from Charemza and Deadman (1997) and Mackinnon (1991). The lower values are reported only in Charemza and Deadman (1997). It is worth noting that the intercept terms are in the ADF equations. In all cases, no augmentation is necessary to be sufficient to secure lack of auto-correlation of error-terms.

Table 2. DF Likelihood Ratio (LR) Joint Test For DSP vs TSP

Variable	Test Statistics	Critical Values (n=20)		
		5%	10%	1%
$LGDP_t$	1.85	6.99	5.76	9.96
LGE_t	3.22	"	"	"
$LGENT_t$	3.50	"	"	"

The corresponding critical values obtained from Dickey and Fuller (1981, p.1063, Table VI) level for 20 number of observations. In all cases, an augmentation of one appeared to be sufficient to secure lack of autocorrelation of the error terms. It is worth noting that the critical values for 20 number of observations do not exist in the relevant table which is tabulated by Dickey and Fuller (1981). This table indicates that critical values tend to increase as sample size (n) decreases. Hence the reported values can be accepted for 20 number of observations

Table 3. Perron Unit Root Test for Structural Break

Variable	Break Year	Test Statistics		Critical value	
		Level	1st difference	(5%) λ=0.6	(5%) λ=0.7
$LGDP_t$	1991	-1.91	-4.57	-3.78	-3.67
LGE_t	1988	-1.17	-4.19	"	"
$LGENT_t$	1988	-1.17	-4.70	"	"

We use the critical values reported by Rybinski instead of the original critical values reported by Perron. The corresponding break fraction for 20 number of observation are calculated easily with $\lambda = (T_b/T)$ [See Perron and Vogelsang, 1992]. For 1988 and 1991, the relevant break fractions are λ=12/20=0.6 and λ=15/20=0.7. In most cases, an augmentation of one or two appear to be sufficient to secure lack of autocorrelation of the error terms.

Table 4. Johansen Maximum Likelihood (ML) Procedure

Cointegration Likelihood Ratio (LR) Test to determine the number of cointegration vectors (r) based on Maximal Eigen value of the stochastic matrix, Trace of the stochastic matrix and the (T-P) version is for the small sample suggested by Reimers (1992).

Cointegration Regression	Null Hypothesis	Alternative Hypothesis	λ_{max}	λ_{max} (T-P)	Critical value at 5%	λ_{trace}	λ_{trace} (T-P)	Critical value at 5%
LGE_t= f($LGDP_t$, DU88)	r=0	r=1	20.07	17.06	15.67	29.19	24.81	19.96
	r<=1	r=2	9.11	7.74	9.24	9.12	7.75	9.24
$LGENT_t$= f($LGDP_t$, DU88)	r=0	r=1	20.38	17.32	15.67	26.06	22.15	19.96
	r<=1	r=2	5.67	4.82	9.24	5.68	4.83	9.24

r indicates the number of cointegrating relationships.
λ_{max} is the maximum eigen value statistic, λ_{trace} is the trace statistic. The (T-P) version is the corrected statistic for small samples suggested by Reimers (1992). VAR 1 based on AIC is used in the Johansen procedure and the restricted constant and no trend are not rejected in all cases. DU88 is considered as exogenous I(1) variable. The critical values are obtained from Osterwald-Lenum (1992).

Table 5. The Residual-based ADF test for cointegration

Cointegration Regression	R^2	$\bar{R}^2$	CRDW	Calculated ADF Residuals	Critical value			
					Charemza and Deadman		Mackinnon	
					5%	10%	5%	10%
LGE_t = f($LGDP_t$, DU88)	0.93	0.92	1.94	-4.55	-4.34	-3.91	-4.19	-3.77
$LGENT_t$ = f($LGDP_t$, DU88)	0.89	0.88	1.79	-4.35	-4.34	-3.91	-4.19	-3.77

The reported critical values are obtained from Charemza and Deadman (1997) and Mackinnon (1991). The lower values are reported only in Charemza and Deadman (1997). They correspond to 20 number of observations. It is worth noting that the intercept terms are included in the residual based ADF equations. No augmentation is necessary to be sufficient to secure lack of autocorrelation of the error terms.

Table 6. Elasticity estimates of multivariate long-run relationship
A comparison of different approaches

Elasticity Estimates

Variable	Static OLS (Engle-Granger)	(Engle-Yoo) Three-Step Corrected Values	OLS with time domain correction (Saikkonen)
C	-8.41 (-4.55)++	-9.79 (-2.82)*	-10.33 (-6.54)++
$LGDP_t$	1.86 (8.48)++	1.69 (4.04)++	2.08 (11.10)++
DU88	-0.28 (-2.57)**	-0.22 (-1.82)***	-0.33 (-3.77)++

Different approaches (techniques) have been run on the equation below:

$LGE_t = f(LGDP_t, DU88)$
(t-values are shown in parentheses)
one * indicates significance at the 1% level, two ** indicate significance at the 5% level, and three *** indicate significance at 10% level.

Table 7. Elasticity estimates of multivariate long-run relationship
A comparison of different approaches

Elasticity Estimates

Variable	Static OLS (Engle-Granger)	(Engle-Yoo) Three-Step Corrected Values	OLS with time domain correction (Saikkonen)
C	-5.26 (-2.93)*	-6.48 (-2.10)**	-7.12 (-3.47)++
$LGDP_t$	1.45 (6.78)++	1.59 (4.09)++	1.66 (7.08)++
DU88	-0.20 (-1.93)**	-0.31 (-1.72)***	-0.25 (-2.35)**

Different approaches (techniques) have been run on the equation below:

$LGENT_t = f(LGDP_t, DU88)$
(t-values are shown in parentheses)
One * indicates significance at the 1% level, two ** indicate significance at the 5% level, three *** indicate significance at 10% level; and ++ indicate very significance.

Table 8. Selection of lag lengths using Final Prediction Error (FPE)

Dependent variable	Independent variable	m^*	n^*	FPE (m^*)	FPE (m^*, n^*)
DLGE	DLGDP	1	1	$7.34*10^{-3}$	$7.86*10^{-3}$
DLGDP	DLGE	1	2	$1.78*10^{-3}$	$1.39*10^{-3}$
DLGENT	DLGDP	3	2	$2.15*10^{-3}$	$2.31*10^{-3}$
DLGDP	DLGENT	1	2	$2.09*10^{-3}$	$1.7*10^{-3}$

Notes: If FPE (m^*,n^*) < FPE (m^*), Y Granger-Causes X
m^* denotes maximum lag on dependent variable
n^* denotes minimum lag on independent variable

Table 9. Granger-Causality between Government expenditure (GE) and Gross domestic product (GDP) on ordinary least squares estimation

Dependent variable	Independent variable[a]	Degrees of freedom [b]	Wald test	Sims' LR test
DLGE	DLGDP	1	0.46	0.62
DLGDP	DLGE	2	6.06**	7.46**
DLGENT	DLGDP	2	1.25	2.33
DLGDP	DLGENT	2	5.96**	6.75**

Notes: ** indicates significance at the 5% level
a; dummy variable is included as explanatory variable
b; χ^2 degrees of freedom for both Wald and LR tests.

Table 10. Results based on log-levels data

Dependent variable Independent variable	LGE LGDP	LGDP LGE	LGENT LGDP	LGDP LGENT
m^*	1	2	1	1
n^*	1	3	2	2
FPE(m^*)	$8.97*10^{-3}$	$1.66*10^{-3}$	$7.53*10^{-3}$	$1.55*10^{-3}$
FPE(m^*,n^*)	$8.28*10^{-3}$	$1.34*10^{-3}$	$6.10*10^{-3}$	$2.02*10^{-3}$
Wald test	2.83	2.73	5.98	3.44
Sims' LR test	3.50	3.99	6.88	4.53
degrees of freedom (d.f.)	1	3	2	2

Notes: If FPE (m^*,n^*) < FPE (m^*), Y Granger-Causes X
m^* denotes maximum lag on dependent variable
n^* denotes minimum lag on independent variable
d.f.; χ^2 degrees of freedom for both Wald and Sims' LR tests.
** indicates significance at the 5% level.

Table 11. Summary of Causality Results

log-differences		log-levels	
FPE	χ^2 tests	FPE	χ^2 tests
GE→GDP	GE→GDP	GE↔GDP	GE - GDP (No Causality)
GENT→ GDP	GENT→ GDP	GENT←GDP	GENT←GDP

Notes: GE, real government expenditure; GENT, non-transfer real government expenditure; GDP, real GDP