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Cointegration, Causality and Kaldor's Hypothesis: Evidence from Turkey, 1946-1995

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This paper, unlike the previous studies dealing with Kaldor's engine-of-economic growth hypothesis, applies the techniques of cointegration and Granger causality to investigate the causal relationship between industrial growth and overall economic performance in the Turkish economy. The empirical evidence presented in the paper finds support for the Kaldor's hypothesis.

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1. Introduction

The hypothesis that industrial sector is the engine of the economic growth, called Kaldor's engine-of-growth (KEG) hypothesis is recently attracting considerable interest (see, for example, Bairam, 1991; Drakopoulos and Theodossiou, 1991; and Atesoglu, 1993). These studies found a significant statistical association between growth rate of industrial production and economic growth. Such a finding has been used to support the KEG hypothesis. The testing methodology employed in all three studies, however, has concentrated upon simple regression analyses. Namely, these studies investigated the validity of the hypothesis by regressing real output growth on the growth rate of industrial output. If the coefficient of the growth rate of industrial output is found to be statistically significant and positive, it is then concluded that the growth rate of industrial output totally or partially determines the overall economic growth. Clearly, this kind of methodology is not appropriate and sufficient to test the KEG hypothesis for two reasons. First, simple regression equations used in the previous studies can only show the presence (or lack) of the statistical correlation between growth of industrial output and economic growth, but have no bearing on the causal relationship between the two variables. Second, the validity of the KEG hypothesis requires not only the existence of the significant

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correlation between industrial and economic growth but also the causality running from the growth in the industrial sector to the overall economic performance.

The purpose of this study is to re-examine the KEG hypothesis using the Granger causality technique. The test is applied on the Turkish data for the period 1946-1995.

2. Data, methodology and empirical results

The data used in this study are annual and, cover the period of 1946-1995. All data come from Statistical Indicators 1923-1995 published by State Institute of Statistics Prime Ministry, Republic of Turkey.

The methodology employed in this study is that of the Granger causality. Granger causality test is carried out by depending on the results of the cointegration test. As shown by Engle and Granger (1987), two variables, the logarithm of the level of the industrial production (log IND) and the logarithm of the level of the real GNP (log GNP) are cointegrated if each is non-stationary but there exists a linear combination of two that is stationary.

As an initial step in the cointegration test, stationarity tests must be performed for each of the relevant variables. There have been a variety of proposed methods for implementing stationarity tests and each has been widely used in the applied economics literature. However, there is now a growing consensus that the stationarity test procedure due to Dickey and Fuller (1979) has superior small sample properties compared to its alternatives. Therefore, in this study, the augmented Dickey-Fuller (ADF) test procedure was employed for implementing stationarity tests. Table 1 reports the ADF tests of the null hypothesis that a single unit root exists in the logarithm as well as first (logged) difference of each series. The number of lags used in the ADF regressions were selected using the Akaike information criterion (AIC). Based on the ADF-t statistics, the null hypothesis of a unit root in log levels can not be rejected, while the null hypothesis of a second unit root is rejected. Thus, the evidence suggests that the levels of log GNP and log IND are characterised as I(1) process.

Table 1. ADF test statistics

Variables	Without trend	With trend
log GNP	-1.7435 [0] (-2.912)	-2.2235 [0] (-3.502)
log IND	-2.0081 [5] (-2.928)	-1.9791 [0] (-3.502)
Δ log GNP	-8.0795 [0] (-2.912)	-8.5775 [0] (-3.502)
Δ log IND	-4.6178 [4] (-2.928)	-5.0799 [4] (-3.513)

Note: Figures in parentheses refer to 95% critical values taken from MacKinnon (1991). Number inside the bracket is the number of lags used in the ADF regression.

Since both variables, log IND and log GNP, are not individually stationary in their levels but in their first differences, performing cointegration tests for both variables is theoretically possible. The long-run relationship between log IND and log GNP can be detected by the cointegration method developed by Johansen (1988) and Johansen and Juselius (1990). The Johansen method applies the maximum likelihood procedure to determine the presence of cointegrating vector(s) in non-stationary time series. The number of lags applied in the cointegration tests were based on the information provided by the AIC. Table 2 reports the results of the cointegration tests between log IND and log GNP. The AIC indicated that one lag was appropriate for the VAR system. Two test statistics were used to test for the number of cointegrating vectors: the maximum eigenvalue and trace test statistics. Results based on both statistics indicate the presence of a stationary long-run relationship at 10% level between log GNP and log IND.

Table 2. The cointegration test

Variables included in the cointegration vector: Log GNP - Log IND			
Null	**Alternative**	**l - Max statistics**	**Trace statistics**
r = 0	r = 1	14.7912 (12.9120)	16.9739 (15.6630)
r ≤ 1	r = 2	2.1827 (6.5030)	2.1827 (6.5030)

Note: Figures in parentheses refer to 90% critical values taken from Johansen and Juselius (1990)

Granger (1986) and Engle and Granger (1987) argue that as long as variables are cointegrated, causality has to exist at least in one direction. Following the methodology of Engle and Granger (1987) the direction of causality between D log IND and D log GNP can be detected by estimating the following error-correction models.

$$\Delta \log GNP_t = \alpha_o + \sum_{s=1}^{k} \alpha_{1s}\Delta \log GNP_{t-s} + \sum_{s=1}^{l} \alpha_{2s}\Delta \log IND_{t-s} + \psi_1 RES1_{t-1} + \varepsilon_{1t} \quad (1)$$

$$\Delta \log IND_t = \beta_o + \sum_{s=1}^{m} \beta_{1s}\Delta \log IND_{t-s} + \sum_{s=1}^{n} \beta_{2s}\Delta \log GNP_{t-s} + \psi_2 RES2_{t-1} + \varepsilon_{2t} \quad (2)$$

where RES1 is the residual from the cointegrating GNP regression and RES2 the residual from the cointegrating IND regression. In equation (1), if either the α_{2s} 's are jointly significant or if ψ_1 is significant, then the null hypothesis that D log GNP does not Granger-cause D log IND is not rejected. A similar interpretation should also be attached to equation (2).

Table 3 presents the results of error-correction estimations. The lag structure in the error-correction models was determined by means of Akaike's final prediction error (FPE) criterion. Based on the coefficient of the error-correction term in equation (1), the null hypothesis of no-causality from industrial output to overall output is rejected at the 10% level. The null hypothesis of no-causality from the overall economic growth to the growth in the industrial sector is also rejected through error-correction term at 5% level. Thus, there appears to be a two-way causality between real GNP and industrial output. The fact that the growth rate of the industrial output causes the overall economic growth supports the KEG hypothesis for Turkey during the period under consideration.

Table 3. Granger causality test

Independent Variables	Dependent Variable Δ log GNP_t	Δ log IND_t
Constant	1.635[c]	-2.351[b]
	(1.95)	(2.56)
$RES1_{t-1}$	-0.275[c]	
	(1.88)	
$RES2_{t-1}$		-0.316[b]
		(2.62)
Δ log GNP_{t-1}	0.111	-0.208
	(0.54)	(0.34)
Δ log IND_{t-1}	-0.064	0.149
	(0.61)	(0.92)
Δ log IND_{t-2}	-0.044	
	(0.67)	
Δ log IND_{t-3}	-0.014	
	(0.88)	
Δ log IND_{t-4}	-0.290[a]	
	(2.74)	
$F_{\Delta \log GNP}$		0.910
		[0.34]
$F_{\Delta \log IND}$	1.959	
	[0.12]	
c^2_S	0.727	0.100
	[0.39]	[0.75]
c^2_F	0.163	0.096
	[0.68]	[0.75]
c^2_H	1.476	1.348
	[0.22]	[0.24]

Note: F statistics refer to a test of zero restrictions on the independent variables. χ^2S, χ^2F and χ^2H refer to the lagrange multiplier tests for serial correlation, functional form and heteroscedasticity, respectively. Numbers in parentheses represent the absolute values of t- statistics. Numbers inside brackets are p-values. [a]Significant at the 1% level; [b]Significant at the 5% level; [c]Significant at the 10% level.

3. Conclusion

In this paper, unlike the study of Bairam (1991) dealing with the application of the KEG hypothesis to Turkey, the cointegration and Granger causality techniques were used to identify the long-run and causal relationships between industrial output and real GNP in Turkey for the period of 1946-1995. The empirical results indicate that industrial sector and overall economy are cointegrated. The evidence on the Granger causality test shows that there exists a two-way causal relationship between industrial sector and overall economy, supporting the KEG hypothesis and findings of Bairam (1991) for Turkey.

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