Study of the relationship between construction sector and the Sri Lankan economy

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Abstract

The construction sector is an invaluable part of any economy which stimulates growth in other sectors and thereby growth in the overall economy through its relationships. Many researchers found that the construction sector has always been closely related to the national economy. This paper investigates the causal relationship between construction investment and economic growth using data from Sri Lanka over the period of 1980-2004. The relationship between economic growth and construction investment was tested using Granger causality tests. The results of regression analysis show that the Granger causality between economic growth and construction sector is in one direction; construction causes the economy to grow, and not vice versa. This supports the view of Hillebrandt (1985), Ofori (1990), and Chan (2001). They argued that construction flow causes economic output and not vice-versa. However, it contradicts with Tse and Ganesan's (1997) finding that GDP causes the construction growth using Hong Kong data. Further, the results show that construction leads GDP by only one year.

1. Introduction

The relationship between construction and the national economy has been studied by many researchers in the past. They found that the construction industry has always been closely related to the national economy. Turin (1969) saw a strong positive relationship between construction output and economic growth particularly in developing countries. Then the subsequent studies of Strassmann (1970), Drewer (1980), Edmonds and Miles (1984) and Wells (1985) also established a strong relationship between construction activity and economic development using various measures of construction output.

Some researchers have even found that there is a causal effect between construction and the national economy. Construction is defined as the creation of physical facilities that are needed in the development of other productive activities (Wells, 1984). It implies that construction causes economy to grow. This view has been taken by majority of researchers in the past. Among them Ofori (1990) argued that construction flow causes Gross Domestic Product (GDP) as the construction sector buys the other sector's output. Chan (2001) attempted to determine whether a change in construction output precedes the outputs of other sectors in the Singapore economy and GDP. He showed that the construction output leads the economic output and not vice-versa. Chan (2002) analyzed the impact of a change in construction output on the economy not only in terms of GDP but also in terms of other sectoral outputs, balance of payments and domestic prices etc., and concluded that construction leads other sectoral output and GDP.

Contrary to the popular view, Tse and Ganesan (1997) found that GDP causes the construction flow and not vice versa using quarterly construction data of Hong Kong. Briscoe (1988) has also subscribed to this view as he found that the construction sector greatly depends on changes in the economy since construction output is a response to the demand for other products and services. The sensitiveness of construction industry to the national economy is evidenced in china through its rapid economic expansion that has resulted many construction activities to follow (Sjoholt, 1997). An interesting work by Green (1997) established the relationship between construction investment and Gross Domestic Product (GDP). He divided the construction investment into two as residential and non-residential. He found that the residential investment causes GDP to grow. However, in the case of non-residential investment the opposite was found to be true.

The preceding paragraph highlighted the contradicting views on the lead/lag relationship between construction and economic growth. This study is aimed at testing this relationship using empirical data from Sri Lanka. Construction is the fourth largest sector in the national economy, which has contributed around 6-7% to GDP over the past decade. The total value of new construction work is between 40-60% of the total Gross Domestic Capital Formation (Central Bank of Sri Lanka, 2004). Construction in Sri Lanka provides employment on average to about 5-6 % of those employed in the national economy (Department of Census and Statistics, 2003).

Past research on this topic has used data from either industrialized or newly industrializing countries. A gap could be found in the literature in terms of developing countries concerned. The aim of this study was to fill that gap and to test the hypothesis using Sri Lankan data. This paper is organized as follows. First, the methodology and the data are discussed with emphasis on their usage in previous studies. Next, the tools used in the study are discussed in detail. Finally, the results of the analysis are presented with a discussion.

2. Methodology and Data

The Granger Causality Test, an econometric technique pioneered by Granger and Newbold (1986) has been widely used to analyze the relationships between economic variables. Demirbas (1999) applied Granger causality in testing the causal relationship between public expenditure and GNP. In the field of construction, Granger and Newbold (1986), Hendry (1986) and Engle and Granger (1987) had used this test to determine the causal relationship between construction output and other sectoral outputs, between construction output and balance of payments, and between construction output and general prices. Further, Odedokun (1996) applied the concept to find the relationship between financial sector and economic growth, and stock market and economic growth. Thus, this study uses the "Granger causality test" to determine the causal relationship between construction flow and national economy.

The previous research carried out on this topic shows that there are many measures to represent the economic performance of a country. The studies of Strassmann (1970), Drewer (1980), Edmonds and Miles (1984) and Wells (1985) used GDP per capita in finding the relationship between construction and economic development. The works of Briscoe (1988), Ofori (1990), Tse and Ganesan (1997), Green (1997) and Chan (2001, 2002) used GDP and National Income (NI) in finding the causal relationship. Though previous researchers used different indicators, the selection of indicators depends on certain factors like availability and reliability of data, and the relative importance of the data in the country concerned. After a thorough review, this research decided to use GDP as the macro level indicator, represents the value of all final goods and services produced in the economy in a given time period to signify the economic performance due its availability and reliability.

To represent construction flow Construction Value Added in GDP, Construction Real Output, and Gross Domestic Fixed Capital Formation (CGDFCF) in construction are the three candidate indicators. Out of the three, construction Real output has to be eliminated due to non-availability of data in Sri Lanka. Out of the remaining two, Capital Formation is considered as an important growth-inducing factor in many countries (Ofori, 1990). Further, capital formation in construction can be considered as one of the determinant of economic development. Therefore, this research uses CGDFCF to represent the construction performance.

The GDP and CGDFCF compiled using current market prices for the period of 1980-2004 is used in the study. The data was obtained from the Central Bank Annual Reports (Central Bank of Sri Lanka, various issuses).

3. Granger Causality Test

In econometrics the Granger causality is defined, as X is a Granger cause of Y (denoted as $X \rightarrow Y$), if present Y can be predicted with better accuracy by using past values of X rather than by not doing so, other information being identical (Charemza and Deadman, 1992). Sims (1972) also defines the causality of a regression model as X Granger causes Y when previous observations on a variable X provides significant information about another variable, Y, when lagged observations of Y is present. It is represented by the following mathematical equation.

$$Y_t = \alpha_1 + \sum_{i=1}^{m} \gamma_i Y_{t-i} + \sum_{i=1}^{m} \beta i_1 X_{t-i} + \in_t \quad (1)$$

In Granger causality null hypothesis is tested by running the following regressions.

Unrestricted regression:

$$\Delta Y_t = \alpha_1 + \sum_{i=1}^{m} \gamma_i Y_{t-i} + \sum_{i=1}^{m} \beta i_1 \Delta X_{t-i} + \in_t \quad (2)$$

Restricted regression: $$\Delta Y_t = \alpha_2 + \sum_{i=1}^{m} \delta i Y_{t-i} + \partial_t \quad (3)$$

Where m is number of lag, $\in_t$ and ∂_t are two uncorrelated white - noise series, $\in_t \sim N(0, \sigma^2)$. According to equation (2), the null hypothesis that X does not Granger cause Y is rejected if the coefficients of βi_1 s are jointly significant (i.e. $\beta i_1 \neq 0$), based on the standard F-test. By running the same regressions as above, but switching X and Y in equation (2), the null hypothesis Y does not Granger cause X is tested. In the second equation, the null hypothesis that Y does not Granger cause X is rejected if the βi_2 s are jointly significant (i.e. $\beta i_2 \neq 0$), based on the standard F-test and if both some $\beta i_1 \neq 0$, and some $\beta i_2 \neq 0$ then there is feed back between Y and X. It is noted that the number of lags in the regressions are arbitrary. Therefore, it is better to run the tests for few different values of m.

However in running the regression it is important to check whether a series is stationary or not before using it in a regression. The recent developments in time series analysis showed that most macroeconomic time series have a unit root (a stochastic trend). That is time series is non-stationary.The formal method to test the stationarity of a series is the unit root test. According to Nelson and Plosser (1982) first difference of a time series is stationary. Granger and Newbold (1986) also argued that stationarity can be achieved by first differencing.

Several unit root tests are available to test whether the series (or it's first or second difference) is stationary. This study uses the most commonly used tests of Dickey Fuller (DF) (Dickey and Fuller, 1974), Augmented Dickey Fuller (ADF), and Phillips Perron (PP) (Perron, 1988). Consider a simple AR process:

$$Y_t = \rho Y_{t-1} + \delta X_t + \epsilon_t \qquad (4)$$

Where X_t are optional exogenous regressors which may consist of constant, or a constant and trend, ρ and δ are parameters to be estimated, and the ϵ_t are assumed to be white noise. If $|\rho| \geq 1$, is a non-stationary series and the variance of Y increases with time and approaches infinity. If $|\rho| < 1$, Y is a (trend-) stationary series. Thus, the hypothesis of (trend-) stationarity can be evaluated by testing whether the absolute value of ρ is strictly less than one. The unit root tests generally test the null hypothesis $H0{:}\rho=1$ against the one-sided alternative $H1{:}\ \rho<1$.

The validity of the model is checked from residual plots. Residuals should be independent and normally distributed with a mean of zero and constant variance. The following are different residual plots used to validate the model.

1. Standardized error versus regressor. If any significant pattern presents that indicates non-linear pattern.

2. Standardized error versus fitted value. Constant variation pattern shows the constant variance.

3. Straight line for normal plots for standardized residuals indicate the normal pattern.

4. Standard residuals versus time. Significant pattern will indicate serial correlation.

In addition to above, the model is validated using Durbin-Watson statistic (d) value.

4. Results of Granger Causality Test

Figures 1 and 2 present the time series plots for CGDFCF and GDP. As shown in figures both the series of CGDFCF and GDP not stationary. The stationarity of the series was established using unit root test with commonly used methods of Dickey-Fuller, Augmented Dickey-Fuller and Phillips-Perron tests. The Table 1 shows the summary of the unit root tests using DF, ADF and PP methods and the critical values for tests at 1%, 5% and 10% significance levels. The results of the unit root tests shows that the third differenced of CGDFCF and second differenced of GDP series is stationary at 1% significance level.

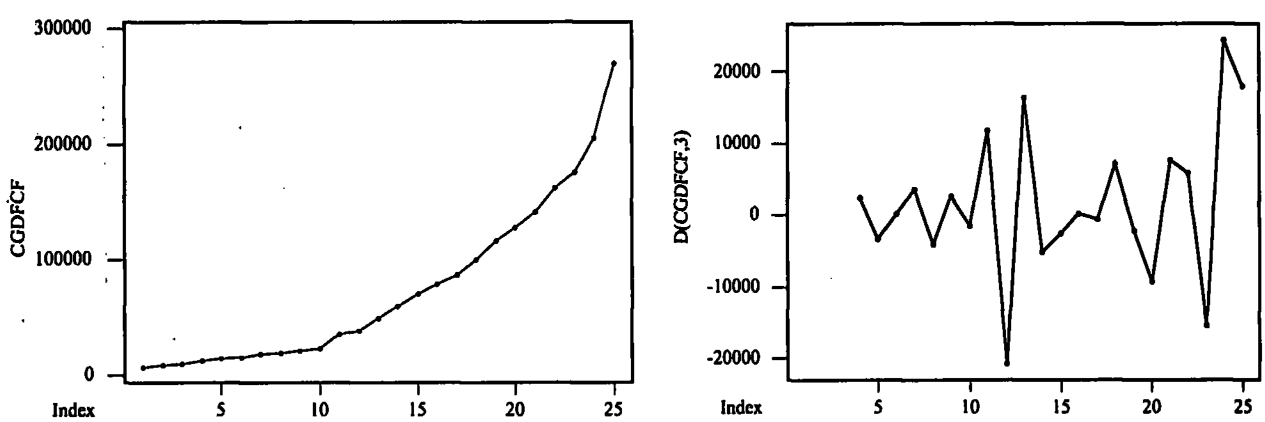

Figure 1: Time series plot for level and third difference of CGDFCF

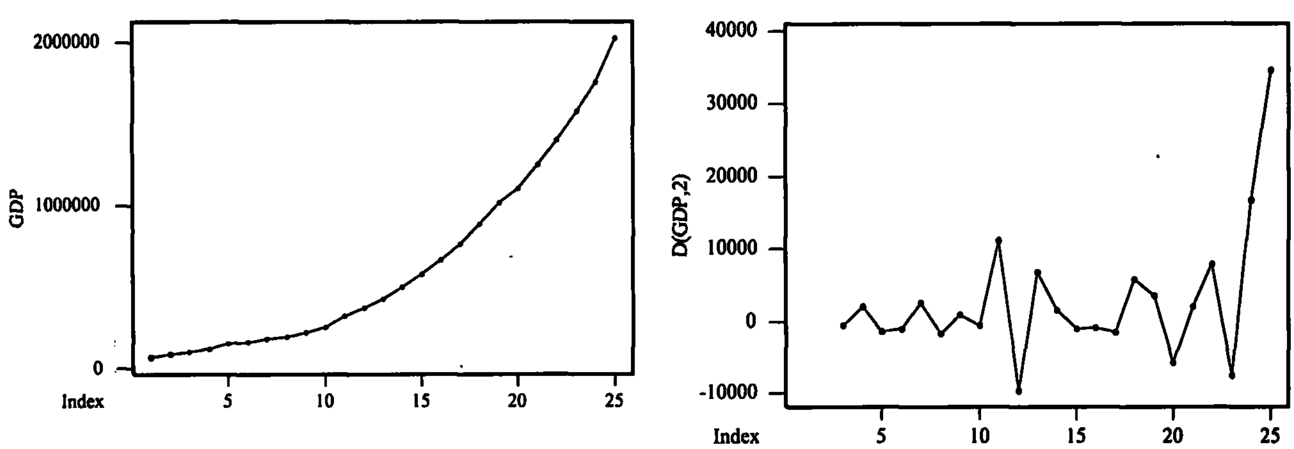

Figure 2: Time series plot for GDP at level and second difference of GDP

Table 1: Unit root tests for GDP and CGDFCF

Series/Critical value	DF test at level		ADF test in 1st difference		PP test in 2nd difference		PP test in 3rd difference	
	No trend	With trend	No trend	With trend	No trend	With trend	No trend	With trend
GDP	-1.15	-0.59	2.56	-1.44	-5.59	-8.42	-	-
CGDFCF	1.38	0.35	1.88	0.39	-2.24	-2.63	-6.48	-7.38
1%	-2.69	-3.77	-4.20	-4.53	-3.86	-4.57	-3.86	-4.62
5%	-1.96	-3.19	-3.18	-3.67	-3.04	-3.69	-3.04	-3.71
10%	-1.61	-2.89	-2.73	-3.28	-2.66	-3.29	-2.66	-3.30

Table 2: Regression between CGDFCF and GDP

Dependent Variable: D (GDP, 2)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	16191.230	5507.489	2.940	0.009
D (GDP (-1), 2)	-0.706	0.263	-2.688	0.015
D (CGDFCF (-1), 3)	1.299	0.560	2.322	0.032
R-squared	0.346	Mean dependent variable		11710.05
Adjusted R-squared	0.273	S.D. dependent variable		27665.33
Durbin-Watson statistic	1.702	Prob (F-statistic)		0.022

In testing the null hypothesis; *"CGDFCF does not Granger cause GDP"*, the regression (2) was run using the second and third differenced of GDP and CGDFCF respectively. In the first instance variables were assigned as dependent variable $\Delta\Delta Y$ = GDP and independent variable $\Delta\Delta\Delta$ X = CGDFCF. Regression results are summarized in Table 2.

In Table 2 a significant p-value provides a strong evidence to reject the null hypothesis at 5% significance level. Thus, the alternative hypothesis, CGDFCF Granger cause GDP at 5% significant level could be accepted. Further, a significant p-value between GDP and lagged GDP also provides a strong evidence to reject the null hypothesis. It shows that present values of GDP depend on past values. Therefore, the test shows that CGDFCF Granger cause GDP for lag one and present value of GDP depends on past values. The model was verified using residual plots as shown in Figures 3-5. The constant variance, randomly scattered, and an approximate straight line in Figures 3, 4 and 5 validates the model. In addition, the Durbin-Watson statistic close to 2.0 also supports this argument.

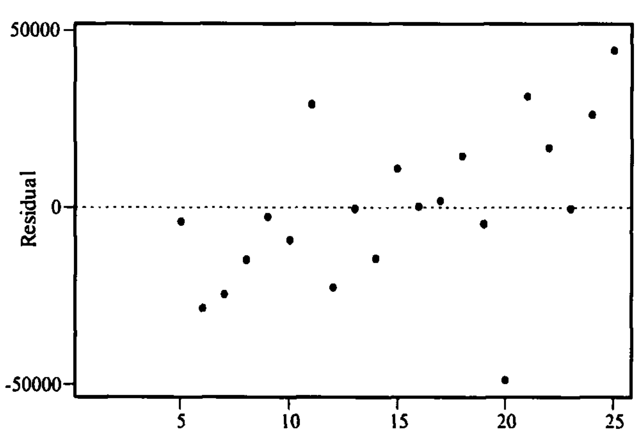

Figure 3: Residual Vs order of the data

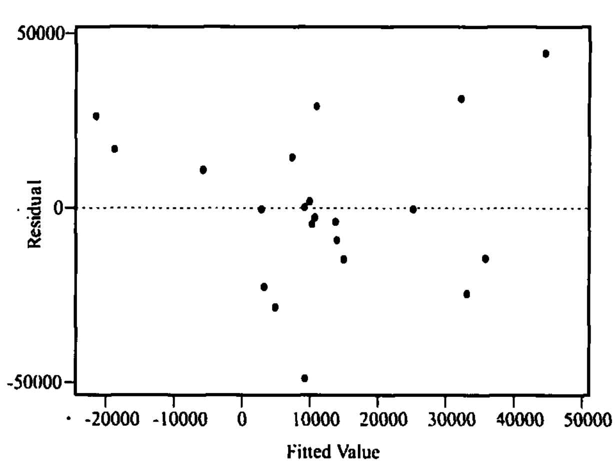

Figure 4: Residual Vs fitted values

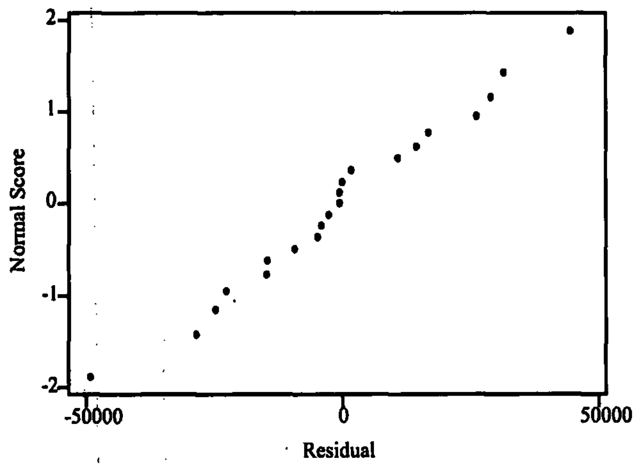

Figure 5: Normal probability plot of the residuals

The results were checked for all possible lags. In Table 3 insignificant p-value for higher order lags except lag one indicates no evidence against the null hypothesis. Thus, it is clear that CGDFCF Granger causes GDP for lag one only.

In order to test the null hypothesis, "GDP does not Granger cause CGDFC", regression was run by switching the variables as dependent variable $\Delta\Delta\Delta X$ = CGDFCF and Independent variable $\Delta\Delta Y$ = GDP. Regression results are summarized in Table 4. Insignificant p-value between GDP and CGDFCF indicates no evidence to reject the null hypothesis at 5% significance level. Thus, it shows that GDP does not cause CGDFCF. Further, insignificant p-value between CGDFCF and CGDFCF (-1) indicates that the present value of capital formation in construction does not depend on the previous values.

The results were checked for all possible lags. As given in Table 5 for all higher order lags, an insignificant p-value indicates no evidence against the null hypothesis. Therefore, the model could be accepted and confirmed that the GDP does not Granger cause CGDFCF for any possible lags.

Table 3: Causality tests of construction on GDP

Lag	Null Hypothesis	F-statistic	Prob.	Conclusion
1	D (CGDFCF, 3) does not Granger Cause D (GDP, 2)	5.3903	0.0322	Strong evidence to reject the null hypothesis at 5%
2	D (CGDFCF, 3) does not Granger Cause D (GDP, 2)	2.7806	0.0939	No evidence to reject
3	D (CGDFCF, 3) does not Granger Cause D (GDP, 2)	2.2312	0.1371	Do-
4	D (CGDFCF, 3) does not Granger Cause D (GDP, 2)	1.0344	0.4407	Do-
5	D (CGDFCF, 3) does not Granger Cause D (GDP, 2)	1.1588	0.4242	Do-
6	D (CGDFCF, 3) does not Granger Cause D (GDP, 2)	1.2151	0.4728	Do-
7	D (CGDFCF, 3) does not Granger Cause D (GDP, 2)	NA	NA	-

Table 4: Regression between GDP and CGDFCF

Dependent Variable: D (CGDFCF, 3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2112.365	2426.328	0.871	0.395
D (GDP (-1), 2)	-0.0309	0.116	-0.267	0.793
D (CGDFCF (-1), 3)	-0.378	0.247	-1.540	0.141
R-squared	0.145	Mean dependent variable		1556.286
Adjusted R-squared	0.045	S.D. dependent variable		10658.09
Durbin-Watson statistic	1.889	Prob (F-statistic)		0.244

Table 5: Causality tests of GDP on construction

Lag	Null Hypothesis	F-statistic	Prob.	Conclusion
1	D (GDP, 2) does not Granger Cause D (CGDFCF, 3)	0.0712	0.7927	No evidence to reject the null hypothesis at 5% significance level
2	D (GDP, 2) does not Granger Cause D (CGDFCF, 3)	0.1016	0.9041	
3	D (GDP, 2) does not Granger Cause D (CGDFCF, 3)	0.3277	0.8055	Do-
4	D (GDP, 2) does not Granger Cause D (CGDFCF, 3)	1.2911	0.3431	Do-
5	D (GDP, 2) does not Granger Cause D (CGDFCF, 3)	3.3772	0.0853	Do-
6	D (GDP, 2) does not Granger Cause D (CGDFCF, 3)	1.84015	0.3298	Do-
7	D (GDP, 2) does not Granger Cause D (CGDFCF, 3)	NA	NA	-

Conclusions

This paper discussed the causal relationship between construction sector and the economy of Sri Lanka using the Granger causality test. In finding the causal relationship, Gross Domestic Product (GDP) and Construction in Gross Domestic Fixed Capital Formation (CGDFCF) were used to represent the economy and the construction flow respectively. Results show that the Granger causality between GDP and CGDFCF is in one direction; construction causes the economy to grow, and not vice versa. This finding supports the view of Hillebrandt (1985), Ofori (1990), and Chan (2001). They proposed that construction flow causes economic output and not vice-versa. However, it contradicts the findings of Tse and Ganesan (1997) that GDP causes the construction growth using Hong Kong data. Further, the study shows that CGDFCF leads GDP by only one year. Chan (2001) found that construction leads GDP by two years.

References

Ball, M. (1988) Rebuilding construction:Economic change and the British construction industry, Routledge, London.

Briscoe, G. (1988) The economics of the construction industry, Mitchell, London.

Central Bank of Sri Lanka (2002) *Central Bank Annual Report,* Colombo, Central Bank of Sri Lanka

Central Bank of Sri Lanka (2004) *Central Bank Annual Report,* Colombo, Central Bank of Sri Lanka

Chan, S.L. (2001) Empirical tests to discern linkages between construction and other economic sectors in Singapore, *Construction Management and Economics,* 19(4), 355-63.

Chan, S.L. (2002) Responses of selected economic indicators to construction output shocks: The case of Singapore, *Construction Management and Economics,* 20, 523-533.

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

Demirbas, S. (1999) Co integration analysis – causality testing and Wagner's law: The case of Turkey, 1950-1990,

Department of Census and Statistics (2003) *Sri Lanka Labour Force Survey*, Colombo.

Dickey, D.A. and Fuller, W.A. (1979) Distributions of the estimators for autoregressive time series with a unit root, *Journal of the American Statistical Association,* 74, 427-31.

Drewer, S. (1980) Construction and development: a new perspective, *Habitat International*, 5(4), 395-428.

Edmonds, G. and Miles, D. (1984) Foundations for change: Aspects of the construction industry in developing countries, IT publications, London.

Engle, R.F. and Granger, C.W.J. (1987) Co integration and error correction representation, estimating and testing, *Econometrica*, 55(2), 251-76.

Granger, C.W.J. and Newbold, P. (1986) Forcasting Economic Time Series, Academic Press, Orlando, FL.

Green, R.K. (1997) Follow the leader: How changes in residential and non-residential investment predict changes in GDP, *Real Estate Economics*, 25(2), 253-70.

Hendry, D. (1986) Econometric modeling with co-integrated variables: an overview. Oxford Bulletin of Economics and Statistics, 48, 201-12.

Hillebrandt, P. (1985) Analysis of the British Construction Industry, Macmillan, London.

Nelson, C.R. and Plosser, C.I. (1982) Trends and random walks in macro economic time series: Some evidence and implications, *Journal of Monetary Economics,* 10, 139-162.

Odedokun, M.O. (1996) Alternative econometric approaches analyzing the role of the financial sector in economic growth: time –series evidence from LDCs, Journal of Development Economics, 50(1), 119-46.

Ofori, G. (1990) *The construction industry: Aspects of its Economics and Management,* Singapore University press, Singapore.

Perron, P. (1988) Trends and random walks in macroeconomic time series: Further evidence from a new approach, *Journal of Economic Dynamics and Control,* 12, 297-332.

Sims, C. (1972) Money, income and causality, American Economic Review 62, 540-552.

Sjoholt, O. (1997) A summary of project 189, Building Research and Information, 25(1), 3-4.

Strassmann, P. (1970) The construction sector in economic development, *The Scottish Journal of Political Economy,* 17(3), 390-410.

Tse, R.Y.C. and Ganesan, S. (1997) Causal relationship between construction flows and GDP: Evidence fom Hong Kong, *Construction Management and Economics*, 15, 371-6.

Turin, D. (1969) The construction industry: its economic significance and its role in development, UNIDO, London.

Wells, J. (1984) The construction industry in the context of development: a new perspective, *Habitat International,* 8(3/4), 9-28.

Wells, J. (1985) The role of construction in economic growth and development, *Habitat International,* 9(1), 55-70.