Athens Institute for Education and Research
ATINER

ATINER's Conference Paper Series
TEN2014-1066

Profitability and its Leading Determinants of Listed Construction Firms in Hong Kong

Tsang Yick Tat
Instructor
City University of Hong Kong
Hong Kong

Ng S. Thomas
Professor
The University of Hong Kong
Hong Kong

An Introduction to ATINER's Conference Paper Series

ATINER started to publish this conference papers series in 2012. It includes only the papers submitted for publication after they were presented at one of the conferences organized by our Institute every year. The papers published in the series have not been refereed and are published as they were submitted by the author. The series serves two purposes. First, we want to disseminate the information as fast as possible. Second, by doing so, the authors can receive comments useful to revise their papers before they are considered for publication in one of ATINER's books, following our standard procedures of a blind review.

Dr. Gregory T. Papanikos
President
Athens Institute for Education and Research

This paper should be cited as follows:

Tsang, Y.T. and Ng, S.T., (2014) **"Profitability and its Leading Determinants of Listed Construction Firms in Hong Kong",** Athens: ATINER'S Conference Paper Series, No: **TEN2014-1066**.

Athens Institute for Education and Research
8 Valaoritou Street, Kolonaki, 10671 Athens, Greece
Tel: + 30 210 3634210 Fax: + 30 210 3634209
Email: info@atiner.gr URL: www.atiner.gr
URL Conference Papers Series: www.atiner.gr/papers.htm
Printed in Athens, Greece by the Athens Institute for Education and Research.

ISSN **2241-2891**
24/07/2014

Profitability and its Leading Determinants of Listed Construction Firms in Hong Kong

Tsang Yick Tat
Instructor
City University of Hong Kong
Hong Kong

Ng S. Thomas
Professor
The University of Hong Kong
Hong Kong

Abstract

Construction business is sensitive to the fluctuation of its business environment. This research involved applications of quantitative modeling techniques to investigate the profitability of construction firms in Hong Kong. Based on the published financial data of listed construction contractors in Hong Kong between 1992 and 2010, the profitability was first estimated by using factor analysis. Leading environmental determinants including the macroeconomic condition, construction market demand, tender price, construction productivity, construction cost and weather were identified and their significances were empirically assessed by means of bivariate cross-correction analysis. The findings serve the basis of monitoring and predicting the financial well-being of construction firms in reacting to environmental change.

Keywords: Construction firm, profitability, cross-correlation analysis, factor analysis

Introduction

A number of researchers (e.g., Kangari 1988; Ofori 1990; Hillebrandt 2000) have conceptualised the interrelatedness of the construction industry and its construction business environment. They have commonly recognised that the industry is very sensitive to the trends and volatility of the business environment. When a national economy declines, the construction industry is usually severely impaired and *vice versa* (Tang & Ogunlana 2003; Rwelamila et al. 2004). Many empirical studies such as those by Ren and Shang (1996), Ofori et al. (1996), Russel and Zhai (1996) and Chan et al. (2005) documented that a country's construction industry is developed in close relation to its macro socio-economic development.

The ability of businesses to understand, predict and prepare for external changes is undoubtedly paramount, as it allows them to exploit opportunities as they arise and to protect themselves against potential threat (Gillespie 2010). A construction business decline usually begins with a failure to recognise the negative forces around an organisation and a failure to respond to opportunities that may affect the organisation's present and future conditions (Koksal & Arditi 2004a; Ng et al. 2011). Empirical studies (e.g., Russell & Zhai 1996; Koksal & Arditi 2004b) have shown that the construction business failure was correlated to the environmental factors.

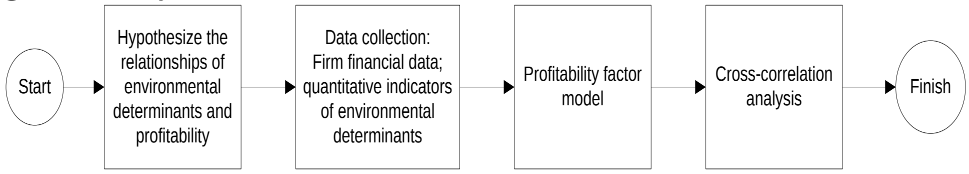
In Hong Kong, the changing environment has affected the construction business significantly as reported by Chan et al. (2005) and Wong et al. (2008). Nevertheless, scarce effort was devoted to performance evaluation at the firm level (Cheah et al. 2004; Yu et al. 2007). Phua (2006) further indicated that the operable predictors of firm performance for the construction industry are still under-explored.

Among the different performance measurement methodologies, most studies (e.g., Beaver 1966; Altman 1968; Ohlson 1980; Edum-Fotwe et al. 1996) have agreed that financial performance are the most plausible measures of firm performance, the most convincing evidence of business decisions and the most informative signals of business failure. The financial well-being of a firm is multidimensional (Pinches et al. 1975; Gombola & Ketz 1983; Tsang et al. 2012). Among different dimensions, the firm's profitability is recognized as the most appealing one (Milliner 1988) since it connects directly to the probable return received by shareholders (Skinner 1999; Chen 2009) and the value of a corporation in the capital market from the investor perspective (Brigham & Ehrhardt 2005). Consequently, the aim of this study is to examine the general trend of the profitability of the construction firms and to identify its leading environmental determinants.

Methodology

The research mode is basically deductive, as the theoretical hypotheses are first derived and then tested via empirical models (Buckley et al. 1976). The study framework is illustrated in the Figure 1:

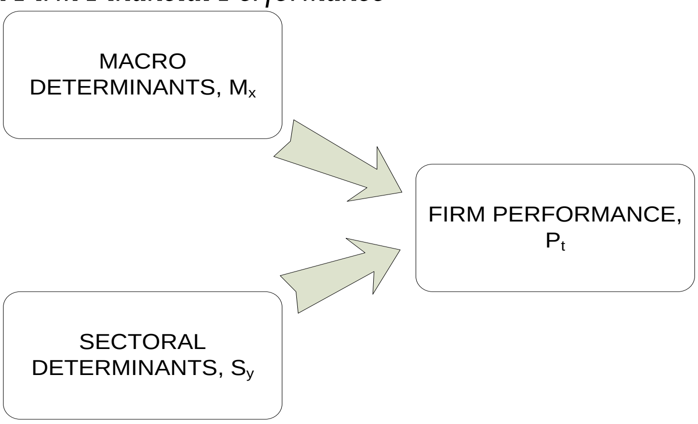
Figure 1. *Study Framework*



Conceptually, the change in external business environment concurrently influences every firm within the construction sector. The environmental determinants can naturally be treated as the common propellants or constraints of the financial performance of the firms within the sector. The general financial performance is thus defined as the central tendencies of all examined construction firms' individual financial performance. The general financial performance can be inferred as a benchmark of industry-wide performance.

A theoretical framework is thus established in order to conceptualise the interrelatedness between general financial performance of construction firms and environmental determinants. Based on the literature review of Ofori (1990), Warszawski (1996), Arditi et al. (2000), Rwelamila et al. (2004), Koksal and Arditi (2004a), Chan et al. (2005) and Gillespie (2010), it suggests that the environmental determinants of construction firm performance can be commonly divided into two categories: macro determinants, i.e., determinants related to regional socio-economic conditions, and sectoral determinants, i.e., immediate industry-level determinants directly related to construction. This categorisation helps to better denote the basic nature of the determinants. A theoretical framework of the flow of influence from the determinants to construction firms is shown in Figure 2.

Figure 2. *Theoretical Framework of Interrelatedness of Determinants and Construction Firm Financial Performance*



It is hypothesised that the environmental determinants may have contemporary and lagging effects on firm performance (Hillebrandt 2000; Giang & Low 2011). Thus, the functional form of the relationships can be given mathematically by:

$$P_t = f\ (M_x, S_y)$$

where P_t = the general financial performance of the construction firms at time t;

M_x = the macro determinants at time x and $x \le t$; and
S_y = the sectoral determinants at time y and $y \le t$.

The financial ratio analysis is the most popular tool for measuring and predicting a firm's financial performance (Miller 1972; Wild et al. 2004; Adrian & Adrian 2006). A thorough evaluation of financial performance should contain a group of ratios, considering the multidimensional nature of financial performance (Ginevičius & Podvezko 2006). Nevertheless, different studies (e.g., Chen & Shimerda 1981; Edum-Fotwe et al. 1996; Hossari & Rahman 2005; Ginevičius & Podvezko 2006) developed different sets of financial ratios that a solid consensus has yet to be achieved.

To establish a reliable set of financial ratios, a survey of previous relevant studies is first conducted to collect a comprehensive list of relevant financial ratios used in those studies. A strategy based on exploratory factor analysis is subsequently adopted to consolidate the large numbers of ratios into manageable sets while representing the original underlying key structure of the sampled data (Tsang et al. 2012).

In exploratory factor analysis, the q manifest variables can be represented as the vector $\mathbf{X}' = [x_1, x_2, \ldots, x_q]$. A regression-type model assumes the manifest variables to be related to a smaller number of unobserved latent variables, the common factors, represented by the vector $\mathbf{F}' = [f_1, f_2, \ldots, f_k]$ where $k < q$. As such,

$$\mathbf{X} = \mathbf{\Lambda F} + \mathbf{U}$$

where $\mathbf{\Lambda}$ is the association coefficient matrix and $\mathbf{U}$ is a matrix of the residual terms. Eventually, the common factor related to profitability of construction firms is extracted.

The list of theoretical environmental determinants and its quantitative indicators is established based on a comprehensive review of relevant literature and previous studies. In the identification of suitable indicators, a pragmatic approach, involving considerations: (1) the economic plausibility of the leading character, (2) data availability, (3) responsiveness to the represented determinant and (4) the modelling specifications used in previous studies, is adopted (Akintoye et al. 1998; Ng et al. 2000; Wong & Ng 2010).

To statistically examine the leading effect of the environmental determinants on the firms' profitability, the bivariate cross-correlation analysis is utilized. The cross-correlation function, CCF, can be derived to measure the strength of the relationship between two time series variables, say, y_t and x_{t-k}, where k is a positive or negative integer representing the lag or lead relationship between these variables. The cross-correlation coefficient of CCF for *n* number of observations is mathematically equal to:

$$CCF(k) = \frac{c_{xy}(k)}{\sqrt{\sum_{t=1}^{n}(x_t - \bar{x})^2 \sum_{t=1}^{n}(y_t - \bar{y})^2}} \qquad \text{where k} = 0, \pm 1, \pm 2, \ldots$$

$$\text{and} \quad c_{xy}(k) = \begin{cases} \sum_{t=1}^{n-k}(x_t - \bar{x})(y_{t+k} - \bar{y})/n & \text{when k=0,1,2,...} \\ \sum_{t=1}^{n+k}(x_{t-k} - \bar{x})(y_t - \bar{y})/n & \text{when k=0,-1,-2,...} \end{cases}$$

A cross-correlogram can be generated to graphically display a pattern of estimated CCFs over *k* number of lags. A cross-correlation coefficient is said to be significant when the estimated value exceeds the two standard error bounds (DeLurgio, 1998).

Before running the cross-correlation analysis, data pre-possessing for the raw data collected is typical necessary to improve the efficiency of statistical analysis (Tabachnick & Fidell 2001). The procedure adopted including data winsorising, temporal disaggregation, deflation and seasonal adjustment depending on the properties of the variables.

Another important statistical procedure for time series data is to examine the stationarity of the variables. A time series is stationary if the means and variances are constant over time and the autocovariances between two periods *t* and *t*+*k* depend only on the distance *k* between the periods and not on the actual period *t* at which the covariances are considered. Non-stationary time series will incur the *spurious* regression problem (Granger & Newbold 1974). The stationarity can be verified by means of augmented Dickey-Fuller unit root test (Hill et al. 2011). Once non-stationarity is observed, a non-stationary series can be rendered stationary via differencing.

The statistical softwares, SPSS 19.0 and EViews 6.0, are employed in the analysis.

Data Collection and Analysis

The theoretical environmental determinants and its quantitative indicators selected in the literature review are summarized in Table 1. The quarterly raw data of quantitative indicators were retrieved from the official publications or databases of public agents or large companies in Hong Kong (e.g. the Census and Statistics Department of the Government). The sample period runs from 1990 to 2010.

Table 1. *Quantitative Indicators of Environmental Determinants*

Theoretical Environmental Determinant	Quantitative Indicator / Unit	Notation
Macroeconomic condition	GDP (in chained 2009 dollars) / HK$ million	*GDP*
	Unemployment rate (seasonally adjusted) / %	*UNEMPLOY*
	Index of payroll per person engaged (1999 Q1=100)	*PAYROLL*
	Hang Seng Index 100-day moving average	*HSI*
Inflation	Composite consumer price index (2004/05 based)	*CPI*
	Implicit GDP deflator (2009=100)	*DEFLATOR*
Credit availability	Hong Kong 3-month interbank offered rates / % per annum	*INTEREST*
	Money supply M3 /HK$ million	*M3*
Trade activities	Value index of total exports of goods seasonally adjusted (2000=100)	*EXPORT*
	Value index of imports of goods seasonally adjusted (2000=100)	*IMPORT*
Demographic factor	Number of resident population / thousand number	*POPU*
	Number of domestic households / thousand number	*HSEHOLD*
Construction market demand	Gross value of construction work performed - seasonal adjusted (in 2009 price) / HK$ million	*CONSTR*
	GDP by construction activity (in chained 2009 dollars) / HK$ million	*GDPC*
	Price index of private domestic units (1999=100)	*DOMPRICE*
	Price index of office premises (1999=100)	*OFFPRICE*
	Real public expenditure on housing and infrastructure / HK$ million	*PUBEXP*
	Total residential flats with consents to commence / number of flat	*FLATCOM*
	Total land sales area / square metre	*LANDSALE*
Tender price	Architectural Services Department building works tender price index (1970 Q1=100)	*ASDTENDER*
	Rider Levett Bucknall tender price index (1968 Q4=100)	*RLBTENDER*
Construction cost	Construction cost index (June 1995=100)	*COSTINDEX*
Productivity	Productivity index	*PROINDEX*
Weather conditions	Total rainfall (mm)	*RAINFALL*
	Total bright sunshine (hours)	*SUNSHINE*

For financial data collection, the publicly listed construction firms in Hong Kong were the sampling targets. This is because the listed firms are usually market leaders (Chan et al. 2005) that performed at a level indicative of the industry. In addition, the quality of the data is reliable, as they are prepared and audited under standardised practices by qualified accounting professionals as required by the listing rules, which are further monitored by the official regulators. The financial data originating from the annual financial reports of the samples were mainly collected through financial database provided by Bloomberg Finance Limited Partner. As a result, the financial data of 31 listed construction firms in Hong Kong spanning over 1992-2010 was collected.

Table 2 shows 35 financial ratios which were identified from published empirical studies that had used financial ratios to assess performance or build models in the construction management field. The raw financial data collected was converted into these financial ratios for each sampled firms.

Table 2. *Financial Ratios Identified*

Current ratio	Quick ratio	EBIT to total assets ratio	Current liabilities to total liabilities ratio
Return on equity	Liabilities to equity ratio	Net profit margin	Price to book value ratio
Return on assets	Fixed assets turnover	Equity ratio	Price to earnings ratio
Receivable turnover ratio	Working capital turnover	Inventory turnover	Gross profit to total assets ratio
Times interest earned ratio	Cash flow to total liabilities ratio	Total asset cash recovery ratio	Pretax margin
EBIT margin	Cash flow to current liabilities ratio	Growth of revenue for 1-year	Current assets to net assets
Earnings per share	Gross profit margin	Fixed assets to equity ratio	Current assets to total assets ratio
Equity turnover	Asset turnover	Inventory to total assets ratio	Fixed assets to total assets
Liabilities to asset ratio	EBIT to equity ratio	Long-term debt to equity ratio	

Factor analysis was applied to the dataset of financial ratios to uncover the common factors in the dataset. These factors are viewed as the fundamental underlying dimensions of the financial well-being of the examined construction firms. Based on the factor models developed previously by the authors (Tsang et al. 2012), 5 common factors were eventually established for interpreting the financial performance of listed construction firms in Hong Kong, namely, profitability factor, liquidity factor, asset structure factor, activity factor and debt structure factor. For the purpose of this study, the profitability factor is utilised, which is defined as follows:

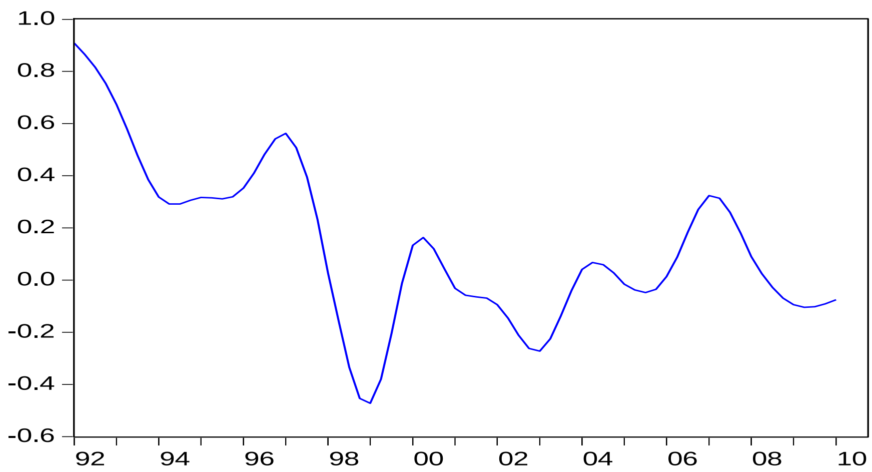
$$PF_{kt} = -0.01CR_{kt} + 0.317ROE_{kt} + 0.355EBIT_{kt} + 0.407EPS_{kt} \\ -0.027TL/TA_{kt} - 0.007QR_{kt} - 0.028TL/TE_{kt} + 0.045S/FA_{kt}$$

$+0.012S/WC_{kt} +0.019FA/TE_{kt} +0.037LD/TE_{kt} -0.059CA/TA_{kt} - 0.033FA/TA_{kt} +0.025S/TA_{kt}$

where *PF* = profitability score; *CR* = current ratio; *ROE* = return on equity; *EBIT* = earnings before interest & taxes / sales; *EPS* = earnings per share; *TL/TA* = Liabilities to asset ratio; *QR* =quick ratio; *TL/TE* = liabilities to equity ratio; *S/FA* = fixed assets turnover; *S/WC* = working capital turnover; *FA/TE* = fixed assets to equity ratio; *LD/TE* = long-term debt to equity ratio; *CA/TA* = current assets to total assets ratio; *FA/TA* = fixed assets to total assets; *S/TA* = Total asset turnover; *k* = firm number and *t* = time.

The profitability scores of each sampled construction firm were thus computed. To derive the central tendency of the firms' profitability, the median of the profitability scores were computed (Hines & Douglas 1980). The time series plot of profitability median score between 1992 -2010 is illustrated in Figure 3. It suggests a cyclical movement inherent to the financial performance of local construction businesses. This observation indicates that the construction industry business cycle suggested by current theories (e.g., Ofori 1990; Rwelamila et al. 2004) does exist. The profitability shows a V-shape pattern over the periods 1992-2010 and hits a historical low in 1999 Q1, after which it gradually improves. Nevertheless, the profit level is barely comparable to that before 1997.

Figure 3. *Profitability Median Score of Construction Firms in Hong Kong from 1992 to 2010*



Before the cross-correlation analysis, profitability median score and quantitative indicators were transformed by taking natural logarithms. The augmented Dickey-Fuller unit root test confirmed that all variables were non-stationary in level but stationary in first difference. Therefore, first differencing transformation was applied to all variables.

The cross-correlation analysis was performed to identify the significant lead-lag relationship of each quantitative indicator on the profitability median score. In the analysis, cross-correlograms were generated to identify the significant CCF. The maximum lag length was fixed to eight quarters, which is considered adequate to forecasting studies in construction sector (Wong et al. 2007). The significant bivariate lead-lag relationships confirmed by the analysis are summarized in Table 3.

Table 3. *Results of Bivariate Cross-Correlation Analysis*

Profitability of listed construction firms	**Quantitative indicators with Significant CCF**
Δlog*PF* (Profitability median score)	Δlog*GDP* (Lag = 0, 1, 2; sign +ve), Δlog*UNEMPLOY* (Lag = 0; sign -ve), Δlog*HSI* (Lag = 0, 1, 2; sign +ve), Δlog*IMPORT* (Lag = 0, 1; sign +ve), Δlog*PUBEXP* (Lag = 4, 5, 6; sign +ve), Δlog*LANDSALE* (Lag = 8; sign +ve), Δlog*RLBTENDER* (Lag = 8; sign +ve), Δlog*PROINDEX* (Lag = 5, 6, 7, 8; sign +ve), Δlog*COSTINDEX* (Lag = 2, 3, 4, 5; sign -ve), Δlog*SUNSHINE* (Lag = 3, 4, 5; sign +ve).

Notes: The lag and sign in the brackets indicate the preceding quarters of the quantitative indicators significantly correlated to the profitaiblity and the sign of the relationship respectively.

The statistically significant leading environmental determinants for the firm profitability include macroeconomic condition (as indicated by the GDP, unemployment rate, stock index and imports), construction market demand (as indicated by public construction expenditure and land sales), the tender price (as indicated by the tender price index), construction productivity (as indicated by the productivity index), construction cost (as indicated by the cost index) and bright sunshine hours. Both macroeconomic condition and construction market demand have positive leading effects on the profitability. The increasing prosperity of economy and market demand creates more business for the construction industry that eventually enhances firm profits. A rise in the tender price also naturally boosts the profitability of a firm. Construction productivity has a positive leading effect on the profitability, and the factor is negatively related to construction costs. Increasing productivity is obviously beneficial to a firm’s profit, and increasing costs are detrimental. The favourable weather conditions reflected by bright sunshine hours also create a desirable site working condition for boosting the profit. The findings of the correlation analysis provide empirical justification of the hypothesised interrelatedness of the profitability of the construction firms and the theoretical determinants suggested by the literature. It also supports the existence of lagging effects of these determinants in various lengths.

Conclusion

This paper contributes to provide empirical examination of the listed construction firms' profitability and its environmental determinants in Hong Kong. The profitability of the sampled firms was derived based on factor analysis. Through the bivariate cross-correlation analysis, a number of environmental determinants were proven to have significant leading effects on the firms' profitability. The leading effect of these determinants could extend up to eight preceding quarters. The insight drawn in this paper is useful for developing forecasting models of the financial performance of construction business.

References

Adrian, J. J. & Adrian, D. J., 2006. *Construction accounting: financial, managerial, auditing and risk.* 4th ed. Illinois: Stipes.

Akintoye, A., Bowen, P. & Hardcastle, C., 1998. Macro-economic leading indicators of construction contract prices. *Construction Management and Economics,* 16(2), pp. 159-175.

Altman, E. I., 1968. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *Journal of Finance,* 23(4), pp. 589-609.

Arditi, D., Koksal, A. & Kale, S., 2000. Business failures in the construction industry. *Engineering Construction and Architectural Management*, 7(2), p. 120.

Beaver, W. H., 1966. Financial ratios as predictors of failure. *Journal of Accounting Research,* 4(3), pp. 71-111.

Brigham, E. F. & Ehrhardt, M., 2005. *Financial management: theory and practice.* 11th ed. Ohio: Thomson.

Buckley, J. W., Buckley, M. H. & Chiang, H. F., 1976. *Research methodology and business decisions.* New York: National Association of Accounts & The Society of Industrial Accountants of Canada.

Chan, J. K. W., Tam, C. M. & Cheung, R. K. C., 2005. Construction firms at the crossroads in Hong Kong: going insolvency or seeking opportunity. *Engineering Construction and Architectural Management,* 12(2), pp. 111-124.

Cheah, C. Y. J., Garvin, M. J. & Miller, J. B., 2004. Empirical study of strategic performance of global construction firms. *Journal of Construction Engineering and Management,* 130(6), pp. 808-817.

Chen, H. L., 2009. Model for predicting financial performance of development and construction corporations. *Journal of Construction Engineering and Management,* 135(11), pp. 1190-1200.

Chen, K. H. & Shimerda, T. A., 1981. An empirical analysis of useful financial ratios. *Financial Management,* 10(1), pp. 51-60.

DeLurgio, S. A., 1998. *Forecasting principles and applications.* Boston: Irwin/McGraw-Hill.

Edum-Fotwe, F., Price, A. & Thorpe, A., 1996. A review of financial ration tools for predicting contractor insolvency. *Construction Management and Economics,* 14(3), p. 189-198.

Giang, D. T. H. & Low, S. P., 2011. Role of construction in economic development: review of key concepts in the past 40 years. *Habitat International,* 35(1), pp. 118-125.

Gillespie, A., 2010. *Business economics.* Oxford: Oxford University Press.

Ginevičius, R. & Podvezko, V., 2006. Assessing the financial state of construction enterprises. *Technological and Economic Development of Economy,* 12(3), pp. 188-194.

Gombola, M. J. & Ketz, J. E., 1983. A note on cash flow and classification patterns of financial ratios. *Accounting Review,* 58(1), pp. 105-114.

Granger, C. W. J. & Newbold, P., 1974. Spurious regressions in econometrics. *Journal of Econometrics,* 2(2), pp. 111-120.

Hill, R. C., Griffiths, W. E. & Lim, G. C., 2011. *Principles of econometrics.* 4th ed. Hoboken: Wiley.

Hillebrandt, P. M., 2000. *Economic theory and the construction industry.* 3rd ed. Basingstoke: Macmillan.

Hines, W. & Douglas, C., 1980. *Probability and statistics in engineering and management science.* New York: John Wiley & Sons.

Hossari, G. & Rahman, S., 2005. A comprehensive formal ranking of the popularity of financial ratios in multivariate modeling of corporate collapse. *Journal of American Academy of Business, Cambridge,* 6(1), pp. 321-327.

Kangari, R., 1988. Business failure in construction industry. *Journal of Construction Engineering and Management*, 114(2), pp. 172-190.

Koksal, A. & Arditi, D., 2004a. Predicting construction company decline. *Journal of Construction Engineering and Management,* 130(6), pp. 799-807.

Koksal, A. & Arditi, D., 2004b. An input/output model for business failures in the construction industry. *Journal of Construction Research,* 5(1), pp. 1-16.

Miller, D. E., 1972. *The meaningful interpretation of financial statements.* Revised ed. New York: American Management Association.

Milliner, M. S., 1988. *Contractor's business handbook: accounting, finance, tax management, cost control.* Kingston: R.S. Means Co.

Ng, S. T., Cheung, S. O., Skitmore, R. M., Lam, K. C. & Wong, L. Y., 2000. Prediction of tender price index directional changes. *Construction Management and Economics*, 18(7), pp. 843-852.

Ng, S. T., Wong, J. M. W. & Zhang, J., 2011. Applying Z-score model to distinguish insolvent construction companies in China. *Habitat International,* 35(4), pp. 599-607.

Ofori, G., 1990. *The construction industry: aspects of its economics and management.* Singapore: Singapore University Press.

Ofori, G., Hindle, R. & Hugo, F., 1996. Improving the construction industry of South Africa: a strategy. *Habitat International*, 20(2), pp. 203-220.

Ohlson, J. A., 1980. Financial ratios and the probabilistic prediction of bankruptcy. *Journal of Accounting Research,* 18(1), pp. 109-131.

Phua, F. T. T., 2006. Predicting construction firm performance: an empirical assessment of the differential impact between industry- and firm-specific factors. *Construction Management and Economics,* 24(3), pp. 309-320.

Pinches, G. E., Eubank, A. A., Mingo, K. A. & Caruthers, J. K., 1975. The hierarchical classification of financial ratios. *Journal of Business Research,* 3(4), pp. 295-310.

Ren, H. & Lin, S. S., 1996. The UK construction industry under cyclical high inflation, high interest rates and recession. *International Journal of Project Management*, 14(5), pp. 301-305.

Russell, J. S. & Zhai, H., 1996. Predicting contractor failure using stochastic dynamics of economic and financial variables. *Journal of Construction Engineering and Management*, 122(2), p. 183.

Rwelamila, P. D., Lobelo, L. & Kupakuwana, P. S., 2004. Insolvencies among civil engineering enterprises in South Africa - a time to reflect. *Cost Engineering,* 46(7), pp. 12-37.

Skinner, D. J., 1999. How well does net income measure firm performance? a discussion of two studies. *Journal of Accounting and Economics,* 26(1-3), pp. 105-111.

Tabachnick, B. G. & Fidell, L. S., 2001. *Using multivariate statistics.* 4th ed. Boston: Allyn and Bacon.

Tang, Y. H. & Ogunlana, S. O., 2003. Modelling the dynamic performance of a construction organization. *Construction Management and Economics,* 21(2), pp. 127-136.

Tsang, Y.T., Ng, S. T. & Lam, K. C., 2012. Selection of financial performance indicators for construction companies in Hong Kong by factor analysis. In: M. Hajdu & M. J. Skibniewski, eds. *Proceeding of Creative Construction Conference 2012.* Budapest, Hungary, 30 June -3 July 2012. Budapest: Diamond Congress.

Warszawski, A., 1996. Strategic planning in construction companies. *Journal of Construction Engineering and Management*, 122(2), p. 133.

Wild, J. J., Subramanyam, K. R. & Halsey, R. F., 2004. *Financial statement analysis.* 8th ed. New York: McGraw-Hill.

Wong, J. M. W., Chan, A. P. C. & Chiang, Y. H., 2007. Forecasting construction manpower demand: a vector error correction model. *Building and Environment,* 42(8), pp. 3030-3041.

Wong, J. M. W., Chiang, Y. H. & Ng, T. S., 2008. Construction and economic development: the case of Hong Kong. *Construction Management and Economics,* 26(8), pp. 815-826.

Wong, J. M. W. & Ng, S. T., 2010. Forecasting construction tender price index in Hong Kong using vector error correction model. *Construction Management and Economics*, 28(12), pp. 1255-1268.

Yu, I., Kim, K., Jung, Y. & Chin, S., 2007. Comparable performance measurement system for construction companies. *Journal of Management in Engineering,* 23(3), pp. 131-139.