Seventh International Conference on Construction in the 21st Century (CITC-VII)
"Challenges in Innovation, Integration and Collaboration in Construction & Engineering"
December 19-21, 2013, Bangkok, Thailand

An Empirical Analysis of Macroeconomic Factor that Affect the International Construction Market

Jung Ki Lee
Master Student, Dept. of Civil and Environmental Engineering, Yonsei University, Seoul, Korea
tommyjtl@hotmail.com

Jaebum Lee
Master Student, Dept. of Civil and Environmental Engineering, Yonsei University, Seoul, Korea
mamafan@yonsei.ac.kr

Kang-Wook Lee
Ph. D Candidate, Dept. of Civil and Environmental Engineering, Yonsei University, Seoul, Korea
Celebrity3@yonsei.ac.kr

Seung Heon Han
Professor, Dept. of Civil and Environmental Engineering, Yonsei University, Seoul, Korea
shh6018@yonsei.ac.kr

Pil-sun Jung
Master of Engineering, Graduate School of Engineering, Yonsei University, Seoul, Korea
luck@dreampress.co.kr

Abstract
Over the past decade, the international construction market has been sensitive to macroeconomic issues, such as the East Asian currency crisis and the later global financial crisis. Although this market has emerged as an attractive market for multinational enterprises, the influences of macroeconomic factors pertaining to the construction industry have rarely been examined. In relation to this, this paper aims to analyze the effects of macroeconomic factors on the international construction market empirically. Through an extensive literature review, five major factors are initially derived (gross domestic product, the dollar exchange rate, the oil price, stock indexes, and the trade balance). We then collected panel data from a Korean national sample over a period of 21 years (1990-2010). Using the vector autoregression model (VARM), we analyzed the relationship between macroeconomic factors and the international contract volume of Korean construction firms. The results show that of the five major factors, the oil price had the largest correlation compared to the other factors, as most of the international contracts were in Middle Eastern countries in which oil is procured. This implies that international construction fluctuates due to macroeconomic factors and that consideration of these factors is needed for a successful project.

Keywords
International Construction Market, Macroeconomic Factors, Korean Construction Firms, Vector Autoregression Model

1. Introduction

In our rapidly changing world, the construction industry has been growing over the past few decades. Due to the urbanization and globalization of multiple nations around the world, the construction industry has become an attractive market for multinational enterprises. Top firms around the world not only compete in their own countries but also in the international construction market (Cho *et. al.*, 2013), where they compete with both foreign and local firms for projects. As the international construction market grows, various risks must be assessed. Moreover, strategic planning is required for new emerging markets (Park, 2013). Though it has become a large part of the economy in various countries, the causal relationships between the international construction market and other macroeconomic factors have yet to be analyzed. Therefore, this research aims to analyze the effect of macroeconomic factors in South Korea empirically with respect to the international construction contract volume of Korean firms using the vector autoregression model (VARM) and derive the factors that affect the contract volume of these firms most.

2. Overview of Previous Approaches

Regarding the selection of the macroeconomic factors that are used in this research, an extensive literature review is performed to extract the factors that have been analyzed in the academic field. Numerous studies on the use of macroeconomic factors and their effects on target factors have been done in the fields of finance and economics. Studies that analyze macroeconomic factors and stock markets have been conducted. Bilson *et al.* (2001) studied factors that affected the stock market and Kwon and Shin (1999) analyzed cointegration and causality between macroeconomic factors and stock market returns. Also, Gjerde and Saettem (1999) investigated causal relationships among stock returns and macroeconomic factors in specific locations, such as an open economy.

Another factor that has been extensively investigated is oil prices. The impact of the oil price shock (Iwayemi and Fowowe, 2011) and the effect of oil price fluctuations (Eltony and Al-Awadi, 2001) on macroeconomic factors, as well as an analysis of the role of oil price shocks in the Malaysian economy and the monetary response were analyzed using a structural VAR (SVAR) approach (Ahmed and Wadud, 2011). Also, an analysis of the causal relationships using oil prices and US real exchange rates was done by Amano & Norden (1998), where the oil price showed a causal relationship with exchange rates.

Causal relationship analysis using different factors are frequently done. Abdalla & Murinde (1997) investigated the relationship between exchange rates and stock prices in the field of finance. Also, Narayan (2004) used a Granger causality test to examine New Zealand’s trade balance considering the exchange rate, domestic income, and foreign income.

Though there aren’t many analyses which targeted the construction market and its relationship with macroeconomic factors, Tse and Ganesan (1996) investigated the causal relationship between construction flows and GDP using data from Hong Kong. In addition, Sang *et al.* (2013) examined macroeconomic fluctuations of insolvency in Korean construction companies. Similarly, Kwon *et al.* (2013) derived the characteristics of construction companies which become insolvent by investigating macroeconomic fluctuations.

Given the lack of research that aimed to test the causal relationships among macroeconomic factors and the construction market directly, this study aims to analyze the effect of the GDP, exchange rates, oil prices, stock indexes, and finally the trade balance on the Korean international construction market empirically using the VAR model.

3. Data and Analysis Method

The data used in this research range from 1990 to 2010, and each factor is tested primarily for unit roots. This is done to check whether the data would return to its original trend when an instant impact is made in relation to a factor. For the data to be used in the VAR model, each factor is to be tested as to whether panel data are stationary. There are two methods for testing for the unit root, the augmented Dickey Fuller test (or the ADF test), and the Phillips-Parron method.

This research uses the VAR model, which is a combination of a regression analysis and a time series analysis with the model being a multivariate model extended from the traditional autoregression model (Jung, 2012). The advantage of using it is that an analysis of each factor's relationships can be derived by performing an impulse response analysis and variance decomposition analyses. In this way, the factor that most affects the independent variable can be derived.

In establishing the VAR model, the order of the factors is important, where the independence and the causal relationships between each factor are tested through the Granger causality test. The Granger causality test allows us to check whether there are any long-term co-integration relationships between each factor. In addition, the lag order of each factor is considered in the VAR model. Given that our independent variable is the contract volume of a construction project, there are some time lags between each factor and the volume of international construction contracts. Therefore, an appropriate order selection (Eltony & Al-Awadi, 2001) is determined using the Acaike information criteria, AIC, and the Schwarz information criteria, SIC. The order is separated from a '0-year' order to a '4-year' order. The results are shown in the empirical analysis section.

Next, two analyses are done to examine the changes that would occur in each factor when it is presented with a shock. The first analysis is an impulse response analysis, where the result is shown as a curve that examines the change of the dependent variable when the independent variable is constant (Ahmed & Wadud, 2011). This analysis presents the change of the factor due to an external impact. The second analysis performed is a variance decomposition analysis, which shows the error forecasting of each factor according to the time series of each dataset (Jung, 2012). The variance of the error is analyzed; it is represented as a percentage, where the result explains the contribution of the dependent variable. The percentage does not show a direct causal relationship between each factor, but it implies the ability of forecasting with a high percentage value as a result.

4. Empirical Analysis

Using the data accumulated for use in this research, the unit root test is initially performed using the ADF and the Phillips Parron methods.

Table 1: Unit Root Test for Each Factor (Zero Difference)

Factors	ADF Test		PP Test	
	t test	Probability	t test	Probability
Contract Volume	-2.1400	0.2320	-2.6060	0.1080
GDP	1.8745	0.9995	3.4570	1.0000
Dollar Exchange	-0.7900	0.7648	-0.0587	0.8200
Oil Price	0.2620	0.9693	0.1910	0.9648
Stock Index	-2.7370	0.0926	-2.6260	0.1112
Trade Balance	-2.2580	0.1938	-2.1800	0.2186

As shown in Table 1, the test result shows that none of the factors have a unit root and that this is non-stationary panel data. Therefore, we performed the test again by differencing each factor at the first difference, as shown in Table 2.

Table 2: Unit Root Test for Each Factor (First Difference)

Factors	ADF Test		PP Test	
	t test	Probability	t test	Probability
Contract Volume	-4.2170	0.0048	-5.6920	0.0002
GDP	-0.3206	0.0355	-3.1750	0.0376
Dollar Exchange	-2.6330	0.1427	-0.9140	0.7056
Oil Price	-5.7680	0.0002	-5.7490	0.0002
Stock Index	-3.1380	0.0559	-5.9730	0.0004
Trade Balance	-3.9420	0.0096	-7.0250	0.0000

After the first difference of each factor, the factors are tested as to whether they are stationary. The data above is now used to perform the Granger causality test. Table 3 shows the result of the causal relationships between each of the factors in this research.

Table 3: Granger Causality Tests

Null Hypothesis	F-Probability	P-value
GDP does not Granger Cause DOLLAR_EXCHANGE	2.2338	0.1439
DOLLAR_EXCHANGE does not Granger Cause GDP	0.2511	0.7814
OIL_COST does not Granger Cause DOLLAR_EXCHANGE	0.8791	0.4369
DOLLAR_EXCHANGE does not Granger Cause OIL_COST	3.1662	0.0734
PROFIT does not Granger Cause DOLLAR_EXCHANGE	2.7646	0.0973
DOLLAR_EXCHANGE does not Granger Cause PROFIT	4.1998	0.0373
STOCK_PRICE_INDEX does not Granger Cause DOLLAR_EXCHANGE	1.5902	0.2386
DOLLAR_EXCHANGE does not Granger Cause STOCK_PRICE_INDEX	2.0840	0.1613
COST does not Granger Cause DOLLAR_EXCHANGE	2.0076	0.1712
DOLLAR_EXCHANGE does not Granger Cause COST	0.0297	0.9708
OIL_COST does not Granger Cause GDP	3.7716	0.0490
GDP does not Granger Cause OIL_COST	2.3202	0.1348
PROFIT does not Granger Cause GDP	1.0714	0.3690
GDP does not Granger Cause PROFIT	4.2069	0.0371
STOCK_PRICE_INDEX does not Granger Cause GDP	0.2886	0.7537

GDP does not Granger Cause STOCK_PRICE_INDEX	11.1825	0.0013
COST does not Granger Cause GDP	0.9944	0.3946
GDP does not Granger Cause COST	1.4116	0.2764
PROFIT does not Granger Cause OIL_COST	4.3222	0.0345
OIL_COST does not Granger Cause PROFIT	2.2113	0.1464
STOCK_PRICE_INDEX does not Granger Cause OIL_COST	7.4286	0.0063
OIL_COST does not Granger Cause STOCK_PRICE_INDEX	5.8121	0.0145
COST does not Granger Cause OIL_COST	5.0092	0.0229
OIL_COST does not Granger Cause COST	3.6120	0.0543
STOCK_PRICE_INDEX does not Granger Cause PROFIT	3.7122	0.0509
PROFIT does not Granger Cause STOCK_PRICE_INDEX	6.0121	0.0130
COST does not Granger Cause PROFIT	0.8886	0.4332
PROFIT does not Granger Cause COST	0.9806	0.3994
COST does not Granger Cause STOCK_PRICE_INDEX	2.5612	0.1128
STOCK_PRICE_INDEX does not Granger Cause COST	7.3234	0.0067

As shown in the table above, some factors show a clear causal relationship between each other and some factors only show a weak causal relationship. This result shows that the dollar exchange factor and contract volume factor have a high causal relationship according to the Granger causality test.

Next, for a more realistic result in the search for causal relationships, selecting an appropriate lag order must be performed (Eltony & Al-Awadi, 2001). Determining the lag order is necessary because financing in the field of construction does not come into direct effect, instead taking approximately a year or two before the project is financed and can therefore start. To determine the lag order, this research used two methods: the AIC and the SIC method. The maximum lag order is set to be four years, and Table 4 shows the result of the determination of the lag order.

Table 4: Lag Order Determination using AIC and SIC

Method	Lag Order			
	1	2	3	4
AIC	29.5917	28.9621	29.0718	29.1876
SIC	29.8472	31.0059	32.9040	34.8081

The SIC method result shows that as the lag order increases, the value of SIC increases as well, which shows that it cannot be used to determine the lag order. Therefore, this research uses the AIC method. As the AIC value in the lag order position of 2 is at the lowest point, the appropriate lag order was determined to be two years.

Through these analysis results, the VAR model is estimated for all of the factors used in this research. Due to the page limitation, a generalized formula of the VAR model will be presented. For each estimate, the equation would be $\mathbf{Y_t} = \boldsymbol{A_1 Y_{t-1}} + \cdots + \boldsymbol{A_p Y_{t-p}} + \boldsymbol{U_t}$. In this equation, $\mathbf{Y_t}$ is the endogenous vector, $\mathbf{X_t}$ is the exogenous vector, p is the number of lags, $\mathbf{A_1}, \boldsymbol{A_2} \ldots \boldsymbol{A_p}$ are the other factors used in this research, and $\mathbf{U_t}$is the error term for the equation (Zheng and He, 2010). Using the VAR model for each factor, the impulse response and variance decomposition analyses are performed.

4.1 Impulse Response Analysis

The following is the result of the impulse response analysis using a lag order of two years for each factor.

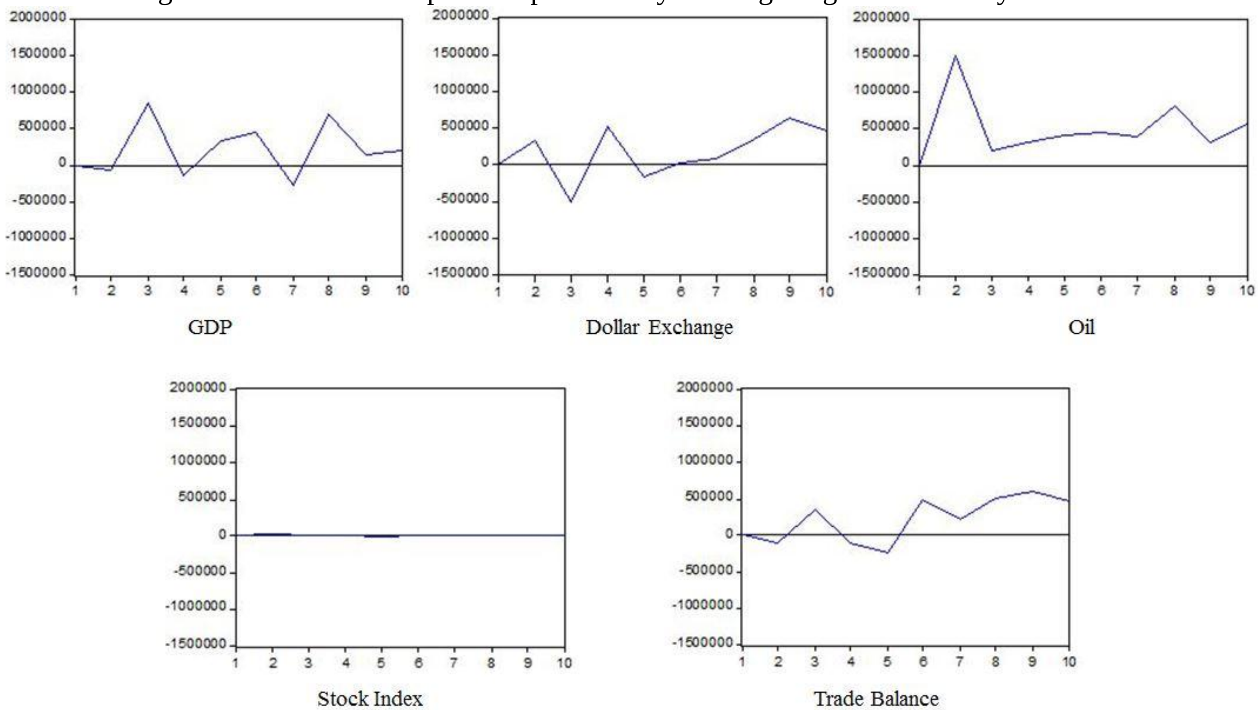

Figure 1: Impulse response analysis of the factors

The impulse response of the GDP with respect to the contract volume fluctuates throughout the time series. Although there are some strong fluctuations, most of the results are shown to be positive. Except for years 2, 4 and 7, as the volume of international construction contracts increases, the GDP presents a positive shock to the contract volume. To explain this trend, the data of the GDP and the contract volume are compared where, in year 3, the impulse response showed a positive result. However, the data showed that the GDP decreased as the international construction contract volume increased. Therefore, the effect of the GDP on the contract volume is shown to be negative.

Concerning the dollar exchange result, there appears to be some fluctuation during both positive and negative shocks throughout the years of the analysis. The lowest point is shown to occur during the third year, indicating that the dollar exchange factor presents the largest negative shock on the contract volume. The reason for this negativity is the sudden change of the exchange rate in our data. On the other hand, year 9 shows the strongest positive shock, indicating that as the dollar exchange rate increases, the volume of contracts increases as well.

Next is the result of the oil price. The result shows that the oil price presents a positive shock throughout the entire time series, with the strongest shock during year 2. This can be explained by the fact that as the oil price increases, the contract volume increases tremendously during year 2. After year 3, the shock of oil price becomes stable, but a positive shock is maintained throughout. Compared with our data, the peak in our result is caused by the price increase in the early 1990s and during 2008. As the price increased, the contract volume increased as well, proving the positive relationship between the two factors. The oil price factor is shown to differ from the other factors that it maintains its positive result.

Next is the impulse response result of the stock index. This result shows that there are neither positive nor negative shocks to the contract volume, signifying that while stocks change over the time series, these changes do not have an effect on the contract volume.

The impulse response of the trade balance is examined next. The level of shock throughout the time series is stable, where the majority of the shock moves in a positive direction. Apart from years 2, 3 and 5, the trade balance increases as the contract volume increases as well.

4.2 Variance Decomposition Analysis

The following table shows the results of the variance decomposition analysis.

Table 5: Variance Decomposition Analysis Results

Period	GDP	Dollar Exchange	Oil Price	Stock Index	Trade Balance
1	0.0242	1.7054	41.0672	0.0166	1.0574
2	0.0867	2.0759	39.0642	0.0158	0.2034
3	10.0177	4.9093	30.6441	0.0126	1.8453
4	9.8220	7.9934	30.2838	0.0150	1.9073
5	10.8072	7.9034	30.8605	0.0157	2.4787
6	12.2527	7.3027	30.8053	0.0158	5.0257
7	12.4757	7.0605	31.1474	0.0152	5.3484
8	13.9817	6.6420	30.1410	0.0119	6.4636
9	12.1524	8.6570	26.6011	0.0102	8.2723
10	10.7586	8.8566	24.9877	0.0089	8.5096
11	11.1920	8.7522	22.0157	0.0075	10.9357
12	9.6416	10.7164	19.0343	0.0064	11.3890
13	8.4289	11.9630	16.2150	0.0057	10.9941
14	7.4128	13.0256	14.1994	0.0050	11.6550
15	6.9298	13.7302	13.2090	0.0046	11.5241
16	6.4824	14.2212	12.8881	0.0043	11.3458
17	6.6074	14.6048	14.3487	0.0041	10.7783
18	7.1872	14.2538	16.4387	0.0041	10.4307
19	7.7005	13.5051	19.3833	0.0039	10.1910
20	8.9457	12.3074	22.1088	0.0035	10.4352

As the table above shows, the variance decomposition analysis of each factor depicts where the percentages change among the factors. Out of the five factors used in this research, the oil price resulted in the highest correlation, followed by the dollar exchange and the GDP. The percentage of the oil price started off with a high level of explanatory power (Bilson *et al.*, 2001), remaining at 20 percent throughout the series.

Supported by the impulse response result, the variance decomposition analysis also showed that the oil price had the strongest effect on the contract volume of the international construction market. With the impulse response being positive and the correlation between the two factors being higher than other factors, this allows the conclusion that out of the five macroeconomic factors used in this research, the oil price affected the Korean international construction contract volume most.

5. Conclusion

In conclusion, by empirically analyzing the macroeconomic factors used in this research, each macroeconomic factor was found to affect the contract volume of the international construction market generally. Among the five macroeconomic factors assessed here, oil prices had the strongest effect on the independent variable. On the other hand, stock prices had the weakest effect. As the analysis showed, oil prices always had a positive result, showing that regardless of whether the oil prices changed during the time series, the contract volume of the international construction did not decrease. This can be explained as follows: because the portion of international construction by Korean firms greatly expanded to include projects in Middle Eastern countries, the fluctuation in the oil price did not affect the volume of international contracts. Nevertheless, construction market is closely related to different external factors that change the industry as a whole. Therefore considering these factors are crucial in determining the success of a construction market.

With the methodology employed in this research, construction market participants can observe for the first time the overall trend related to each macroeconomic factor through panel data. Then, with the different analysis techniques mentioned above, the analyzed input factors (macroeconomic factors) are processed and are returned as output that shows the correlation with the independent variable (the contract volume). The result presents a broad picture of how the macro-economy and the construction market are related to each other. Also, through this research, Korean construction firms can prioritize which macroeconomic factors are likely to affect the construction industry market. Furthermore, the results of the impulse response analysis can be used as a reference when forecasting the future of the construction market with respect to macroeconomic factors, especially when determining whether fluctuations in each factor will decrease or increase the contract volume in the near future.

6. Acknowledgement

This research was supported by the Korea Science and Engineering Foundation, funded by the Ministry of Education, Science and Technology (2009-0081326).

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