U.S Economic Indicators and Stock Prices of Construction Equipment Manufacturers: A Statistical Relationship Analysis

Herbert BARBER\textsuperscript{1} and Islam EL-ADAWAY\textsuperscript{2}

\begin{itemize}
  \item \textsuperscript{1} Chief Executive Officer: Xicon Infrastructure, Post Office Box 556, Statesboro, Georgia 30459; e-mail: hbarber@xiconinc.com
  \item \textsuperscript{2} Richard A. Rula Endowed Professor of Construction Engineering and Management, Assistant Professor of Civil and Environmental Engineering, Mississippi State University, 501 Hardy Road, 235C Walker Hall, P.O Box 9546, Mississippi State, MS 39762; e-mail: eladaway@cee.msstate.edu.
\end{itemize}

ABSTRACT

This paper investigates the relationships and interrelationships associated with the commonly accepted U.S. economic indicators and stock prices of major construction equipment manufacturers. The authors developed a three-step research methodology that comprised data collection, hypotheses development, and statistical analysis. Various U.S. economic indicators, i.e. Real Gross Domestic Product, Inflation Rate, Turner Construction Cost Index, price of Gold, and price of Crude Oil, were analyzed relative to the stock prices of U.S. construction equipment manufacturers, i.e. Caterpillar, Deere & Company, and Manitowoc. In general, relationships among the three construction equipment companies did not consistently parallel one another with respect to the various economic indicators. Perhaps one of the most telling findings was that no significant relationships were found between the stock prices of Caterpillar or Manitowoc and GDP or Construction Cost Index. However, there were significant relationships between the stock prices of Deere & Company, GDP, and the Construction Cost index. Equally as telling, Caterpillar stock price did not correlate with the U.S. unemployment rate. Also, it became obvious that the stock price of Caterpillar was clearly different than that of Deere & Company and Manitowoc. In addition, through close inspection of the nearly perfect correlation between GDP and the Construction Cost Index, it appears that the 2007 collapse of the U.S. construction industry, and consequently the U.S. economy, could have been predicted through a casual investigation of construction material and labor costs. This research opens horizons for abandoning the notion of studying the construction industry solely using residential construction, i.e. housing market, realizing that the construction sector involves other significant decision making variables.

INTRODUCTION

Construction economists regularly analyze variables associated with the economy as a mean of determining relationships among various variables and forecasting other variables. It is also common to use respective industry’s data as a mean of determining relationships and forecasting various dependent variables. To this end, using the construction industry, economists have traditionally measured variables as a means of forecasting the success of the overall economy of the United States. For example, in the United States, economists often use the volume of residential construction, i.e. housing market, as a means of forecasting the economic
growth of the nation, while neglecting other areas of the construction industry altogether. Some authors have suggested that housing is in fact “a proxy for other consumption or wealth indicators” (Ghent and Owyang 2010). Others argue that economists underestimate real estate markets altogether when it comes to its relationship to economic growth. Nonetheless, most economists still consider the housing sector in general as the single most preferred predictor of gross domestic product (GDP) in the United States (Leamer 2007). To this end, In a review of the U.S. Federal Reserve’s (FED) work regarding monetary policy decisions that are based on econometric forecasts of GDP, unemployment, and other indices, it was determined that the FED often makes systematic errors in their analyses, and that these errors often inadvertently skew policy decisions. Thus, economic growth was both overstated and understated in various models (Sinclair et al. 2010).

The housing market has been credited as the most credible predictor of economic recovery since the 2007 economic collapse in the U.S., particularly when considering wealth of the nation. In fact, the volume of building permits issued has been used as a predictor of economic recovery over the last several recessions (Strauss 2013). However, some researchers have begun questioning such strong reliance on the housing market due to the recent world economic collapse (Diewert et al. 2009), giving way for other indicators to be considered when estimating economic output.

PURPOSE

The purpose of this study is to investigate the relationships and interrelationships associated with most commonly accepted U.S. economic indicators and stock prices of major construction equipment manufacturers. To this end, this study explored the possibility of using the historical stock prices of U.S. construction equipment manufacturers as a means of estimating economic well-being of the United States. Findings in this study open opportunities for abandoning the notion of studying the construction industry solely using residential construction (i.e. housing market); realizing rather that the construction sector involves other significant decision making variables.

BACKGROUND INFORMATION

The engineering and construction industry plays an important role in the economy of most countries (Fan, Ng, & Wong, 2010). From a holistic perspective, the U.S. construction industry is divided into building construction and infrastructure construction (Yitmen, Akiner, & Mara, 2012). The United States Bureau of Labor Statistics (2012) broadly divides the construction industry into three areas, including 1) building construction, heavy and civil engineering construction, and specialty trade construction. When considering these three sectors collectively, U.S. construction industry spending consisted of USD778 billion in 2011 (US Department of Commerce, 2012).

The construction research literature is noticeably void of studies that address the construction industry at large as it relates to descriptive economic-related data within the construction industry. However, the research literature provides numerous studies that investigate the relationships between construction spending and economic
output. In fact, since the 2007 world economic collapse, a host of scholars from multiple professional and academic disciplines has begun investigating the various links between the construction industry and economic output, at least at the macroeconomic level (Lopes, Nunes, & Balsa, 2011). For example, Green (1997) analyzed the impact residential construction spending has on GDP versus the impact that non-residential spending has on GDP. Green concluded that residential construction spending did affect GDP but that non-residential construction spending did not affect GDP. Anaman (2003) also studied the relationship between the construction industry and macroeconomics. Anaman’s 2003 study investigated time series data on GDP and concluded that an increase in GDP in the previous year led to an increase in construction value in the current year.

As such, the debate as to whether the relationship between construction investment and economic output is unidirectional, bidirectional, or no relationship exists whatsoever, continues. This research is an attempt to address these ambiguities.

METHODOLOGY
First, the authors collected data for both the U.S economic indicators and U.S. stock prices of construction equipment manufacturers. For the economic indicators, the dataset covered the period between 1970 and 2010 in relation to: (1) Real Gross Domestic Product (U.S. Bureau of Economic Analysis, 2011); (2) Inflation Rate (U.S. Inflation Rates 2011); (3) Construction Cost Index (Turner Construction 2011); (4) price of Gold (National Mining Association 2011); and (5) price of Crude Oil (Historical Oil Prices 2012). For the stock prices, the construction equipment manufacturers in this study included Caterpillar, Deere & Company, and Manitowoc due to their widely established name recognition within the U.S. construction industry as well as their readily available data. Caterpillar is a long-standing equipment manufacturer in the United States, having been established over 85 years ago. Caterpillar’s equipment has served to improve construction efficiencies from the construction of the Golden Gate Bridge, to the Pennsylvania Turnpike, to the current expansion of the Panama Canal, and to countless other construction projects, both nationally and internationally. The company owns numerous brands and manufactures several types of equipment used in the construction industry, some of which includes loaders, scrapers, compactors, excavators, and trucks (Caterpillar 2012). A close competitor of Caterpillar is Deere & Company that was founded in 1837 by John Deere as a means of helping farmers plow their fields. Through its 173 years of operation, Deere & Company manufactures construction equipment, as well as other types of similarly related equipment such as bulldozers, loaders, graders, scrapers, and tractors (Deere & Company 2012). Manitowoc was founded in 1902 and is currently operating in over 20 countries. Manitowoc is recognized throughout the world as one of the world’s largest manufacturers of construction cranes and similar equipment (Manitowoc, 2012).

Second, the authors developed the following two null hypotheses and from each hypothesis, several relationships were investigated: 1) There will be no significant relationship between the stock prices of U.S. construction equipment manufacturers and U.S. economic indicators, and 2) There will be no significant
relationship between the stock prices of U.S. construction equipment manufacturers and the Turner Construction Cost Index.

To gain deeper understanding of the collected dataset, and in addition to studying the relationships between economic indicators and the stock prices of construction equipment manufacturers, the authors investigated the interrelationships between the economic indicators themselves on one hand and the stock prices of the construction equipment manufacturers on the other hand.

Third, the authors calculated the bivariate correlations using the Pearson product moment method to test for statistical significance of relationships. In accordance with Davis (1971), the Pearson equation is noted below where the correlation relationships were characterized as 0.70 or higher (very strong association), 0.50 to 0.69 (substantial association), 0.30 to 0.49 (moderate association), 0.20 to 0.29 (low association), and 0.01 to .019 (negligible association).

$$
\rho_{xy} = \frac{\sum_{i=0}^{N-1} (x_i - \bar{x}) \cdot (y_i - \bar{y})}{\sqrt{\sum_{i=0}^{N-1} (x_i - \bar{x})^2 \cdot \sum_{i=0}^{N-1} (y_i - \bar{y})^2}}
$$

RESULTS AND ANALYSIS

Hypothesis 1

The relationships between stock prices of U.S. construction equipment manufacturers and U.S. economic indicators were investigated as they related to the first hypothesis. The authors initially investigated the relationship between stock prices of construction equipment manufacturers and the U.S. Gross Domestic Product (GDP\textsubscript{Real}). Correlation coefficients were calculated between GDP and the stock prices of Caterpillar, Deere & Company, and Manitowoc.

No significant relationship was found between GDP and the price of stock of Caterpillar. The relationship was considered to have a moderate association using Davis’ scale ($r=.301$, $p=.056$). However, given a p-value of .056, the relationship could be considered significant at the 0.1 level, should the authors have established the .1 alpha level as significant. Likewise, there was no significant relationship found between GDP and the stock price of Manitowoc ($r=.297$, $p=.192$), with a low association. However, the relationship between GDP and the stock price of Deere & Company was found to be statistically significant and have a very strong association ($r=.745$, $p<.01$).

The relationships between the U.S. inflation rate and the stock prices of Caterpillar, Deere & Company, and Manitowoc were also investigated. However, no significant relationships were found to exist. All associations were found to be negligible. A slightly inverse relationship was found between the inflation rate and the price of Caterpillar stock, though the relationship was negligible.

The authors also calculated the relationships between the U.S. unemployment rate and the stock prices of Caterpillar, Deere & Company, and Manitowoc. Two the three relationships were found to be statistically significant. The relationship between Deere & Company and the unemployment rate was found to be inverse and
significant at the .05 level ($r=-.380$, moderate association). Likewise, the authors found the relationship between the stock price of Manitowoc and the unemployment rate to be inversely related and significant ($r=-.706$, $p<.01$, very strong association). However, no significant relationship was found between the stock price of Caterpillar and inflation rate, and its association was considered negligible.

The price of gold was also used as an economic indicator in this study. Thus, the relationships between the price of gold and the stock price of Caterpillar, Deere & Company, and Manitowoc were investigated. Again, the stock price of Deere & Company and an economic indicator, i.e. gold, correlated significantly at the .05 level. The association was considered moderate, and the correlation coefficient was calculated to be .407 ($p=.209$). However, no significant relationships were found between the stock price of Caterpillar and the price of gold, or the stock price of Manitowoc and the price of gold. Their respective associations were considered negligible ($r=.189$, $p=.237$) and low ($r=-.238$, $r=.299$).

The relationships between the price of crude oil and the stock price of Caterpillar, Deere & Company, and Manitowoc were also determined. The authors again found a significant relationship between the price of crude oil and the stock price of Deere & Company. The relationship was determined significant at the .01 level ($p=.002$), and the association was considered to be substantial ($r=.551$). However, no significant relationship was found between the price of crude oil and the stock price of Caterpillar ($r=.206$, $p=.196$), and its association was considered low. Likewise, no significant relationship was found between the price of crude oil and the stock price of Manitowoc ($r=.113$, $p=.625$), and no association existed.

**Hypothesis 2**

It was further hypothesized that there would be no significant relationship between the stock prices of U.S. construction equipment manufacturers and the Turner Construction Cost Index. To investigate this hypothesis, relationships between the Turner Construction Cost Index and stock prices of Caterpillar, Deere & Company, and Manitowoc were calculated. Surprisingly, only one statistically significant relationship was found. The stock price of Deere & Company correlated positively with the Turner Construction Index ($r=.732$, $p<.01$) and had a very strong association. Conversely, no significant relationship was found between the Turner Construction Index and the stock price of Caterpillar ($r=.259$, $p=.102$) or Manitowoc ($r=-.218$, $p=.344$); both had low associations.

**Interrelationships between economic indicators**

The authors calculated the interrelationships between the economic indicators. The Turner Construction Cost Index (ConIdx) correlated significantly with the U.S. inflation rate ($r=-.618$, $p<.01$), the price of crude oil ($r=.780$, $p<.01$), and the price of gold ($r=.752$, $p<.01$). Interestingly, inflation, oil, and gold all correlated at the .01 alpha level, with inflation correlating negatively with the construction index as would be expected. Perhaps ironically, or against so-called “conventional wisdom” promoted by gold distributors, the price of gold did not significantly correlate with inflation, though the relationship was inverse ($r=-.272$, $p=.085$, low association). However, the price of gold did significantly correlate with unemployment ($r=.336,$
p=.032, moderate association), as well as the price of crude oil (r=.864, p<.01, very strong association).

GDP correlated significantly with every economic indicator except the unemployment rate (r=-.228, p=.152), though as expected, GDP increased as unemployment decreased. The relationship between GDP and the price of crude oil was found to be significant at the .01 level (r=.729), and the relationship between GDP and the price of gold was also found to be significant at the .01 level (r=.679). Likewise, the relationship between GDP and the inflation rate inversely correlated significantly (r =-.626, p< .01). The relationship between GDP and the Turnier Construction Index (ConIndex) correlated almost perfectly (r=.989, p<.01). Given the relatively recent collapse of the U.S. housing market, the construction industry at large, and the U.S. economy, the authors reviewed this relationship more closely. As such, the authors plotted GDP and the construction index and calculated explained variances for each, simply as a means of reviewing the regression of the data.

Through Figures 1 and 2, shown afterwards, it appears that the U.S. economy began moving outside what would be statistically expected. Around 2002, as the construction index (consisting of U.S. material and labor prices) and, subsequently, GDP began increasing rapidly. Given such high explained variances (R²_GDP=.9735 and R²_CONINDEX=.9686), it leaves the authors to suggest that the recent collapse of the U.S. construction industry, and consequently the U.S. economy, could have easily been predicted before it actually occurred. To this end, consequent by the authors omitting 2008-2012 data for both GDP and the construction index, strong explained variances were revealed. Accordingly, GDP and the construction index were modeled using the following:

\[
Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \epsilon
\]

Modeling of GDP for years 1970-2012 yielded the following equation: \(Y=337.32X_1-.682.17\). Modeling of the construction index over the same years yielded: \(Y=17.52X_1+80.12\). These data are depicted graphically in Figure 1 below.

Likewise, a closer inspection of the Turner Construction Cost Index revealed the collapse of the U.S. economy, clearly depicting the economic collapse beginning between 2002 and 2003. Additionally, using a one-way analysis of variance (ANOVA) on the construction index for the years leading up to the actual 2007 collapse, 1970-2007, the authors found the effect of construction materials and labor on GDP to be significant at the .01 alpha level (F(1,36)=1591.851, p<.01, R²=.978).

While explained variances for GDP data are slightly stronger, as would be expected, it should be noted that the construction index is not only reflective of the housing sector, but the U.S. construction industry at large, suggesting that other indicators associated with the construction industry may better serve as indicators of future economic growth in the U.S. rather than the housing market.
For further substantiation, the authors present Figure 2 below depicting new single-family housing starts from 1974-2012 and the associated volatility of the housing market (M=725.90, SD=245.16).

**interrelationships between Construction Equipment Manufacturers**

The authors calculated the interrelationships between the construction equipment manufacturers. To this end, there was a significant relationship between the stock price of Deere & Company and the stock price of Manitowoc (r=.622, p<.01), and the association was considered to be substantial. There was also a significant relationship between Deere & Company and Caterpillar (r=.680, p<.01); its association was considered to very strong. However, no significant relationship
was found between Caterpillar and Manitowoc \((r=0.364, p=0.105)\), though its association was considered to be moderate. It is apparent that the stock price of Deere & Company was unique when compared to the stock prices of Caterpillar and Manitowoc. This is despite the fact that the relationship between the stock prices of Deere & Company and Caterpillar were significant. For example, there was a significant relationship between the stock price of Deere & Company and GDP, price of oil, gold, and construction cost index, while no significant relationships were found between these economic indicators and the stock prices of Caterpillar and Manitowoc. Additionally, the stock prices of Deere & Company and Manitowoc both correlated significantly with the U.S. unemployment rate, with both relationships being inverse, but again, no significant inverse relationship was found between the stock price of Caterpillar and the unemployment rate.

The authors reviewed the relationships of the stock prices of the construction equipment manufacturers in this study as shown below in Figure 3 and determined that significantly more work was necessary to understand the stock prices of these manufacturers, particularly the stock price of Caterpillar. Consequently, it was concluded that the price of Caterpillar stock is more volatile than that of Deere & Company and Manitowoc, especially for years 1995-2010.

![Figure 3. Stock Prices for Caterpillar, Deere & Co, and Manitowoc: 1970 - 2010](image)

**CONCLUSION**

This paper studied the relationships and interrelationships associated with most commonly accepted U.S. economic indicators as well as stock prices of major construction equipment manufacturers. Bivariate correlations were calculated using the Pearson product moment method to test the relationships for statistical significance.

In general, relationships among the three construction equipment companies did not consistently parallel one another with respect to the various economic...
indicators. For example, the stock price of Caterpillar rarely significantly correlated with the stock price of Deere & Company, and the stock price of Manitowoc significantly correlated only occasionally, regardless of the variables investigated. Perhaps one of the most telling findings was that no significant relationships were found between the stock prices of Caterpillar and Manitowoc and GDP. In addition, no significant relationships were found between the stock prices of Caterpillar, Manitowoc, and the construction cost index. However, there were significant relationships between the stock prices of Deere & Company, GDP, and the construction cost index. Equally as telling, Caterpillar stock price did not correlate with the U.S. unemployment rate; that relationship should have been inverse.

With no doubt, one would have expected there to be significant correlations among these relationships. Subsequently, there almost certainly exist reasons why stock prices of Caterpillar, in particular, seemed to perform with an indifference to the noted economic indicators. This finding alone leaves significant room for pondering among researchers, for while some room for discrepancies should be allowed for because Deere & Company and Manitowoc manufacture a few types of equipment not necessarily associated with the construction industry, one would think this fact would only bias a few of the findings herein, if any.

Several significant relationships were found between the variables of this study. However, as with most studies, additional relevant information was captured that was not necessarily a component of this research. To this end, it became obvious that the stock price of Caterpillar was clearly different than that of Deere & Company and Manitowoc. In general, the stock price of Caterpillar did not yield results similar to what the authors expected even when comparing it to the tangential data collected. In fact, many of the findings associated with Caterpillar simply left the authors wondering what differences were inherit within the stock price of Caterpillar that were not inherit in the stock prices of the other construction equipment manufacturers, especially Deere & Company.

Perhaps more importantly than the findings associated with Caterpillar, another finding of this study that was tangential to the actual purpose of the study involved a close inspection of GDP and the construction cost index. That relationship was nearly perfect (r=.989, p<.01). Subsequently, it appears that economists and researchers could have easily predicted the collapse of the U.S. construction industry, as well as the collapse of the U.S. economy, simply through a casual investigation of construction material and labor costs, i.e. construction cost index.

REFERENCES


