

# Risk and Diversification in International Construction

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# **Risk and Diversification in International Construction**

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## **ABSTRACT**

Market diversification is considered as a method to reduce risks regarding to the portfolio and projects. The diversification strategy of firms might affect revenue and market new entries of the companies. Unfortunately, there are few empirical findings regarding diversification of international construction companies. The current study performs an empirical analysis on diversification of international contractors and design firms. The study identifies (1) the pattern of contractors classified into business types, (2) the relationship between diversification level and size of the company, and (3) market entry strategy of US firms. The empirical study findings may be a start to investigation of diversification strategies of construction companies.

## **KEYWORDS**

Market Diversification, Risk Management, International Market, ENR Top 225 International Contractors, ENR Top 200 International Design Firms

## **INTRODUCTION**

There is also an implied understanding that risk is something that can be identified. In reality it seems that risk is not only identifiable and worth managing, but well managed risk can save millions of dollars on a company's balance sheet. Given that fact, companies world-wide put a great deal of effort into identifying, analyzing, preparing for and defending against the adverse effects of risk.

One tried and true method for countering risk associated with market volatility is diversification. Diversification in finance and investment circles is defined as a risk management technique that mixes a wide variety of investments within a portfolio. Diversifying will, on average, yield higher returns and pose a lower risk than any individual investment found within the portfolio.

It is also believed that diversification plays the same sheltering role in a corporate setting. Given this impression, it is understandable why even construction companies might pursue strategies of diversification to protect them in times when a particular construction sector suffers in losses that exceed the rest of the construction market. One problem with this supposition is that investment options vary widely from real-estate and commodities to municipal bonds and domestic or international stocks. For a company in the construction business the business options are much less diverse. The current study discusses construction contractors' market diversification (for different sectors for different types of jobs) and analyzes diversification pattern and firm performance, focusing on international risk.

In many industries, larger firms are usually more diversified than smaller firms. So, market diversification is considered as one of the corporate strategies for risk management depending on the firm size and other situations. However, the current body of knowledge does not provide useful answers to the following question regarding to international construction companies: What are international contractors' purposes in diversification? How much are contractors diversified? What combinations of different business sectors do they diversify into? This research is trying to answer some of these questions. The current study investigates the diversification pattern and associates performance of the largest international construction firms, using 6 years' actual industry data published in Engineering News Record (ENR) top 225 international contractors (The ENR Top 225 International Contractors, 2005-2010). Also, another longitudinal study has been developed using 10 years' actual industry data published in ENR top 200 international design firms (2002~2011). Since the contractors and design firms can be considered as successful firms, their current market position and diversification history are useful information to other international construction firms.

The objective of this study is to provide empirical findings on international construction firms' market diversification. The objective is achieved by identifying: (1) the overall and detailed patterns of the contractors classified by business type; (2) relationship between degree of diversification and firm size; and (3) business sector selection strategy of US contractors.

### **PROBLEM DEFINITION**

The construction market was ballooning around the U.S. companies at an astonishing rate and they were being left behind. How would management leadership and board rooms of these U.S. Contractors respond? With this question came the primary topic of study.

In a sagging U.S. economy, would American contractors seek to mitigate domestic market risk through increased or more varied participation in the international construction market?

1. Is sector diversification among top construction firms correlated with increased international revenue?
2. Are certain international construction sectors more likely to increase revenue than other sectors?
3. Does change in diversification level have any correlation with the international revenue?

These seemed logical questions since an effective tool for protecting against risk is diversification. With these questions in hand and a hefty data set to sort through the study has begun with the analysis of a similar scholarly work on diversification in construction titled "Diversification by the Largest U.S. Contractors" (Jin Kim & Reinschmidt, 2010) . This paper asked very similar questions about diversification within the domestic construction market and provided a jumping off point for the analysis in this research. One particular area of interest was how to quantify diversity in a way that is fair and statistically relevant. The second primary reference was the source data – The Engineering News Records "The Top 225 International Contractors". This source provided all of the revenue values and market participation numbers that were needed to attempt to answer research questions and analyze the findings.

### **TECHNICAL APPROACH**

To facilitate meaningful analysis of the research problem a sound technical approach was needed. Data for the research was obtained from a credible and reliable resource. Engineering News Record (ENR) publishes annual surveys and rankings of top construction and design firms across various construction related industries and sectors. Since this research focused on U.S. firms working abroad, it utilized the ENR Top 225 International Construction Contractors and the ENR Top 200 International Design Firms series of publications (The ENR Top 200 Design Firms, 2001-2011). Data from these publications were drawn from six to ten years of historic data so the reported revenues were normalized utilizing a net present value (NPV) approach based on available inflation data over the same timeframe.

The revenue listed in the international construction publications is the construction revenue each company earned outside of their home country for that year. The data presented in the ENR publications listed the percent of a company's revenue that was divided amongst various construction sectors that it tracked. As the research was to investigate the diversification of U.S. contractors working internationally, a structured approach to assign a diversification rating was needed so their data could be compared to that of their peers in the ranking. Three such approaches will be discussed that were utilized in the research solution methodology.

Once all of the data was normalized, whether by calculating NPV of international revenue or the diversification number based on revenue allocation amongst construction sectors, regression analysis and correlation analysis to graphically view and analyze the data was utilized. The initial attempts at regression analysis and trendlines did not present all of the information that were hoped to glean, but did provide enough to make some important conclusions and bring the inspiration to find a new way to view the data. Viewing the revenue of contractors in a certain diversification range on the same graph as the number of contractors in each diversification range provided the needed view of the data to draw the most appropriate final conclusions about the relationship between revenue and sector diversification for U.S. contractors in the international market.

The final piece of data analysis that will be presented focuses in on determining if there is a statistical correlation between each particular construction sector a company works in and the size of a company's international revenue. To calculate these correlation values, all of the data points from each year analyzed were

compiled and a Microsoft Excel correlation function was utilized to determine the correlation value between all of the percentages in each construction sector and all of the revenue data points. A chart showing the correlation values between international revenue and each construction sector will be presented and discussed in the results section of this report.

## SOLUTION METHODOLOGY

### Diversification Measurement

For each of the ENR top 225 International Contractors and ENR top 200 Design Firms, the individual company's diversification level is measured. In the literature, different measures of firm diversification have been used. The current study uses an entropy measure developed previously (Jacquemin & Berry, 1979) in the literature. Also, two alternative measures named Departure from Max (DFM) diversity value and Divergence from Average (DFA) diversity value is developed by the research group and the results from these three measures are compared.

Entropy measure: This measure is shown in the Equation 1.

#### Equation 1- Entropy Number

$$Entropy = \sum_{i=1}^N P_i \ln\left(\frac{1}{P_i}\right)$$

$P_i$  = revenue share of the  $i^{\text{th}}$  construction market segment

$N$  = the number of market segments (sectors). (Jin Kim & Reinschmidt, 2010)

### Departure from Max (DFM) Value

There are nine different sectors in ENR list: general building, manufacturing, power, transportation, water supply, sewer waste, hazardous waste, industrial/petroleum, and telecommunication. One more group is added to this list called other. The "other" section was added to rectify the fact that the numbers in the ENR sectors did not always add up to 100 percent. It is assumed that these companies generate some part of their revenue from a sector other than those sectors identified in the ENR list. The underlying concept of the DFM method is to assign the highest diversification number value to a company that is equally diversified in every section. So, each company with greater than 10% of their portfolio in a given sector will get the full credit (10) for that sector. Values less than 10% in each sector remain unchanged. All the values are summed and then divided by 10. DFM will have a value between 0 and 10.

### Divergence from Average (DFA) Value

In both the entropy measure and DFM value, the most diversified company is the one that generates equal amounts of revenue in each sector. However, the potential revenue that can be generated from each sector varies widely. For example, the total quantity and revenue of projects in the petroleum/industrial sector are higher than that of the hazardous waste sector. The DFA method is developed to consider the market share of each sector out of the entire market. In this method, instead of considering 10% as the full credit, as it was in DFM value, the average percentile of revenue of all ranked international companies is considered to be fully diversified.

### Control Variables

In order to analyze the correlation between the diversification level of companies and the success of those companies, success of those companies must be defined first. Then it is tried to control the variables that may adversely influence the analysis. The best indicator of the success of the company is the profit rather than the revenue; however, profit data was not an available for this study. In this paper, the total revenue is considered that companies generate as an indicator of their success in international business.

#### *Home Country Variable*

In order to control the home country factors only U.S. companies are considered in the analysis. A comparison between companies with different home countries can be done in future research.

## *Inflation*

In this analysis, a Net Present Value and everything is valued are established in 2010 dollars. The inflation rate considered in the analysis is 2.44% (Inflationdata.com, 2011).

## *Size of the company*

All of these companies are large companies; however, are categorized into three groups – large, medium, and small. In this analysis the authors tried to find correlation between a company's change in revenue from their average revenue ((Revenue of the company in each year - Average revenue of the company in all years that the company is in the ranking) / Average revenue of the company) with the diversification level of that company. By doing this analysis the influence of the size of the companies is controlled in the analysis.

## RESULTS

### Scatter Plots

To determine whether there is a trend in the data, all of the ranking list data from the top 225 construction contractors for years 2005 to 2010 are collected. For this analysis all the non-U.S. companies were removed. The data remaining (i.e. U.S. companies) consisted of 240 rows of values for 80 construction companies.

Each row of data consists of the following:

- Company name;
- International revenue;
- Total revenue;
- Percent of international revenue in each construction sectors.

Then the revenues were altered to their 2010 Net Present Value. This step normalized all revenue values to a 2010 scale. The average of international revenue for each company was calculated and then the difference of international revenue and average revenue for the company was calculated for each year.

Then a scatter plot for this calculated international revenue delta versus DFA diversification number for each company is plotted (Figure 1). As seen in the figure, no linear regression can be fitted to the data points. The trendline drawn has almost no slope (0.0019) and the  $R^2$  is also zero (7E-5).

It has been also tried to create the scatter plot for the change in international revenue versus the entropy number. This plot (Figure 2) also shows no linear regression fitted to the data points.

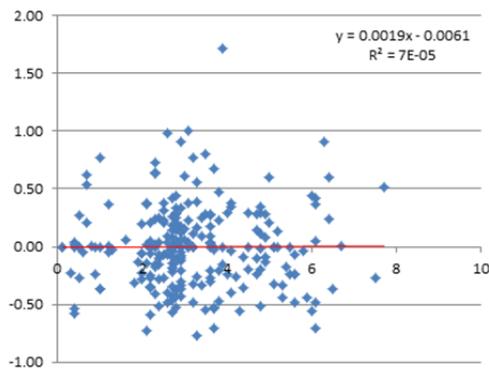


Figure 1- Int'l Revenue Delta vs. DFA Div. No.

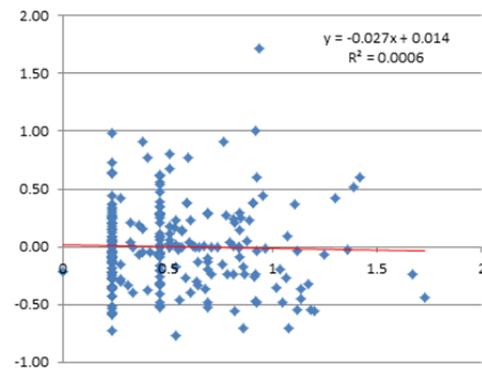


Figure 2- Int'l Revenue Delta vs. Entropy No.

After analyzing these results it was tried to see if a trendline could be drawn for U.S. design firms. To answer this question, all design firm data out of the top 200 design firms ranking for all years between 2001 and 2011 were gathered. This time 919 data points from 199 design firms were plotted. The same calculations were performed and Figure 3 and Figure 4 are plotted for diversification number and entropy number, respectively, based on this data.

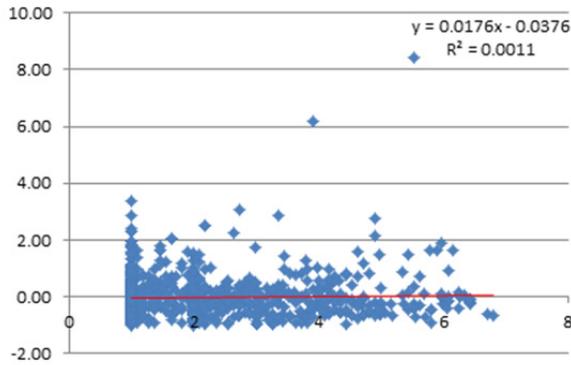


Figure 3- Int'l Revenue Delta vs. Div. No.

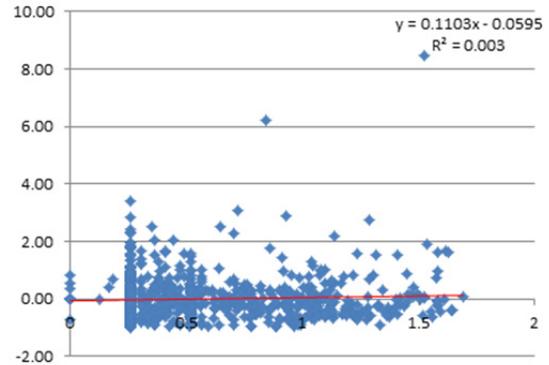


Figure 4- Int'l Revenue Delta vs. Entropy No.

### Bar Charts

To get more out of the data, the average international revenue for all the diversification numbers and the total number of companies in each diversification number were calculated. Figure 5 shows the average international revenues in red histogram bars and the quantity of companies are shown in blue dots. The same graph is plotted for entropy number in Figure 6.

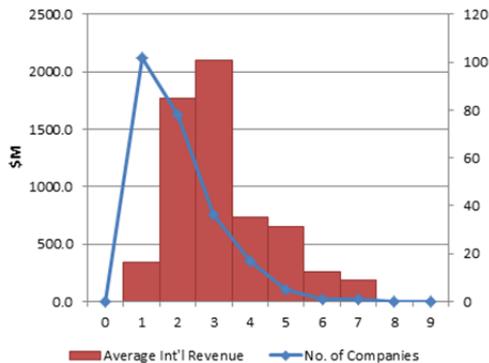


Figure 5- All U.S. Companies, Diversification No.

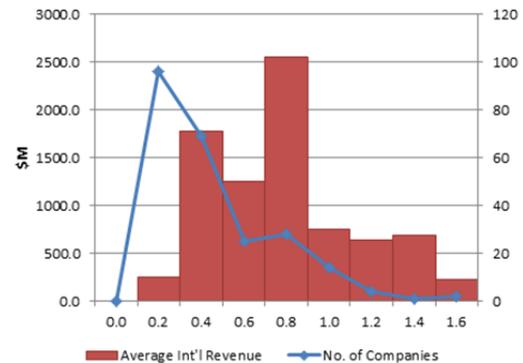


Figure 6- All U.S. Companies, Entropy No.

The above two figures show that:

- Most companies (90%) have a diversity number between 1 and 3, while the companies with the highest average international revenue have a diversity number between 2 and 4
- The entropy number for most of the companies (~80%) is between 0.2 and 0.6 while the companies with entropy number between 0.4 and 0.8 have highest average international revenue

Next, all the companies were divided into three groups. Small companies with international revenue below \$100M, medium-sized companies with international revenue between \$100M and \$500M and large companies with greater than \$500M in international revenue.

The small company group consists of 89 companies. The diversification number and entropy number bar charts are plotted in Figure 7 and Figure 8 respectively.

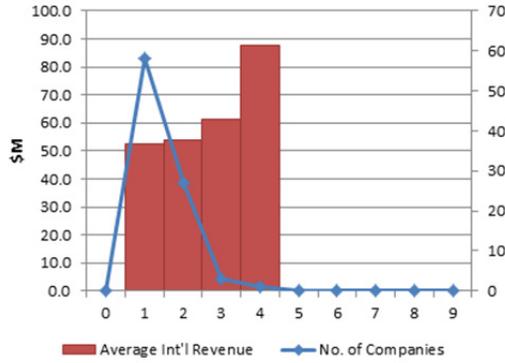


Figure 7- Small Companies, Diversification No

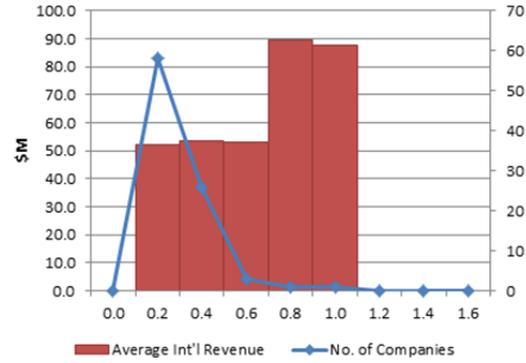


Figure 8- Small Companies, Entropy No.

The above two plots explain that:

- More than 95% of small companies have a diversity number between 1 and 2, while the average international revenue is increasing when the diversity number goes up from 1 to 4. This makes sense since almost all the small companies focus on one sector or at max 2, rather than performing in several sectors.
- 94% of the small companies have the entropy number between 0.2 and 0.4 while the companies with entropy number between 0.8 and 1 have highest average international revenue

The medium-sized group contains 92 companies. Figure 9 shows the diversification number bar chart for this group and Figure 10 is the entropy number bar chart.

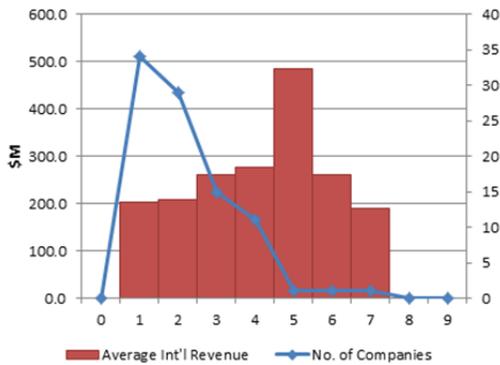


Figure 9- Medium Companies, Diversification No.

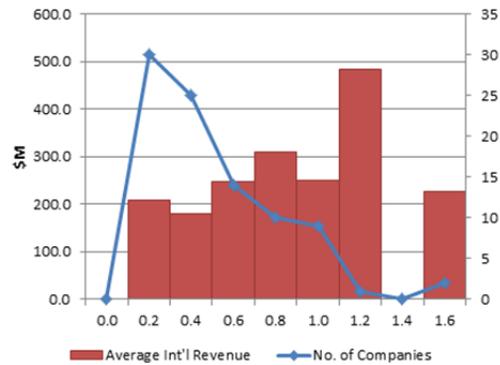


Figure 10- Medium Companies, Entropy No.

By looking at the graphs for medium-sized companies it is seen that:

- Almost 70% of all medium companies have a diversity number between 1 and 2, while the highest average international revenue is for those with diversity number around 5. In this group more companies have their diversity number from 3 to 4 in comparison to the small companies.
- The entropy number for the medium companies is mostly between 0.2 and 0.6 while the companies with entropy number around 1.2 have highest Average international revenue

The two bar charts for the large company group, which consists of 59 companies, are shown in Figure 11 for diversification number and Figure 12 for entropy number.

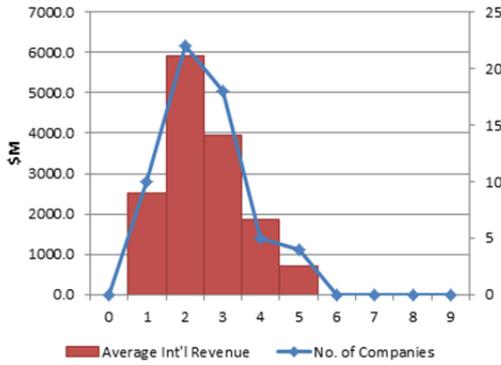


Figure 11- Big Companies, Diversification No.

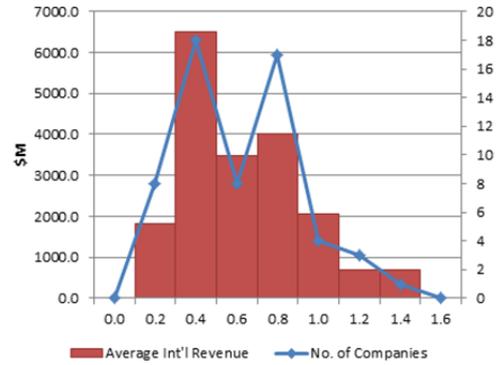


Figure 12- Big Companies, Entropy No.

These last two bar charts show that:

- Most of the big companies have diversity number between 2 and 3 while they are gaining the highest average international revenue with the exact same diversity number range.
- Among the large company group it seems that the companies with the greatest revenue share a diversity number value around 2.

This could show that the largest companies in the U.S. are diversified successfully in around two to three different sectors while showing the greatest average international revenue.

### Correlation

All of the data points of U.S. contractor international revenue were analyzed against each of the sector allocation percentages to determine a correlation value between revenue and each construction sector. Table 1 below shows the values for each year analyzed, for all U.S. companies over all years analyzed, and for all international companies over all years analyzed. Certain squares are highlighted according to the legend below the chart for ease of reviewing and determining trends.

	General Building	Manufacturing	Power	Water Supply	Sewer/Waste	Industrial/petroleum	Transportation	Hazardous Waste	Telecom	Other
2010	-0.13	-0.14	-0.17	-0.13	-0.16	0.36	0.03	-0.24	0.22	-0.13
2009	-0.25	-0.10	-0.20	-0.17	-0.16	0.37	0.03	-0.14	-0.14	0.05
2008	-0.24	-0.14	-0.07	-0.08	-0.10	0.30	0.06	-0.10	0.46	0.15
2007	-0.18	-0.09	-0.08	-0.08	-0.11	0.18	0.11	-0.04	0.10	0.20
2006	-0.10	-0.05	-0.01	-0.06	-0.05	0.13	-0.04	0.03	0.00	0.27
2005	-0.18	-0.07	0.00	-0.09	-0.08	0.09	0.07	-0.03	-0.05	0.42
US Comp /All Yrs	-0.12	-0.06	-0.05	-0.07	-0.09	0.14	0.07	-0.05	-0.02	0.14
All Comp /All Yrs	-0.04	-0.07	-0.06	-0.08	-0.05	0.06	0.06	-0.03	0.01	0.09

> 0.10	< -0.10
> 0.20	< -0.20

Table 1- Correlation Summary of U.S. Contractor Diversification and International Revenue

A quick review of the results shows that the correlations for the individual years range from +0.46 to -0.25. There are sectors such as general building and manufacturing that only produce negative correlations but only one sector that produces only positive correlation values – the industrial/ petroleum sector. The transportation sector does produce positively correlated values in all years but 2006. It is the only specific construction sector other than the industrial/petroleum sector that produces a positive correlation with international revenue for the six years studied.

None of this is to say that a U.S. contractor should stay out of sectors showing negative correlation values to avoid a negative impact to their international revenue. Table 1 just looks at trends in correlation values. There

are U.S. companies that have done well focusing their international attention in markets that are negatively correlated with large revenue. As seen in Table 2, Caddell Construction has dealt solely in the general building sector for international work from 2005 through 2008 when they were listed in the ENR Top 225 International Construction. They showed increasing international revenue from 2005 through 2007, even when there was negative correlation across all U.S. contractors on the list. However, Caddell Contractors did then see their revenue fall in 2008 and then drop off of the list altogether when the negative correlation peaked at -0.25. Table 2 also shows that Parsons was working largely in negatively correlated sectors in 2006 and 2007, but achieved their largest international revenue of the period studied. From 2008 to 2010 they have been more invested in the positively correlated sectors of industrial/petroleum and transportation and have grossed significantly less than in 2006 and 2007. They were, however, able to maintain positions on the list. One could speculate that with the downturn in the global economy that may not have been the case if they did not get into those sectors. This research unfortunately simply looks at the reported numbers and does not get into what causes any of the changes and the actual reasons why the contractors made the decisions that they did.

A comparison of the U.S. correlation results with that of the global market show that working in the industrial/petroleum sector is not as highly correlated with large international revenue for the rest of the world's contractors as it is for U.S. contractors.

ENR Rank	Construction Firm	Year	NPV Internation Revenue (\$ML)		Construction Sector Diversification (Percent of Total Revenue)											
			International Revenue NPV	Total Revenue NPV	General Building	Manufacturing	Power	Water Supply	Sewer/Waste	Industrial/petroleum	Transportation	Hazardous Waste	Telecom	Other	sum	
141	Caddell Construction	2005	92.57	267.64	100	0	0	0	0	0	0	0	0	0	0	100
121	Caddell Construction	2006	189.18	354.22	100	0	0	0	0	0	0	0	0	0	0	100
118	Caddell Construction	2007	215.95	397.21	100	0	0	0	0	0	0	0	0	0	0	100
174	Caddell Construction	2008	147.49	370.45	100	0	0	0	0	0	0	0	0	0	0	100
112	Parsons	2005	166.41	961.60	31	0	0	9	12	27	0	21	0	0	0	100
51	Parsons	2006	816.63	1503.98	58	0	0	12	8	0	0	21	0	1	0	100
87	Parsons	2007	414.61	1416.95	38	0	0	19	1	0	6	36	0	0	0	100
207	Parsons	2008	89.66	1323.97	6	0	0	0	0	10	32	52	0	0	0	100
208	Parsons	2009	131.70	1382.16	21	0	0	4	0	12	63	0	0	0	0	100
215	Parsons	2010	181.73	1144.87	5	0	0	0	0	11	84	0	0	0	0	100
77	Tutor Perini Corp.	2005	388.29	2128.66	25	0	74	0	0	0	1	0	0	0	0	100
110	Tutor Perini Corp.	2006	214.34	1955.00	54	0	45	0	0	0	1	0	0	0	0	100
135	Tutor Perini Corp.	2007	170.69	3351.04	87	0	13	0	0	0	0	0	0	0	0	100
177	Tutor Perini Corp.	2008	142.98	4975.10	98	0	0	0	0	0	2	0	0	0	0	100
175	Tutor Perini Corp.	2009	204.63	5939.58	96	0	3	0	0	0	1	0	0	0	0	100
218	Tutor Perini Corp.	2010	174.35	3273.47	72	0	0	0	12	0	16	0	0	0	0	100
152	Tutor-Saliba Corp.	2005	72.80	651.77	62	0	0	0	0	0	38	0	0	0	0	100
191	Tutor-Saliba Corp.	2006	53.02	699.42	72	0	0	0	0	0	28	0	0	0	0	100
180	Tutor-Saliba Corp.	2007	85.90	813.81	53	0	0	0	0	0	47	0	0	0	0	100
193	Tutor-Saliba Corp.	2008	107.50	1950.05	49	0	0	0	0	0	51	0	0	0	0	100

Table 2- Excerpt of All U.S. Contractor International Revenue and Sector Diversification

### CONCLUSION

This analysis of the data compiled in the ENR reports did reveal some good insight into the correlation between the various construction sectors and revenue, but not directly to the amount of risk present in the decision making. This correlation analysis, Table 1, showed that more of the high revenue contractors were invested more heavily in the positively correlated sectors of industrial/petroleum and transportation. This analysis pointed out the strongest sectors, but could not be used to conduct causal analysis of a contractor's rise or decline in annual international revenue.

It took a few attempts to obtain a graphical presentation to allow us to draw a useful final conclusion from the plots of international revenue and diversification number. The scatter graphs of change in revenue versus increasing diversity showed a trendline without any relevant slope. When viewing the trendline, there was no relevant increase or decrease in international revenue as the diversification level increased. Throughout all of the data points, it can be concluded that there is not data to support a hypothesis that merely increasing a company's diversification level will lead to increased international revenue. A decision to increase one's diversification level

needs to be well thought out. If a construction company is already diversified and is attempting to become more diversified, it likely has not found the formula for greatest success in the international market.

The bar graph/line graph combination plots showcasing average international revenue and the number of contractors per diversification range highlighted the most prominent finding. The analysis has showed that the highest revenue contractors are diversified, but only across a select number of sectors in the international market. These U.S. companies, especially the highest grossing of these top companies and the ones with the most proven staying power, do not lose sight of their areas of expertise when confronted with the thought or opportunity to further diversify.

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