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# Is the Construction Industry More Concentrated After the COVID-19 Pandemic? An Empirical Study on the U.S. Revenue Data from 2004 to 2021

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As a most important industry in the U.S., the construction industry faces multiple challenges since the COVID-19 pandemic. Backed by government interventions that have helped streamline construction projects, however, the aftermath of the pandemic is still vague. One of the imperative issues to be examined is the construction market concentration since the pandemic, especially how it is compared to the Great Recession. This study statistically analyzes the revenue gaps among the U.S. construction companies and the changes of their revenue rankings. This study uses the data from Engineering News-Record Top List of Contractors. The results show that unlike the Great Recession, which obviously enlarged the revenue gaps, there is no evidence yet demonstrating that the COVID-19 pandemic caused noteworthy disruptions to the revenue gap among construction companies. The government interventions, such as the Paycheck Protection Program and the Infrastructure Investment and Job Act, are regarded as effective stabilizers, until the cutoff of data collection at the beginning of 2022. The medians of ranking changes across years generally remain stable, including the period of pandemic. The study also indicates the necessity to include more longitudinal data and sectional data to explore long-term impacts and sector-wise conditions.

**Key Words:** COVID-19, Construction Industry, Market Concentration, Empirical Study

## Introduction

The toll of the COVID-19 pandemic affecting the global economy has been significant. The U.S. construction industry is no exception. It is shadowed by the general economic status of the nation, albeit being declared as an essential business during the stay-at-home orders. Many owners canceled their projects, causing delays in the completion of ongoing projects and increasing the construction cost (AIA Group 2020). Thanks to the continuous government interventions, such as the Paycheck Protection Program and the Covid-19 Relief Package, many construction projects that were halted due to the pandemic have been back on track (Karakaplan 2021). Nonetheless, many firms in the

construction industry continue to experience the after-effects of the pandemic, such as a shortage of construction materials and rising inflation, which lead to increased competition and decreased profits. Despite the optimistic view towards the construction industry by the chief economist of Associated Builders and Contractors (Obando 2022), the United States has practically entered a recession after two consecutive quarters of economic contraction, according to the data by the Bureau of Economic Analysis as of the second quarter of 2022 (BEA 2022).

Looking back at the Great Recession, firms in the construction industry diverged greatly in their responses to the recovery from the unprecedented crisis starting from December 2007 (Biörck et al. 2020). The construction firms in the bottom quintile were hit much more severely by the disruption. A quarter of those bottom-quintile firms failed to make a profit, while more than a quarter of the top-quintile firms made positive returns (Biörck et al. 2020). In the age of corporation inequality, a small percentage of top-earning companies earn significantly more profits than their competitors (Bloom 2017). Moreover, these top-earning companies are more and more likely to maintain their dominant positions, while other corporations are less and less likely to grow and become profitable (Govindarajan et al., 2019). Many businesses outside the top tier are vulnerable to changes in circumstances over which they have no control, such as an economic crisis or a pandemic. As a result, they exhibit relatively low resilience in terms of adaptability and flexibility (Smallbone et al. 2012).

Researchers have introduced varied perspectives to explain the unbalanced impacts by the Great Recession to construction companies at different sizes. For instance, Tansey et al. (2014) found that contractors gained resilience by tending to adopt the most differentiation strategies, which help distinguish themselves from their competitors. The discussions originally focusing on the economic downturn during the Great Recession resume when there are accumulating evidences on the arrival of a new, post-pandemic economic downturn. For example, Bistrova et al. (2021) suggest that in order to survive the economic downturns caused by the COVID-19 pandemic, businesses should be more innovative, flexible, and productive than their competitors.

Before proceeding with the discussion, it is necessary to examine if the revenue gaps among construction companies are widened since the pandemic, like what happened during the Great Recession. Or if the pandemic brings opportunities to many companies by narrowing the gap between giants and others? It is also unclear if the pandemic consolidates the rankings or brings more changes to the rankings. The exploration on the revenue and the exploration on the change of revenue ranking echo the above-mentioned studies by Bloom (2017) and Govindarajan et al. (2019), respectively. Revenue reflects cross-sectional status, while the change of rankings indicates trends. Even though Phillips and Bousquin (2021) assert that the COVID-19 has ununiformly affected construction companies through soaring material prices and increased competition, it is neither endorsed by empirical data nor rigorous statistical analysis. Narrowing the identified gap by statistically analyzing related empirical data is the point of departure of this study.

## **Research Questions, Data Collection, and Methodology**

The overarching objective of this study is to empirically examine the patterns of market concentration in U.S. construction industry since the COVID-19 pandemic. Market concentration, a term originated from economics, measures the extent to which market shares are concentrated between a small number of firms. In this study, market concentration is indicated by the revenues of companies. To achieve this objective, the study proposes two specific research questions: (1) Whether the revenue gap between giant U.S. construction companies and others is widened, when it is compared to the

period before the pandemic? and (2) Whether the market positions (measured by revenue rankings) of U.S. construction companies are consolidated, when they are compared to the period before the pandemic? The disruption by the pandemic will be compared with the counterpart by the Great Recession, which lasted from December 2007 to June 2009 in the U.S. (Rich 2013), to gain insights on the ongoing crisis.

The data used in this study come from Engineering News-Record (ENR) Top List – Contractors. Every year, the list ranks largest U.S.-based general contractors based on their annual revenue in the year before. The rankings, together with the news and cost indices by ENR, have been widely applied in studies published on well-recognized construction journals (e.g., Ashuri and Lu 2010, Liang et al. 2022, and Vashani et al. 2016). The ranking data used in this study cover top 100 companies from 2005 to 2022, which reflect their corresponding annual revenues from 2004 to 2021. The dataset has 1,800 observations (= 100 companies × 18 years), and each observation contains the company name, ranking of the year, and the revenue of previous year. The rationale of using “top 100” is threefold. First, that is a well-established tradition of company ranking (e.g., Forbes 100). Second and more importantly, the use of top 100 companies can satisfyingly serve the research objective – exploring whether the gaps between construction giants (i.e., those well-known companies occupying enormous market shares) and others are widening. As shown in Table 1, the revenues of the 100<sup>th</sup> companies have always been relatively negligible, compared to the 1<sup>st</sup> companies. Even though the names of first-ranked companies are familiar to most construction professionals, the names of 100<sup>th</sup> companies are probably unheard. Therefore, it is reasonable to claim that the involvement of top 100 has covered both “giants” and “others”. This empirical evidence is aligned with the Law of Proportionate Effect – a classic principle established by Gibrat (1931) – claiming that the typical size-distribution of firms is positively skew, with a few large firms and many other firms. Furthermore, the results in Table 1 echo the results of another recent study: Coughran (2019) sampled 363 industrial and nonresidential U.S. construction companies ranging from \$1 million to over \$1 billion in revenue. Goughran found that 51.4 percent of those firms are in the ninth or tenth decile, earning less than \$100 million per year. Third and practically, although there are indeed a number of companies smaller than the 100<sup>th</sup> companies, such as some local firms, their revenues are hard to track and validate. Therefore, a cutoff of 100 can provide sufficient data to examine if the gap between giants and other construction companies is enlarged.

Table 1

*Relative sizes of the 100<sup>th</sup> companies to the 1<sup>st</sup> companies – descriptive statics from 2004 to 2021*

<b>Median</b>	<b>Average</b>	<b>Maximum</b>	<b>Minimum</b>
3.10%	3.64%	6.88%	1.98%

The following research steps were adopted to achieve research objectives:

1. (For research objective#1) Fitting a Pareto distribution to the revenue and ranking data. The relationships between the size of a company and the ranking of a company have been found generally approximating the Pareto distribution, as denoted by Equation (1) (Hart 1962).

$$\log S = a + b \cdot \log R \quad \text{Equation (1)}$$

where  $S$  is the size of a company measured by revenue, and  $R$  is the ranking of a company in order of size. The coefficient  $b$  is the Pareto coefficient, which is an indication of the gap between different

companies: a larger absolute value of  $b$  means that the revenue gap between two companies with consecutive rankings is greater and the market is more concentrated.

2. (Step 2 to Step 4 are for research objective#2) Calculating descriptive statistics of the change of ranking from 2005-2022. The change of ranking is denoted by Equation (2)

$$C_{i,j} = |i - R_{i,j}| \tag{Equation (2)}$$

where  $C_{i,j}$  is the change of ranking of an  $i^{\text{th}}$  company in the year of  $j$ ,  $R_{i,j}$  is the ranking of the same company in the year before.  $i \in [1,100]$ ,  $j \in [2005,2022]$ ,  $i, j \in Z^+$ . This step illustrates how the patterns of change of ranking (i.e., a measurement of the consolidation of market position) evolve across years.

3. Conducting Shapiro-Wilk normality test, a commonly-used test for univariate normality (Shapiro and Wilk 1965), on the changes of ranking within a same year (i.e.,  $C_{i,j^*}$ , where  $j^*$  is a constant). Normality assumption – the distribution of data within each group (i.e., changes of ranking within a same year in this study) is normally distributed – is a premise of the one-way ANOVA (analysis of variance) to be performed in the next step.

4. Using one-way ANOVA (when normality test passed) or equivalent nonparametric test (when normality test failed) to test if the mean values of the changes of ranking across years are statistically significantly different. This step empirically examines if the changes of ranking during the COVID-19 pandemic demonstrate different patterns. In other words, this step provides statistical evidence on if market positions of construction companies are more consolidated due to the pandemic.

## Results and Discussions

Table 2 shows the parametric details of Pareto distribution fitting (i.e., research step#1). The values of adjusted  $R^2$  and p-values confirm the strong explanatory capability of Pareto distribution in terms of the relationship between the size of a company (measured by revenue) and the ranking of a company. The revenue gap between construction companies, measured by the absolute value of  $b$  (a dimensionless quantity), is as shown in Figure 1.

Table 2

*Pareto distribution fitting of the relationships between a company’s revenue (2004-2021) and ranking (2005-2022)*

Year (by revenue)	$a$	$b$	Adjusted $R^2$	p-value	Note
2021	4.51	-0.74	0.95	$< 2.2 \times 10^{-16}$	The period of COVID-19
2020	4.48	-0.73	0.96	$< 2.2 \times 10^{-16}$	
2019	4.50	-0.75	0.97	$< 2.2 \times 10^{-16}$	The pre-pandemic era
2018	4.52	-0.77	0.98	$< 2.2 \times 10^{-16}$	
2017	4.50	-0.78	0.98	$< 2.2 \times 10^{-16}$	
2016	4.50	-0.79	0.99	$< 2.2 \times 10^{-16}$	
2015	4.52	-0.82	0.99	$< 2.2 \times 10^{-16}$	
2014	4.58	-0.88	0.99	$< 2.2 \times 10^{-16}$	

2013	4.59	-0.90	0.99	$< 2.2 \times 10^{-16}$	
2012	4.54	-0.88	0.98	$< 2.2 \times 10^{-16}$	
2011	4.51	-0.88	0.99	$< 2.2 \times 10^{-16}$	
2010	4.49	-0.90	0.99	$< 2.2 \times 10^{-16}$	
2009	4.59	-0.94	0.98	$< 2.2 \times 10^{-16}$	The Great Recession
2008	4.56	-0.86	0.98	$< 2.2 \times 10^{-16}$	
2007	4.45	-0.81	0.97	$< 2.2 \times 10^{-16}$	
2006	4.40	-0.83	0.97	$< 2.2 \times 10^{-16}$	The pre-recession period
2005	4.41	-0.89	0.98	$< 2.2 \times 10^{-16}$	
2004	4.36	-0.88	0.99	$< 2.2 \times 10^{-16}$	

\* This column will be 2005-2022 if it was by rank. Because the ranking of a certain year is based on the revenue of the previous year (e.g., the ranking of 2022 is based on the annual revenue of 2021).

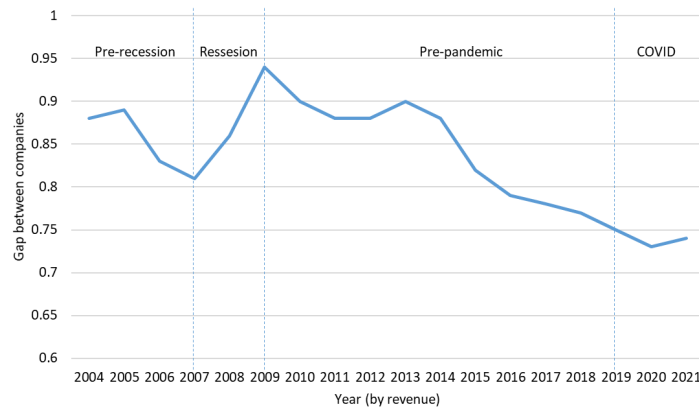


Figure 1 Revenue Gap between Construction Companies from 2004 to 2021

As shown in Figure 1, the revenue gap between construction companies was enlarged by around 116% during the Great Recession. During the period before recession (i.e., 2004-2007) and the period after the recession (i.e., 2010-2019), the revenue gap was narrowed by around 4%/year and 2%/year, respectively. As to the U.S. COVID-19 timeline, the first lab-confirmed case happened in January 2020, and the first shutdown happened in March 2020. Until the end of 2020, most States in the U.S. had lifted their shutdowns (CDC 2022). During 2020, the first year of the pandemic, the revenue gap between construction companies continued the previous decreasing trend with a rate of around 3%/year. In the second year (i.e., 2021), the revenue gap stopped going downwards and rose slightly by 1%. However, it is too early to call that the pandemic reverses the narrowing trend of revenue gaps. Current empirical evidence can confirm that until two years after the outbreak of the COVID-19 pandemic, there is not yet an obvious disruption to the revenue gap between construction companies. This is very different from the last crisis – the Great Recession.

Table 3, Figure 2, and Figure 3 show the results of research step#2 and #3. Since the normality assumption was rejected, Kruskal-Wallis (K-W) test – a non-parametric equivalence of one-way ANOVA – was performed on the 18 groups of change of ranking (i.e., 2005-2022). Corresponding to research step#4, the K-W test examines whether samples originate from the same distribution (Kruskal and Wallis 1952). The results of K-W test fail to reject the null hypothesis – the medians of all groups are equal. The details of K-W test are shown in Table 4.

The medians of ranking change across years generally remain stable, even during the Great Recession and the COVID-19 pandemic. The mean of medians is 5.25 out of 100. Compared to the Great Recession period, the mean value of ranking change and the standard deviation of ranking change are less during the pandemic, which implies the market positions of construction companies are generally more consolidated. This statement can also be supported by less large outliers in terms of ranking change during the pandemic (Figure 2).

Table 3

*Descriptive statistics and normality test of the changes of rank from 2005 to 2022 (SD = standard deviation, S-W = Shapiro-Wilk)*

Statistics	Year									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
<b>Mean</b>	7.81	9.37	13.89	12.67	9.30	8.88	8.30	9.87	10.17	10.98
<b>Median</b>	5	6	9	4	5	4	5	6	5	5
<b>SD</b>	8.02	13.65	14.58	22.84	10.59	11.20	9.27	11.64	18.54	17.28
<b>S-W*</b>	$1*10^{-9}$	$3*10^{-15}$	$1*10^{-9}$	$1*10^{-15}$	$1*10^{-10}$	$1*10^{-11}$	$1*10^{-10}$	$3*10^{-11}$	$2*10^{-16}$	$7*10^{-15}$
	2013	2012	2011	2010	2009	2008	2007	2006	2005	
<b>Mean</b>	10.98	12.27	9.28	13.34	15.55	11.82	12.21	10.13	8.67	
<b>Median</b>	5	5	4	7	6	4.5	5	4	5	
<b>SD</b>	17.28	23.89	12.76	18.73	37.23	35.93	18.30	21.71	13.37	
<b>S-W</b>	$7*10^{-15}$	$2*10^{-16}$	$3*10^{-13}$	$4*10^{-13}$	$2*10^{-16}$	$2*10^{-16}$	$5*10^{-14}$	$2*10^{-16}$	$8*10^{-15}$	

\*The null hypothesis of S-W test is the data is normally distributed. The minimal value of S-W test that can be calculated is  $2*10^{-16}$

Overall, the COVID-19 pandemic has not yet brought obvious shocks, neither increase or decrease, to the revenue gap between U.S. construction companies and suggests a more consolidated profile of market positions. That constitutes a sharp contrast with the Great Recession, which enlarged the revenue gap and triggered more position changes. According to the Federal Reserve Bank (Şahin et al. 2011), there is a disproportionate relationship between the decline during the Great Recession and the size of company. The smaller the company, the more significant difficulties in raising funds for regular operations or new investments may occur. Compared to the companies which have more diversified sources of financing, companies smaller in size tend to heavily rely on bank loans. For instance, the balance-sheet data surveyed by the Federal Reserve Bank of New York show that bank loans account for 2/3 of the total debt of small companies, while the number is ¼ for large companies. And bank loans declined significantly since the start of Great Recession. The study by the Federal Reserve Bank further points out that the Great Recession leads to shrunk total needs, which exaggerates the existing disadvantaged status in competitions of many companies. However, the COVID-19 pandemic suggests a very different context. First, the Coronavirus Aid, Relief, and Economic Security (CARES) Act became law in March 2020. As one of the key provisions, the Paycheck Protection Program (PPP) managed by the U.S. Small Business Administration provided \$669 billion in assistance, with 90% of the funds allocated by the first week of May 2020 (Kapinos 2021). Furthermore, the 1.2 trillion Infrastructure Investment and Jobs Act became law in November 2021, which can be dated back to the American Jobs Plan first proposed in March 2021. The massive infrastructure investment plan suggests a very different scenario in terms of the confidence to U.S. construction market compared to the days during the Great Recession. Nevertheless, it is worthy to note that current empirical evidence can only support statements on the impacts until the beginning of 2022. It is too early to examine the long-term impacts of the COVID-19 pandemic on the revenue gap between U.S. construction companies and to evaluate the effectiveness of government interventions.

The vibrant merger-and-acquisition activity in U.S. construction industry since 2010 helps giant construction companies consolidate their market positions and can explain the stable ranking changes across years. Giant construction companies tend to become more competitive after merging smaller but capable competitors. The activity slowed down during the Great Recession as a result of paralysis over business climate and resumed again afterwards (Rubin 2010). The suspension of merger-and-acquisition paused the consolidation and brought more changes of market positions. However, the current crisis suggests a context different from the Great Recession: in addition to the stimulus to infrastructure sectors, the housing market remains hot during the pandemic (Florida 2022).

Table 4

*Results of Kruskal-Wallis test with the null hypothesis that the medians of all groups are equal*

<b>Chi-squared</b>	<b>Degree of freedom</b>	<b>p-value</b>
17.28	17	0.44

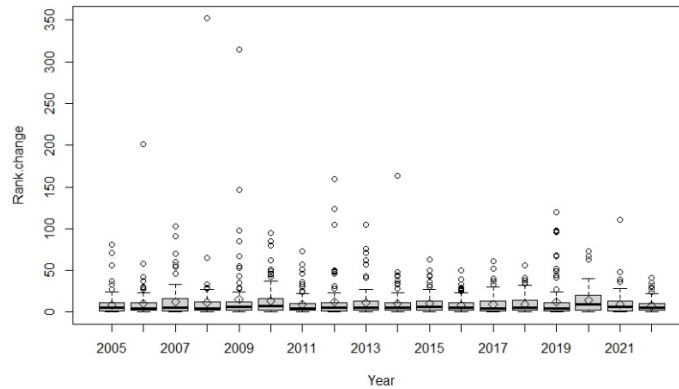


Figure 2 Boxplot of change of ranking from 2005 to 2022 (original plot)

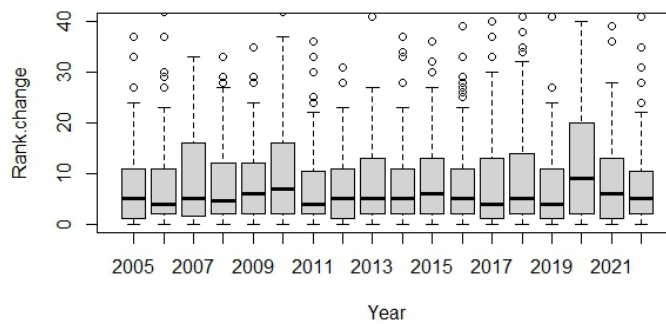


Figure 3 Boxplot of change of ranking from 2005 to 2022 (outlier-removed)

### Conclusions and Future Works

This study responds to the concerns if the U.S. construction industry is more consolidated since the COVID-19 pandemic. Both absolute revenue (measured by U.S. dollar) and relative revenue

(measured by revenue ranking) were examined, using the data from ENR. The results of statistical analysis show that until the beginning of 2022, no obvious disruptions on the evolvement of revenue gap have incurred. Over the past 18 years (including the pandemic period), the revenue gap between U.S. companies generally narrows except the period of the Great Recession. The analysis also shows that the change of ranking across years generally remains stable, despite the higher volatility during the Great Recession. The impacts of the two crises, i.e., the pandemic and the Great Recession, on the market concentration of the U.S. construction industry are very different. By comparatively analyzing the natures of the two crises with focuses on their impacts to the U.S. construction industry, the study argues that government interventions are generally effective stabilizers, until the cutoff for data collection in this study, i.e., the beginning of 2022.

The future works can be continued from two aspects: First, longitudinal data before 2004 and longitudinal data since 2022 need to be involved. Currently, the pre-recession period only contains the data from four years, and the COVID period only contains two-year data. The period of post-COVID has not yet been constructed. Extended length of study can be expected to generate more robust results. Second, the industry sector (e.g., transportation, industrial, and power) needs to be included as an explanatory variable. The levels of market concentration of various industry sectors are different. For instance, in 2021, top 20 transportation general contractors account for 56.4% of the total revenue of top 400 transportation general contractors. The numbers are 82.6%, 73.5%, 96.9%, 92.2% for the power sector, the industrial sector, the petroleum sector, and the telecommunication sector, respectively (ENR 2022). The inclusion of industry sector can generate more specified results on the pattern of market concentration.

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