Subcontracting and Injury Rates in Construction

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Abstract

This research examines whether the process of extending and articulating subcontracting in construction, which has taken place over the past 40 years, has, controlling for other factors, raised or lowered the risk of injury. One hypothesis is that subcontracting lowers the risk of injury by reassigning work to the subcontractor best able to manage it, including managing the risk of injury. The alternative hypothesis is that subcontracting increases the risk of on-site injuries by shifting risk to contractors with a higher tolerance for injuries and by creating an environment where lack of cross-contractor coordination increases the dangers of construction work.

Introduction

By several measures, construction is one of the most dangerous industries in the United States. More workers are killed annually in construction than in any other single major segment of the economy. Injury rates and workers compensation costs are substantially higher than most other segments of the economy. Because of the transient relationships between contractors and workers, construction shares with agriculture the dangers of a casual labor market where workers are often not trained regarding safety and many work-related illnesses and even injuries (e.g., back strain) occur while employed by one contractor or grower and yet manifest themselves only later while working for a second employer. Construction shares with mining the dangers of below-ground work—more construction workers are killed in ditches and other excavation work than in any other single segment of construction (Su-

ruda et al. 2002). Construction shares with transportation the dangers of moving heavy equipment, with many accidents and deaths associated with construction site traffic.

There is another aspect that construction shares with agriculture and transportation—the widespread use of subcontracting. Some have claimed that subcontracting is an independent contributor to the dangers associated with construction work.

> Subcontracting is associated with poor occupational health and safety outcomes, and an erosion of safety standards. It's no coincidence that in the US, three of the four highest risk occupations, truck drivers, farm workers and construction labourers are jobs with a high proportion of self-employed or subcontract workers. (Long 1999:21)

Yet this claim is not entirely obvious. Subcontracting often entails the creation of specialized firms. These specialty contractors, by focusing on one set of construction activities, may develop expertise that make them better suited to manage safety risks in their chosen segment of construction. Thus, this paper considers two competing hypotheses regarding the relationship between subcontracting and workplace safety.

Hypothesis 1: The Right Contractor for the Job

One hypothesis is that subcontracting lowers the risk of injury by allocating work to the subcontractor best able to manage it, including managing the risk of injury. This hypothesis is based on the notion that, with growth and specialization in construction, firms emerge that profit by being better able to manage and reduce risks within their special area of competence on the work site. Thus, one possible partial explanation for the well-known downward trend in injury rates in the construction industry (along with most other industries in the past 30 years) may be the long-term trend toward greater specialization and subcontracting in construction.

Hypothesis 2: Slipping between the Cracks

The alternative hypothesis is that subcontracting increases the risk of on-site construction injuries by shifting risk to contractors with a higher tolerance for injuries and by creating an environment where lack of cross-contractor coordination increases the dangers of construction work. Subcontracting heightens the risk of injury by shifting work to smaller business units that can less afford the fixed costs of safety programs while they can more afford to go out of business (and restart under a new name). This hypothesis posits that subcontracting shifts the risk of injury to contractors that are not as well posi-

tioned to manage it but better positioned to avoid and externalize its costs through bankruptcies. In construction, subcontracting is on-site subcontracting. Thus, articulated subcontracting increases problems of coordination across legally distinct companies. Working side by side, subcontractors also can endanger each other's workers and potentially not be held responsible. The cost of assessing joint responsibility for the injury to a particular contractor's worker has led to a system where the employing contractor is held responsible regardless in the case of assessing workers compensation premiums.

Subcontracting may also create a competitive process where costing-in safety procedures is less feasible, not because of coordination issues, but rather to speed up concerns. Subcontractors also have limited information regarding who other subcontractors on a job are going to be at the time the subcontractor submits his bid. Thus, subcontractors cannot cost-out the labor needed to fix the problems created by other contractors who are atypically sloppy regarding the safety of workers other than their own.

Data and Model

We test the hypothesis that changes in subcontracting practices are causally related to injury rates in construction. Data for our analysis come from three sources. The *U.S. Economic Census, Construction, Geographic Area Series*, published every five years from 1967, provides state-by-state information on total construction employment, construction worker employment, the number of construction establishments, the value of construction work self-performed, and the value of construction work subcontracted to others. From these data, we have calculated our focus variable, the ratio of the value of work subcontracted to the value of self-performed work, and two control variables, the real value of output per worker and the number of employees per establishment. An additional control variable, the state unemployment rate, is taken from the *Statistical Abstract of the United States.*

As a measure of subcontracting, the ratio of the value of subcontracts to the value of self-performed work has the disadvantage of not indicating the number of subcontractors. Thus, theoretically, this ratio can rise without necessarily increasing the number of subcontractors. We are not currently aware of alternative data that would directly measure changes in the number of subcontractors. In practice, however, it is generally believed that the number of subcontractors rises with the ratio of the value of subcontracting to self-performed work. Thus, we do not believe that this poses a serious limitation to the analysis.

The dependent variable, the U.S. Bureau of Labor Statistics (BLS) total nonfatal injury incidence rate per 100 full-time construction workers, published by state and year, is available annually from 1976 to the present.[1] Com-

bining the *U.S. Economic Census, Construction, Geographic Area Series* data with the BLS injury data allows for the creation of a cross-sectional-time-series data structure encompassing five years—1977, 1982, 1987, 1992, and 1997. Four states—Illinois, North Dakota, New Hampshire, and Ohio—are not included in the BLS data and 19 states and the District of Columbia are not available for all years. Thus, an unbalanced panel data set was used consisting of 185 state-year observations.[2]

Our observations are state-by-year averages with the size of construction varying between very large states such as California and much smaller states such as Wyoming. We have weighted observations by the number of construction workers employed in each state and year and these weighted least squares models do not show signs of heteroskedasticity.

We will present four weighted least squares linear regression models. The first three models are nested within the fourth model. The fourth model is a fixed effect weighted least squares linear regression:

$$Y_{it} = \alpha + \beta_1 X1_{it} + \beta_2 X2_{it} + \beta_3 X3_{it} + \beta_4 X4_{it} + \beta_5 Y_{1982} + \beta_6 Y_{1987} +$$
$$\beta_7 Y_{1992} + \beta_8 Y_{1997} + \beta_9 S1 + \ldots + \beta_m Sn + \mu_{it}$$

where

$$
\begin{aligned}
Y_{it} &= \text{total nonfatal injury rate for state } i \text{ in year } t, \\
\alpha &= \text{constant,} \\
X1 &= \text{ratio of the value of subcontracted to self-performed work} \\
&\quad \text{in construction for state } i \text{ in year } t, \\
X2 &= \text{the overall state unemployment rate for state } i \text{ in year } t, \\
X3 &= \text{real output per worker in construction in 1997 dollars for} \\
&\quad \text{state } i \text{ in year } t, \\
X4 &= \text{employees per establishment in construction for state } i \text{ in} \\
&\quad \text{year } t, \\
Y_{1982} \text{ to } Y_{1997} &= \text{dummy variables for each year with 1977 equaling the} \\
&\quad \text{reference year,} \\
S1 \text{ to } Sn &= \text{state dummy variables, and} \\
\mu_{it} &= \text{error term with } i = \text{state and } t = \text{year.}
\end{aligned}
$$

Results

Table 1 shows the results of four weighted least squares linear regression models explaining the total injury incidence rate by year and state for the construction industry. Model 1 is a simple one-variable linear regression that estimates a negative relationship between changes in the ratio of subcontract-

TABLE 1

Weighted Least Squares Linear Regression Models

	Model 1* Simple			Model 2* Time Dummies			Model 3* Fixed State Effects**			Model 4* Fixed Effects with Added Controls**		
	β	Std. Error	Sig.	β	Std. Error	Sig.	β	Std. Error	Sig.	β	Std. Error	Sig.
(Constant)	15.64	1.49	0.00	8.69	1.07	0.00	8.48	2.48	0.00	6.04	3.66	0.10
Ratio of Subcontracted to Self-Performed Work	-8.09	4.23	0.06	22.19	3.26	0.00	22.00	6.53	0.00	22.67	6.04	0.00
Unemployment Rate in State										-0.44	0.10	0.00
Real Output per Worker $1997										0.03	0.01	0.03
Employees per Establishment										0.16	0.13	0.23
1982=1				-0.53	0.58	0.36	-0.42	0.39	0.29	1.08	0.47	0.02
1987=1				-1.09	0.55	0.05	-0.85	0.38	0.03	-1.47	0.36	0.00
1992=1				-4.39	0.56	0.00	-3.54	0.52	0.00	-3.20	0.49	0.00
1997=1				-8.23	0.57	0.00	-7.66	0.65	0.00	-9.07	0.68	0.00
Adjusted R-Square	0.01			0.62			0.84			0.87		
Number of Observations	185			185			185			185		

Dependent Variable = Total Non-Fatal Injury Incidence Rate per 100 Full-Time Workers in Construction

* Weighted least squares linear regression weighted by the number of employed in construction by state and year

ing to self-performed work on the right-hand-side and changes in the injury incidence rate on the left. This relationship is statistically significant at the 10% level. This result is driven by the fact that over the time period under analysis (1977–1997) the practice of subcontracting has tended to increase while reported injury rates have tended to fall. The fit of the model is poor with an adjusted R^2 of 0.01.

In model 2, year dummy variables are introduced to control for the overall time trend in reported injury rates. The benchmark year is 1977 and progressively each subsequent year shows a lower estimate for injury rates with the difference from 1977 becoming statistically significant at the 5% level by 1987. Notably, controlling for an overall time trend in reported injuries, the estimated relationship between the measure of subcontracting and the measure of injury rates becomes positive and statistically significant at the 1% level. With the introduction of time dummies, the adjusted R^2 of the model rises to 0.62.

In model 3, state dummy variables are introduced to control for unobserved differences in injury rates by state. Differences in state injury rates in construction may come from a variety of factors, including differences in weather, regulatory oversight, the composition of construction activity, business cycle conditions, and industrial structure. The addition of these state dummies increases the R^2 to 0.84 while the estimate for the effect of subcontracting on injuries remains essentially unchanged and still statistically significant at the 1% level.

In model 4, the state unemployment rate is introduced to the fixed effects of model 3 in order to capture business cycle effects on injuries. During downturns in the business cycle, construction typically shrinks, expelling marginal workers with less experience. The remaining more experienced workers tend to work more safely and have fewer injuries. Also during cyclical downturns, the pace and intensity of construction work slows, making it safer. In model 4, the unemployment rate has a negative estimated effect on the injury rate with a 1–point increase in unemployment leading to a 0.44 decline in the injury rate. This estimated effect is statistically significant at the 1% level.

Again in model 4, real output per worker is introduced to capture differences in the composition of construction. Industrial construction tends to have higher output per worker compared to commercial construction, which has a higher output per worker compared to residential construction. Injury rates are not reported by construction sector, but it is generally believed that industrial construction is more susceptible to injuries compared to commercial and residential work. The estimate of output per worker is positive and statistically significant at the 5% level.

Finally, in model 4, firm size measured as the average number of employ-

ees per establishment in a state and year is introduced. The hypothesis is that larger firms are safer because they have the resources to implement more complete safety programs. Although the estimated sign for employees per establishment is consistent with this hypothesis, the coefficient is not statistically significantly different from zero.

The key point in Table 1 is that the focus variable, the ratio of subcontracted to self-performed work, is positive and significant and basically the same in all the reported multiple linear regression models. In model 4, selecting 1997 as the year and calculating the predicted injury rate for California, evaluating each of the continuous variables at their mean yields a predicted injury rate of 6.06 injuries per 100 full-time construction workers. Hypothetically increasing the subcontracting ratio by 1 standard deviation (0.06) above its mean raises the predicted injury rate by 24%. Over the period 1977 to 1997, the average subcontracting ratio has risen by 0.09. Controlling for other factors, the 1997 total injury incidence rate is approximately one-third higher because of the expansion of subcontracting practices.

Conclusion

This study attempts to establish statistically that increasing trends in subcontracting in construction have led to deteriorating on-site worker safety, controlling for other factors. Our full model controls for business cycle variations in injuries, and through time dummy variables controls for changes in the underreporting of injuries over time. The statistical results of this study are consistent with the hypothesis that increased on-site subcontracting in construction increases the risks of injuries.

This conclusion does not reject the hypothesis that increased specialization among subcontractors in construction may lead to increased ability to do work safely, controlling for other factors. Rather, our results suggest that, even if specialization by itself leads to better safety factors, other factors associated with on-site subcontracting swamp any favorable specialization effect for a net increase in injury risks.

Our results are limited by two data restrictions. First, our measure of subcontracting, the ratio of the value of subcontracted work to self-performed work does not directly measure changes in the number of subcontractors. A better measure would include not only the value of subcontracting but also the number of subcontractors involved. Second, our results are for construction as a whole. It may be that the net effect of construction subcontracting on injury risks varies by construction segment.

Several policy issues are raised by our findings. First, workers compensation experience ratings could be calculated to include an assessment not only to the employer of the injured worker but also to any contractor who contrib-

uted to the injury. OSHA fines are calculated to include an assessment of joint responsibility. At a minimum, where OSHA finds joint responsibility, workers compensation insurance could be calculated to reflect that finding. Second, OSHA workplace inspections strategies could be amended to focus in part on job sites with unusually articulated subcontracting occurring. Third, the responsibility of general contractors for the overall safety of the construction site could be legally increased though either the exposure to civil penalties or an effect on their own workers compensation experience rating due to any injuries on the site regardless of employer. Fourth, general contractors could be required to reveal to their bidding subcontractors the other subcontractors who are bidding on the project. Subcontractors could then be allowed to submit multiple bids based on which other subcontractors' bids are accepted. This would allow subcontractors to adjust their bid based on the safety reputation of potential on-site partners. In general, policies and bidding procedures should be developed that are sensitive to the injury risks of on-site subcontracting and capable of internalizing the costs of injuries that subcontracting externalizes.

Notes

1. Similar results to the ones reported here were found by using a balanced panel for 27 states and 135 observations.

2. The U.S. BLS provides state data presenting the number and frequency of work-related injuries, illnesses, and fatalities. Nonfatal cases of work-related injuries and illnesses that are recorded by employers under the Occupational Safety and Health Administration's (OSHA) record-keeping guidelines are available for 44 states and territories from the BLS *Survey of Occupational Injuries and Illnesses.* These data are on the web from 1995 to 2001 and available from the BLS in hard copy reports from 1976 to 1994. See "Incidence Rates of Non-Fatal Occupational Injuries and Illnesses by Industry and Selected Case Type," Table 6 (http://www.bls.gov/iif/home.htm).

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