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Construction Industry's Subcontract Structure and Influencing Factors: An Analysis Based on the First Census of the Contracting Group of the Construction Industry

Keren Sun
Department of Economics
University of Utah
United States of America

Peter Philips
Department of Economics
University of Utah
United States of America

Xin Zhao
School of Economics
Ocean University of China
China

Abstract

The word subcontract was used as a noun was in 1660, subcontracting was clearly a common labor system in the Pennsylvania iron industry by 1720s. Subcontracting has been the common practice in construction industry for a long time. The purpose of using subcontracting in construction industry is either to reduce costs or mitigate project risks. 1930 the first census of the contracting group of the construction industry was inaugurated as part of the decennial census, therefore, we use the data of the first census to analyze the U.S. construction industry's subcontract structure and the relative factors that can influence the subcontract structure, and get some conclusions, such as, increasing subcontract will decrease compensation and insurance expense; if the average wage of the workers is high, it will promote subcontract behavior.

Keywords: Subcontract Influencing Factors Construction Industry First Census Structure

1. Introduction

Today, subcontracting often occurs in building works and in civil engineering, and the range of opportunities for subcontractor is much wider[1]. "Subcontractor has become a great subject to all the practitioners in construction industry due to the common practice of subletting construction works into smaller packages in construction industry." (Lew, et al. 2012, pp.444). According to Merriam webster dictionary, the first time the word subcontract was used as a noun was in 1660, and which was used as a verb was in 1842[2].

[1] https://en.wikipedia.org/wiki/Subcontractor
[2] https://www.merriam-webster.com/dictionary/subcontract

"The existence of subcontracting by the 1720s indicates that industrial labor arrangements were in place much earlier than many historians have claimed." (Kennedy,1998, pp.492). The purpose of using subcontracting is either to reduce costs or mitigate project risks, or the above dual purposes at the meantime. "it was not until 1930 that an effective effort was made by the National Government to obtain basic statistics of one of our largest of industries. In that year, the first census of the contracting group of the construction industry was inaugurated as part of the decennial census."[3] (U.S. 1930 Census of Population, Construction Industry, pp.1). Therefore, we use the data of the first census of the contracting group of the construction industry to analyze the U.S. construction industry's subcontract structure and the relative factors that can influence the subcontract structure.

2 Literature Review

Kennedy (1998, pp.502) provides the following data sheet in his paper, this data sheet shows that subcontracting was clearly a common labor system in the Pennsylvania iron industry by 1720s.

Table 1: Percentages of contractors, subcontractors, and helpers among ironworkers by decade, 1720-1789

Decade	Contractors	Subcontractors	Helpers
1720s	5%	11%	10%
1730s	7%	14%	12%
1740s	8%	20%	11%
1750s	9%	23%	12%
1760s	10%	24%	11%
1770s	11%	25%	13%
1780s	11%	28%	14%

Cited from Kennedy, Michael V. (1998), pp.502

The contribution of subcontractors to the total construction process can contribute more than 50% (Albino and Garavelli, 1998), and can account for 80-90% of the total value of the project (Enshassi & Medoukh, 2012). A construction project uses a large number of professional subcontractors, which will complicate the management of the construction project and make the construction industry look unique. So that "success of a construction project is essentially depending on the ability of general contractor to select the appropriate subcontractor during bidding process, and the sufficient management of subcontractor during construction."(Lew, et al. 2012, pp.442). Marzouk, et al. (2013) collect forty-six factors from previous studies that influence sub-contractor selection, and via ten criteria, identify twelve factors as the most important factors that influence the selection of sub-contractors.

Bosch and Philips (2003) articulate the following views about subcontracting: ① subcontracting is a method for managing risk. Construction is an unusually risky endeavor, including work site dangers, financial risks, business cycle risks, etc.; ② subcontracting is a method of labor control and a way to cut labor costs on construction work site; ③ the evolving structure of construction responds to the uncertainties associated with buying and making construction products; ④ the structure of subcontracting varies across countries and across construction subsectors within countries.

We think that the analysis of the first census data of the construction industry in the United States will also help understand the current subcontracting literatures.

[3] https://www2.census.gov/library/publications/decennial/1930/construction/03140634ch01.pdf

3 1929 U.S. Construction Industry's Subcontract Structures

3.1 1929 U.S. construction industry's basic subcontract structure

Table 2 1929 construction industry's basic subcontract structure

Classification of establishments	The rate of under general contract over total value of construction	The rate of under subcontract work value over total value of construction	The rate of subcontract work let expenditures over total value of construction	The rate of wages paid expenditures over total value of construction	The rate of cost of materials expenditures over total value of construction
all classes of establishment	0.786	0.214	0.233	0.235	0.329
operative builders	1.0	0.000	0.672	0.086	0.147
general contractors	0.989	0.011	0.306	0.217	0.282
Subcontractors	0.312	0.688	0.033	0.287	0.433

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

Table 3 average annual salaries and wages in construction industry during 1929

classification of establishments	Average salary of proprietors and firm members	Average salary of officers and clerical staff	Average salary of employees	Average salary of superintendents, foremen, etc.	Average wages of workers
all classes of establishments	3541.413	3122.706	2937.367	2685.26	1770.743
Operative builders	3490.938	2815.374	2748.257	2637.982	1784.122
General contractors	3745.382	3496.841	3047.125	2616.046	1618.995
Subcontractors	3398.87	2735.469	2775.7	2873.28	2105.138

Source: computation based on data in U.S. 1930 Census of Population, Construction

From Table 2, Table 3, we can know that:

① for operative builders, their almost 100 percent business value are under general contract, but the rate of their subcontract work let is high, this rate is 0.672. Such a subcontract structure for operative builders is consistent with the definition of operative builder given by United States Department of Labor: operative builders primarily engaged in the construction of single-family houses and other buildings for sale on their own account rather than as contractors[4]. Operative builders subcontract the majority of their projects out, so the proportion of wages and the proportion of materials are small.

② for subcontractors, the rate of their business value under general contract is 0.312, the rate of their business value under subcontract is 0.688, These above two numbers show that the subcontractors not only undertake the subcontracting business, but also undertake the business of the general contractor. After undertaking the general contractor business, the subcontractors are rarely subcontracted, mainly do these by themselves, so that the rate of subcontractors' subcontract work let over total value of construction is very small, it is 0.033.

[4] https://www.osha.gov/pls/imis/sic_manual.display?id=407&tab=description

③ for general contractors, the rate of their business value under general contract are as very high as 0.989, is just little smaller than that of operative builders, and the rate of general contractors' subcontract work let over total value of construction is 0.306, which is smaller than that of operative builders, but much higher than that of subcontractors. 0.306 also means the general contractors will subcontract 30.6% of their total business out to subcontractors, they will keep the left 69.4%, and do it by themselves.

④ there is a negative correlation between indicator the rate of subcontract work let over total value of construction and indicator the rate of cost of materials expenditures over total value of construction, i.e. if the rate of subcontract work let over total value of construction is high, then indicator the rate of cost of materials expenditures over total value of construction will be small. For example, for operative builders, their rate of subcontract work let expenditures over total value of construction is 0.672, their rate of cost of materials expenditures over total value of construction is as small as 0.147.

⑤ there is a positive correlation between indicator the rate of wages paid expenditures over total value of construction and indicator the rate of cost of materials expenditures over total value of construction, i.e. if the rate wages paid expenditures over total value of construction is high, then indicator the rate of cost of materials expenditures over total value of construction will be high too.

⑥ for both operative builders and general contractors, their rates of under subcontract work value over total value of construction are very small, near to zero, that mean the operative builders and the general contractors dislike to subcontract business from the subcontractors.

⑦ comparing to the general contractors and operative builders, the workers working for the subcontractors get the highest average wages, and the superintendents, foremen, etc. working for subcontractors get the highest average salary. This indicates that the subcontractors' jobs require workers, superintendents, foremen, etc. to have relatively high skills.

⑧ comparing to the subcontractors and operative builders, the employees working for the general contractors get the highest average salaries, and the officers and clerical staff working for general contractors get the highest average salaries. This indicates that the skill requirements for the employees, the officers, the clerical staff working for the general contractors are relatively high.

⑨ comparing to the subcontractors and operative builders, the average salary of proprietors and firm members of the general contractors is the highest. This indicates that the general contractors decrease the costs and risks via subcontracting, then can get more profits.

3.2 Different sizes of the entities' subcontract structures of 1929 U.S. construction industry

Table 4 Subcontract structures of different sizes of general contractors' groups

Size of general contractors' groups	The rate of under general contract over total value of construction	The rate of under subcontract work value over total value of construction	The rate of subcontract work let expenditures over total value of construction	The rate of wages paid expenditures over total value of construction	The rate of cost of materials expenditures over total value of construction
$25000 to $49999	0.988	0.012	0.230	0.243	0.342
$50000 to $99999	0.986	0.014	0.254	0.233	0.319
$100000 to $199999	0.988	0.012	0.262	0.228	0.301
$200000 to $499999	0.9893	0.0108	0.265	0.225	0.302
$500000 to $999999	0.9894	0.0106	0.278	0.221	0.293
$1000000 and over	0.991	0.009	0.387	0.194	0.244

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

From Table 4, we can know that:

① for all size classifications of general contractors' groups, their rates of under general contract over total value of construction are very high, and all are higher than 0.986.

② starting from $50000 to $99999 group, as the scale of group expands, the ratio of under general contract over total value of construction corresponding to that group is increasing.

③ starting from $50000 to $99999 group, as the scale of group expands, the ratio of under subcontract work value over total value of construction corresponding to that group is decreasing.

④ starting from the smallest group, as the scale of group expands, the ratio of subcontract work let expenditures over total value of construction corresponding to that group is increasing.

⑤ starting from the smallest group, as the scale of group expands, the ratio of wages paid expenditures over total value of construction corresponding to that group is decreasing.

⑥ starting from the smallest group, as the scale of group expands, the ratio of cost of materials expenditures over total value of construction corresponding to that group is decreasing.

Table 5 Subcontract structures of different sizes of building contractors' groups

Size of building contractors' groups	The rate of under general contract over total value of construction	The rate of under subcontract work value over total value of construction	The rate of subcontract work let expenditures over total value of construction	The rate of wages paid expenditures over total value of construction	The rate of cost of materials expenditures over total value of construction
$25000 to $49999	0.992	0.008	0.279	0.226	0.354
$50000 to $99999	0.993	0.007	0.320	0.214	0.323
$100000 to $199999	0.995	0.005	0.355	0.207	0.290
$200000 to $499999	0.9953	0.0047	0.394	0.206	0.265
$500000 to $999999	0.994	0.006	0.427	0.197	0.246
$1000000 and over	0.998	0.0015	0.524	0.161	0.198

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

From Table 5, we can know that:

① for all size classifications of building contractors' groups, their rates of under general contract over total value of construction are very high, and are higher than 0.992.

② starting from the smallest group, as the scale of group expands, the ratio of under general contract over total value of construction corresponding to that group is increasing except $500000 to $999999 group.

③ starting from the smallest group, as the scale of group expands, the ratio of under subcontract work value over total value of construction corresponding to that group is decreasing except $50000 to $99999 group.

④ starting from the smallest group, as the scale of group expands, the ratio of subcontract work let expenditures over total value of construction corresponding to that group is increasing.

⑤ starting from the smallest group, as the scale of group expands, the ratio of wages paid expenditures over total value of construction corresponding to that group is decreasing.

⑥ starting from the smallest group, as the scale of group expands, the ratio of cost of materials expenditures over total value of construction corresponding to that group is decreasing.

Table 6 Subcontract structure of different sizes of subcontractors' groups

Size of subcontractors' groups	The rate of under general contract over total value of construction	The rate of under subcontract work value over total value of construction	The rate of subcontract work let expenditures over total value of construction	The rate of wages paid expenditures over total value of construction	The rate of cost of materials expenditures over total value of construction
$25000 to $49999	0.331	0.669	0.010	0.305	0.418
$50000 to $99999	0.315	0.685	0.015	0.306	0.431
$100000 to $199999	0.286	0.714	0.025	0.295	0.436
$200000 to $499999	0.308	0.692	0.036	0.296	0.433
$500000 to $999999	0.282	0.718	0.044	0.300	0.443
$1000000 and over	0.342	0.658	0.057	0.239	0.520

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

From Table 6, we can know that:

① starting from the smallest group, as the scale of group expands, the ratio of subcontract work let expenditures over total value of construction corresponding to that group is increasing.

② starting from the smallest group, as the scale of group expands, almost all the ratios of cost of materials expenditures over total value of construction corresponding to that group are increasing.

③ at the two extremes of subcontractor size, the subcontractors present a relatively high rate of under general contract over total value of construction. This maybe mean that if a subcontractor's size is small, this subcontractor has advantage in general contracting small-scale projects; if a subcontractor's size is big, this subcontractor has advantage in general contracting big-scale projects.

④ due to ③, at the two extremes of subcontractor size, the subcontractors present a relatively small rate of under subcontract over total value of construction.

3.3 1929 U.S. construction industry's subcontract structures of groups which businesses were distributed by class of ownership

Table 7 the subcontract structure of groups which businesses were distributed by class of ownership

Groups which businesses were distributed by class of ownership	Average establishment value	The rate of numbers of subcontractor over numbers of general contractor	The rate of subcontractors' value over general contractors' value
ownership-private	161926.2	1.077	0.531
ownership-quasi public or community	60407.26	1.553	0.457
ownership-public	146938.2	0.697	0.134

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

From Table 7, we can know that the rate of subcontractors' value over general contractors' value decreases along the increasing of the degree of publicity in the construction projects.

Table 8 the subcontract structure of groups which businesses were distributed by class of public ownership

Groups which businesses were distributed by class of ownership	Average establishment value	The rate of numbers of subcontractor over numbers of general contractor	The rate of subcontractors' value over general contractors' value
Public ownership: federal	89097.98	1.057	0.146
Public ownership: state	130297.6	0.419	0.101
Public ownership: country or township	63538.48	0.717	0.144
Public ownership: municipal	114501.2	0.807	0.137

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

From Table 8, we can know that the rates of subcontractors' value over general contractors' value are all small, and between interval 0.101 and 0.146. The data in Table 7 shows that the federal project is relatively concerned with the subcontractor from the value share and the number of subcontractors, i.e. more subcontractors have gotten a share of the federal project. The state public ownership likes to contract the general contractors directly, which maybe mean simple and uncomplicated to the state governments.

3.4 1929 U.S. construction industry's subcontract structures of groups which businesses were relative to the types of building

Table 9 the subcontractor structure of groups which businesses were relative to the types of building

Groups which businesses were relative to the types of building	Average establishment value	The rate of numbers of subcontractor over numbers of general contractor	The rate of subcontractors' value over general contractors' value
building	184639.4	0.519	0.161
Commercial building	113435.8	0.495	0.103
Educational building	80616.66	0.727	0.132
Hotel building	76924.68	1.361	0.100
hospital and institutional building	70851.92	1.042	0.124
Manufacturing building	132951.7	0.852	0.196
military and naval building	62919.69	0.803	0.082
building-public: courts, jails, etc.	50806.9	0.843	0.080
religious and memorial building	36278.98	0.813	0.098
Residential building	71207.23	0.536	0.218
Social and recreational building	50701.84	0.689	0.101
Air transport building	42125.77	0.690	0.114
building-rail and water transportation	111167.5	0.660	0.063
Miscellaneous Building	33641.23	0.685	0.776

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

From Table 9, we can know that the average rates of subcontractors' value over general contractors' value of building is 0.161, which is small. We observe buildings with values of the rate of subcontractors' value over general contractors' value below 0.161, these buildings are all important/complicate buildings, such as military and naval building, rail and water transportation, air transport building, courts, jails, religious and memorial building, etc. The group of miscellaneous building has the high rate of subcontractors' value over general contractors' value, and we can infer that the rates of subcontractors' value over general contractors' value decrease along with the increasing of degree of complexity and difficulty of construction.

3.5 1929 U.S. construction industry's subcontract structures of groups which businesses were relative to the types of construction businesses

Table 10 the subcontract structure of groups which businesses were relative to the types of public works and utilities under general contracts

Groups which businesses were relative to the types of public works and utilities	Average establishment value	The rate of numbers of subcontractor over numbers of general contractor	The rate of subcontractors' value over general contractors' value
public works and utilities	265427.7	0.177	0.076
public works and utilities: bridge, tunnel, etc.	140214.1	0.099	0.114
public works and utilities: central station, light and power plant	338946.6	0.144	0.395
public works and utilities: dock, pier, retaining wall, etc.	115943.8	0.144	0.003
public works and utilities: flood control, irrigation, and land drainage	104357.3	0.085	0.020
public works and utilities: refuse-disposal plant	62491.89	0.523	0.114
public works and utilities: park, grounds, etc.	17193.46	0.308	0.125
public works and utilities: river and harbor improvement	364411.7	0.068	0.003
public works and utilities: sewage disposal and drainage	97443.09	0.098	0.020
public works and utilities: water supply	108964.3	0.197	0.139
public works and utilities: oil and natural gas pipe line	1121769	0.048	**
public works and utilities: telephone line and system, radio tower, etc.	178081.3	**	**
public works and utilities: miscellaneous	24653.34	0.592	0.203

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

From Table 10, we can know that the rates of subcontractors' value over general contractors' value are all small, except the group of public works and utilities: central station, light and power plant and the group of miscellaneous public works and utilities, and also the rates of subcontractors' value over general contractors' value decrease along with the increasing of degree of complexity and difficulty of public works and utilities.

Table 11 the subcontract structure of groups which businesses were relative to the types of construction businesses under general contracts

Groups which businesses were relative to types of construction businesses	Average establishment value	The rate of numbers of subcontractor over numbers of general contractor	The rate of subcontractors' value over general contractors' value
Overall	223011.2	0.553	0.134
Building	184819.1	0.519	0.175
highway and street	85813.85	0.052	0.009
water-power development	224429.9	0.157	0.036
railroad and car line	245258.2	0.174	0.030
public works and utilities	84436.23	0.178	0.075
air transport work	54274.3	0.276	0.124
subway	2644626	0	0
miscellaneous	102682.47	**	0.901

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

From Table 11, we can know that the rates of subcontractors' value over general contractors' value are all small, except the group of miscellaneous projects, and also the rates of subcontractors' value over general contractors' value decrease along with the increasing of difficulty degree of partition construction by owners, or along with the increasing of complexity degree and publicity degree of engineering projects, the rates of subcontractors' value over general contractors' value is decreasing.

Table 12 the subcontract structure of groups which businesses were relative to the types of businesses under subcontract unit: %

Groups which businesses were relative to the types of businesses	Average establishment value	The rate of numbers of subcontractor over numbers of general contractor	The rate of subcontractors' value over general contractors' value
Overall	135488.5	10.94	30.08
carpentering and wood flooring	50324.48	1.86	11.27
Concreting	66930.12	2.08	8.02
Electrical	73446.11	163.5	529.71
elevator construction	547299.4	∞	∞
heating and plumbing	∞	∞	1182.18
Masonry	68222.48	3.75	22.06
painting and decorating	62184.25	56.44	690.78
glass and glazing	92231.91	28.43	424.81
plastering and lathing	105863.4	13.73	163.59
roofing and sheet-metal work	**	**	704.79
steel erection	204534.9	8.09	14.72
Stonework	93159.66	8.45	41.35
marble and tiling	113602.6	170.6	2114.44
Wrecking	36069.33	4.27	42.45
Excavating	44874.35	1.60	4.22
ornamental iron	113501.6	42.71	590.39
Highway	77504.52	0.476	1.19
bridge and culvert	42878.67	0.415	0.518
Grading	49937.3	1.54	1.88
street paving	87830.09	0.89	0.91
sewers, gas, water, conduit	35886.11	0.95	1.28
dam and reservoir	23423.17	0.38	0.20
waterworks	29274	0.44	1.13
dredging, river, harbor, etc.	80965.19	0.23	0.69
soundproofing	40119.45	34	
railroad	112491	1	11.89
foundation	427239	1.56	15.43
central station, light and power plant	71218.34	0.5	1.97
metal work, n.e.s	166469.5	124	
pipe line	57678.17	2	
rental of equipment, trucking etc. and vehicular subway and tunnel	35372.44	1	2.28
flooring, n.e.s	74288.87	34	38.47
miscellaneous	14433.78	7.33	28.17

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

From Table 12, we can know that non-public projects with strong independence, high degree of knowledge or high technical requirements are very attractive to subcontractors, and subcontractors have obvious advantages in these areas.

Table 13 the heating and plumbing's subcontract structure under subcontract

Groups which businesses were distributed by class	Average establishment value	The rate of numbers of subcontractor over numbers of general contractor	The rate of subcontractors' value over general contractors' value
heating and plumbing	**	**	1182.18
heating and piping	53479.87	232.82	967.60
pipe covering	28325.37	115.5	1832.35
plumbing	54469.21	166.76	1038.12
plumbing and heating combined	62348.8		
heating and plumbing	∞	∞	1182.18
automatic temperature control	182792.1	∞	
automatic sprinkler system	133907.8	∞	

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

From Table 13, we can know that subcontractors have obvious advantages in heating and plumbing areas.

3.6 1929 U.S. construction industry's contract structures of groups by location

Table 14 basic construction business structure by location during 1929

classification of establishments	ratio_in_home _city (1)	ratio_in_home_ state (2)	(3): (2)-(1)	ratio_outside_state
all classes of establishments	0.571	0.824	0.253	0.176
operative builders	0.944	0.994	0.050	0.006
general contractors	0.49	0.803	0.313	0.197
Subcontractors	0.679	0.858	0.179	0.142

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

From Table 14, we can know that, operative builders focus their business in the home cities, their business in outside state and outside home city but inside state are close to zero. Both general contractors and subcontractors focus their business in the home state. 80.3% of general contractor business and 85% of subcontractor business are located in the state, and 67.9% of subcontractor business is located in home city. Comparably to subcontractors, general contractor business is relatively balanced in the home city and non-home cities in a state.

Table 15 general contractors' business structure by location during 1929

classification of establishments	ratio_in_home_city (1)	ratio_in_home_state (2)	(3): (2)-(1)	ratio_outside_state
general contractors	0.490	0.803	0.313	0.197
Builders	0.629	0.846	0.217	0.154
Highway	0.105	0.782	0.677	0.218
bridge and culvert	0.221	0.592	0.371	0.408
Grading	0.255	0.794	0.539	0.206
street paving	0.632	0.932	0.3	0.068
sewer, gas, water, conduit	0.520	0.856	0.336	0.144
darn and reservoir	0.153	0.781	0.628	0.219
Waterworks	0.369	0.597	0.228	0.403
dredging, river, harbor, etc.	0.266	0.561	0.295	0.439
Levee	0.036	0.456	0.42	0.544
Railroad	0.189	0.433	0.244	0.567
Foundation	0.615	0.905	0.29	0.095
central station, light and power plant	0.170	0.507	0.337	0.493
air transport work	0.547	0.980	0.433	0.020
refuse disposal plant	0.620	0.775	0.155	0.225
oil and natural gas pipe line	0.012	0.553	0.541	0.447
Subway	0.987	0.992	0.005	0.008
vehicular subway and tunnel	0.150	0.509	0.359	0.491
telephone system, radio tower, miscellaneous	0.444	0.835	0.391	0.165

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

Viewing from Table 15, we can know that the general contractors obtain a relatively large proportion of business from outside state's public engineering projects, such as bridge and culvert; waterworks, dredging, river, harbor; levee; railroad; central station, light and power plant; oil and natural gas pipe line; vehicular subway and tunnel.

Table 16 builder general contractors' business structure by location during 1929

classification of establishments	ratio_in_home_city	ratio_in_home_state	ratio_outside_state
Builders	0.629	0.846	0.154
building not specialized	0.624	0.850	0.150
commercial building only	0.786	0.927	0.073
manufacturing building only	0.084	0.328	0.671
residential building only	0.795	0.970	0.030

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

Viewing from Table 16, we can know that building not specialized builder general contractors, commercial building only builder general contractors, and residential building only builder general contractors focus their business in the home cities, manufacturing building only builder general contractors focus their business in the outside state.

Table 17 subcontractors' business structure by location during 1929

classification of establishments	ratio_in_home _city (1)	ratio_in_home _state (2)	(3): (2)-(1)	ratio_outside _state
Subcontractors	0.679	0.858	0.179	0.142
carpentering and wood flooring	0.584	0.952	0.368	0.048
Concreting	0.660	0.868	0.208	0.132
Electrical	0.762	0.915	0.153	0.085
elevator construction	0.575	0.756	0.181	0.244
heating and plumbing	0.733	0.896	0.163	0.104
Masonry	0.743	0.874	0.131	0.126
painting and decorating	0.833	0.953	0.12	0.047
glass and glazing	0.779	0.941	0.162	0.059
plastering and lathing	0.787	0.941	0.154	0.059
roofing and sheet-metal work	0.721	0.923	0.202	0.077
steel erection	0.455	0.700	0.245	0.300
Stonework	0.698	0.896	0.198	0.104
marble and tilling	0.673	0.876	0.203	0.124
Wrecking	0.789	0.916	0.127	0.084
Excavating	0.625	0.908	0.283	0.092
ornamental iron	0.549	0.777	0.228	0.223
Highway	0.232	0.861	0.629	0.139
bridge and culvert	0.399	0.873	0.474	0.127
Grading	0.398	0.811	0.413	0.189
street paving	0.666	0.9998	0.3338	0.0002
sewer, gas, water, conduit	0.823	0.919	0.096	0.081
dam and reservoir, waterworks	0.559	0.988	0.429	0.012
dredging, river, harbor, etc.	0.519	0.786	0.267	0.214
Soundproofing	0.428	0.783	0.355	0.217
Railroad	0.032	0.200	0.168	0.800
Foundation	0.215	0.299	0.084	0.701
power plant	0.595	0.886	0.291	0.114
metal work, n.e.s and pipe line	0.173	0.414	0.241	0.586
rental of equipment, trucking, etc.	0.458	0.635	0.177	0.365
flooring, n.e.s	0.521	0.710	0.189	0.290
Miscellaneous	0.117	0.277	0.16	0.723

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

Viewing from the Table 17, we can see that the sub-contractor's business focus is in the state, not outside states. However, for a small number of industries, these industries subcontractor's business proportion is also relatively high in the outside state, these industries are needing to be scaled, such as elevator construction, steel erection, ornamental iron, Grading, Soundproofing, Foundation, metal work, n.e.s and pipe line, rental of equipment, trucking, etc., Miscellaneous, and public works, such as dredging, river, harbor, railroad.

Table 18 the proportion of a state construction business outside home state in the total business outside home state
unit: %

State name	State's proportion	general contractors' proportion	Subcontractors' proportion
Alabama	1.841453	1.594615	.2468389
Arizona	.7381917	.5361181	.2020735
Arkansas	1.12449	1.04171	.0827803
California	1.766515	1.446379	.3201353
Colorado	.4260128	.3605796	.0654332
Connecticut	3.728554	3.110779	.6177745
Delaware	.6867924	.585647	.1011455
District of Columbia	1.503845	.9075931	.5962521
Florida	.7358771	.6143314	.1215457
Georgia	.9947354	.7078107	.2869296
Idaho	.2231296	.1938191	.0293105
Illinois	5.275105	4.249299	1.025807
Indiana	3.104422	2.371528	.7909439
Iowa	1.259036	1.102857	.1561789
Kansas	1.373244	1.094661	.2785825
Kentucky	1.372188	1.112127	.2600613
Louisiana	1.355834	1.130732	.2251014
Maine	.8541226	.7694076	.0847156
Maryland	1.931618	1.449027	.4825909
Massachusetts	1.82118	1.243389	.5777906
Michigan	3.462707	2.268201	1.194506
Minnesota	.7600284	.583313	.1767154
Mississippi	.8783911	.7645231	.113868
Missouri	3.488815	3.162772	.3260424
Montana	.4692749	.4202767	.0489982
Nebraska	.3971812	.3211449	.0760362
Nevada	.2187699	.1950127	.0237572
New Hampshire	1.740232	1.667313	.0729194
New Jersey	10.03712	7.509012	2.528105
New Mexico	.2831658	.256559	.0266068
New York	9.665586	6.861747	2.80384
North Carolina	1.717853	1.395912	.3219409
North Dakota	.4269198	.3724937	.054426
Ohio	3.759117	2.713874	1.044662
Oklahoma	.890231	.6585112	.2317199
Oregon	.3981235	.3320175	.066106
Pennsylvania	6.621054	4.950999	1.670054
Rhode Island	.938718	.7804308	.1582873
South Carolina	1.550344	1.233287	.3170564
South Dakota	.2481232	.2128737	.0352495
Tennessee	1.916821	1.684865	.231956
Texas	3.613551	2.929826	.6837242

Utah	.2077233	.1020353	.0476381
Vermont	.8719906	.8230078	.0489828
Virginia	1.441846	1.140321	.3015255
Washington	1.749765	1.531644	.2175398
West Virginia	1.601508	1.372887	.2286216
Wisconsin	1.352827	1.01635	.3364766
Wyoming	.2562785	.2205408	.0357377

Source: computation based on data in U.S. 1930 Census of Population, Construction Industry

Based on the data in the above Table 18, we can compute the correlation coefficient between the general contractors' proportion and subcontractors' proportion, the coefficient value is 0.9341, a very high value, that means the correlation degree between general contractors' proportion and subcontractors' proportion is very high.

4 Factors Affecting Subcontract Structure

We make the variable subexpense_ratio as explained variable, and construct four different econometric models, the model results are as the following:

Model of operative builders and general contractors

subexpense_rate	coefficients
ratio_prtor_re_no	-0.504***
	(-4.70)
ln_aversalary_prtor	0.0360
	(1.55)
ln_aversalary_em	0.114
	(0.31)
ln_aversalary_offi	0.612***
	(4.62)
ln_aversalary_super	-0.790
	(-1.72)
ratio_female	5.161***
	(6.75)
ln_average_pur_equipment	0.130**
	(2.83)
ln_average_wages	0.648*
	(1.90)
ln_equip	-0.193**
	(-2.74)
ln_inven	0.176**
	(2.75)
rate_compensation	-228.0***
	(-3.91)
rate_profit	-0.00695
	(-1.34)
_cons	-4.071*
	(-1.98)
N	21
R-sq	0.973

t statistics in parentheses, * p<.1, ** p<.05, *** p<.01

Model of subcontractors

subexpense_rate	coefficients
ratio_prtor_re_no	-0.00482
	(-0.34)
ln_aversalary_prtor	-0.0663**
	(-2.52)
ln_aversalary_em	0.321
	(1.01)
ln_aversalary_offi	-0.221
	(-1.10)
ln_aversalary_super	0.0218
	(0.19)
ratio_female	0.00604*
	(1.81)
ln_average_pur_equipment	0.0152***
	(3.04)
ln_average_wages	0.00637
	(0.15)
ln_equip	-0.0129
	(-1.36)
ln_inven	0.0133
	(1.29)
rate_compensation	2.589
	(0.42)
rate_profit	0.000392
	(0.58)
_cons	-0.567*
	(-1.84)
N	32
R-sq	0.542

t statistics in parentheses, * p<.1, ** p<.05, *** p<.01

Overall model

subexpense_rate	coefficients
ratio_prtor_re_no	-0.0203*
	(-1.74)
ln_aversalary_prtor	-0.00423
	(-0.84)
ln_aversalary_em	-0.204
	(-1.68)
ln_aversalary_offi	0.163**
	(2.37)
ln_aversalary_super	0.0768
	(1.25)
ratio_female	-0.00886***
	(-3.51)
ln_average_pur_equipment	0.00494
	(1.41)
ln_average_wages	0.0326
	(1.00)
ln_equip	0.000144
	(0.02)
ln_inven	-0.00132
	(-0.16)
rate_compensation	-7.903
	(-1.10)
rate_profit	-0.0122***
	(-16.72)
rate_material	-0.00940***
	(-37.47)
rate_wage	-0.0109***
	(-24.99)
_cons	0.540*
	(1.89)
N	54
R-sq	0.989

t statistics in parentheses, * p<.1, ** p<.05, *** p<.01

Viewing from above four models, we can know that:

① Variable: ratio_prtor_re_no (proprietors and firm members receiving salaries number /proprietors and frim members no receiving salary number) will negative influence explained variable subexpense_rate (subcontract work let expenditure/total value of construction) significantly, i.e. if ratio_prtor_re_no increases, subexpense_rate will decrease, that means if more proprietors and firm members get salaries, means more proprietors and firm members participate in the work of the company, then less work will be subcontract out.

② Variable: ln_aversalary_offi (representing average salary of officers and clerical staffs) will significant influence explained variable subexpense_rate positively, i.e. if the average salary of officers and clerical staffs is high, it will promote subcontract work.

③ Variable: ratio_female (i.e. the ratio of female number to number reported by sex) will significantly influence explained variable subexpense_rate positively, i.e. if the ratio_female is high, it will promote subcontract work.

④ Variable: ln_average_pur_equipment (i.e. equipment purchased /establishments reporting) will significant influence explained variable subexpense_rate positively, i.e. if the ln_average_pur_equipment is high, it will promote subcontract work.

⑤ ln_average_wages will significant influence explained variable subexpense_rate positively, i.e. if the average wage of the workers is high, it will promote subcontract work.

⑥ ln_equip (equipment purchased annual year) will negative influence explained variable subexpense_rate significantly.

⑦ ln_inven (value of inventory equipment at the end of year) will significantly influence explained variable subexpense_rate positively.

⑧ referring to operative builders and general contractors model and subcontractors model, variable rate_profit will influence explained variable subexpense_rate significantly. But referring to general contractor model, variable rate_compensation will influence significantly explained variable subexpense_rate negatively, that means increasing subcontract will decrease compensation and insurance expense.

5 Conclusions

Looking at the analysis of the full text, we can draw the following conclusions:

Different types of contractors have different proportions of general contracts and subcontracts, and different subcontract work let behaviors. Almost 100 percent business value of operative builders is under general contract, but the rate of their subcontract work let is high, this rate is 0.672. Operative builders subcontract the majority of their projects out; the subcontractors not only undertake the subcontracting business, but also undertake the business of the general contractor. After undertaking the general contractor business, the subcontractors are rarely subcontracted, mainly do these by themselves, so that the rate of subcontractors' subcontract work let over total value of construction is very small, it is 0.033; general contractors' business value under general contract are as very high as 0.989, general contractors will subcontract 30.6% of their total business out to subcontractors, they will keep the left 69.4%, and do it by themselves.

There is a negative correlation between indicator the rate of subcontract work let over total value of construction and indicator the rate of cost of materials expenditures over total value of construction. Operative builders and the general contractors gotten subcontract business dislike to subcontract business again.

Comparing to the general contractors and operative builders, the workers working for the subcontractors get the highest average wages, and the superintendents, foremen, etc. working for subcontractors get the highest average salary. This indicates that the subcontractors' jobs require workers, superintendents, foremen, etc. to have relatively high skills.

Comparing to the subcontractors and operative builders, the employees working for the general contractors get the highest average salaries, and the officers and clerical staff working for general contractors get the highest average salaries. This indicates that the skill requirements for the employees, the officers, the clerical staff working for the general contractors are relatively high.

Comparing to the subcontractors and operative builders, the average salary of proprietors and firm members of the general contractors is the highest. This indicates that the general contractors decrease the costs and risks via subcontracting, then can get more profits.

Starting from the smallest group, as the scale of group expands, the ratio of subcontract work let expenditures over total value of construction corresponding to that group is increasing.

The rate of subcontractors' value over general contractors' value decreases along the increasing of the degree of publicity in the construction projects. Referring to businesses are distributed by class of public ownership, the rates of subcontractors' value over general contractors' value are all small, and between interval 0.101 and 0.146.

The ratio of proprietors and firm members receiving salaries number to proprietors and firm members no receiving salary number will negative influence explained variable the ratio of subcontract work let expenditure to total value of construction significantly, i.e. if ratio of proprietors and firm members receiving salaries number to proprietors and firm members no receiving salary number increases, the ratio of subcontract work let expenditure to total value of construction will decrease, that means if more proprietors and firm members get salaries, means more proprietors and firm members participate in the work of the company, then less work will be subcontract out.

Average salary of officers and clerical staffs will significant influence explained variable the ratio of subcontract work let expenditure to total value of construction positively, i.e. if the average salary of officers and clerical staffs is high, it will promote subcontract work.

The ratio of female number to number reported by sex will significantly influence explained variable the ratio of subcontract work let expenditure to total value of construction positively. The ratio of equipment purchased to establishments reporting will significant influence explained variable the ratio of subcontract work let expenditure to total value of construction positively. Average wages will significant influence explained variable the ratio of subcontract work let expenditure to total value of construction positively, i.e. if the average wage of the workers is high, it will promote subcontract work. Equipment purchased annual year will negative influence explained variable the ratio of subcontract work let expenditure to total value of construction significantly. Value of inventory equipment at the end of year) will significantly influence explained variable the ratio of subcontract work let expenditure to total value of construction positively.

Referring to general contractor model, variable the ratio of compensation and insurance expense to total value of construction will influence significantly explained variable the ratio of subcontract work let expenditure to total value of construction negatively, that means increasing subcontract will decrease compensation and insurance expense.

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