The nexus between contracting and construction professional services: empirical evidence from the international market

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Abstract

The construction market around the world has witnessed in recent years the growing eminence of construction professional services (CPS) such as urban planning, architecture, engineering, and consultancy, whilst the traditional contracting sector remains strong. Nowadays, it is not uncommon to see a design firm taking over a traditional main contractor's job, or vice versa, in championing the delivery of a project. The two sectors of contracting and CPS, although sharing the same purpose of materializing the built environment, are differentiated as much as they are interrelated. Much has been said about the nexus between the two but less has been done to articulate it using empirical evidence. This paper attempts to unlock the nexus between contracting and CPS by offering and testing lead-lag effects between the two sectors in the international market. This is done by carrying out a longitudinal panel data analysis of 23 top international construction and CPS firms from the Engineering News Record's top lists over the past 12 years. Surprisingly, it is found from the panel data analyses that CPS business does not have a significant positive casual effect on contracting as a downstream business. Neither does contracting have a significant positive casual effect on CPS. It is further revealed that CPS and contracting subsidiaries, although within the same company, do not necessarily form a consortium to undertake the same project. Rather, they may collaborate with other companies' CPS or contracting counterparts in undertaking projects. This research provides insights into the sophisticated competition in international construction business that are of significant value to business executives and researchers.

Keywords: international business, contracting, construction professional services, lead-lag effect, international construction

Introduction

The global construction market in recent years has seen an increasing amount of integration between contracting and construction professional services (CPS) businesses. It is not uncommon to see a design firm taking over a traditional main contractor's job, or vice versa, to deliver a project. The two types of firms, contracting and CPS, often ally with each other to undertake construction projects. This is not exceptional in the international construction market. For example, to gain advantage from pooling design and construction strengths, Arup signed a memorandum of understanding with the China Railway Group in 2011 for bids in Africa, the Middle East, South America and Southeast Asia (Reina and Tulacz, 2011). At times, construction and CPS firms even "internalize" each other through mergers and acquisitions (M&A). A typical example is that of Balfour Beatty who, as a UK construction company, took over the US design giant Parsons Brinckerhoff in 2009 (Rubin and Reina, 2009). Many companies such as Fluor Corp, Bechtel, Jacobs, McDermott International Inc. often appear on both the ENR's top 225 international contractors (TIC 225) and the top 200 international design firms (TID 200) lists. No longer can one easily tell which is a CPS firm and which is a traditional contractor.

There are several factors driving this convergence of contracting and CPS. Firstly, CPS business is an economic agent in its own right with higher profitability than its contracting counterpart (Lu et al., 2012). Rubin (2011) cited a survey conducted by the Environmental Financial Consulting Group (EFCG) Inc., revealing that chief finance officers (CFOs) of the

120 surveyed design (CPS) firms reported a 9.6% median profit margin for year 2010, whereas the profitability margin of contracting is about 3% around the globe. The difference in margins has long been exhorted as a reason for construction companies to expand to this high-end upstream business. In addition, CPS are suitable for market penetration. The construction sector, in particular the international market, is subject to many different aspects of regulation, such as: controls on land use; building regulations and technical requirements; building permits and inspection; registration of proprietors, contractors and professionals; regulation of fees and remunerations, and; environmental regulations (WTO Secretariat's Note, 1998). These measures, however, may be found to be less onerous for CPS. Hence, CPS and contractors working in tandem can be a competitive strategy to penetrate an international market. Probably, a more important driving factor is that clients nowadays are increasingly demanding integral design and build services. According to Tuiacz and Rubin (2004), the notion that construction management (CM) and design-build are "alternative" methodologies is something of a misnomer now. This is echoed by Jewell et al. (2010) who reported that the international market is experiencing changing forms of procurement and the growth in design-build (D&B), Design, Build, Finance and Operate (DBFO) and other integrated procurement approaches. Under these circumstances, top companies tend to integrate both CPS and contracting within their business lines to meet this demand.

Much has been said about the nexus between the two sectors. For example, Lu et al. (2012) suggested that CPS have a casual effect on the downstream businesses such as contracting, and the export of materials and machinery but they did not provide any empirical evidence. Lu et al. (2013) reported that integration of CPS and contracting could provide procurement innovation which would sharpen the competitive advantage of international companies. However, less has been done to prove their relationships using empirical evidence, despite the

academic and practical significance of understanding the nexus between contracting and CPS. It may help to determine whether a company should entail both CPS and contracting, or just focus on a certain area, which is a typical scenario for testing the "focus" element of Porter's (1980; 1985) generic competitive strategies. From an organizational structure perspective, understanding the effect can help explain whether one should internalize CPS and contracting using a hierarchy, or let the market mechanism drive the coordination of the two business sectors. This is a typical scenario for investigating the dichotomous view of markets and hierarchies in Neoclassical Economic Theory (Coase, 1937; Williamson, 1991). In practical terms, the research will help gain insights into the operations of CPS and contracting companies, which will, in turn, support business executives' rational decision-making for selecting proper contracting or CPS allies, or a proper M&A strategy in the international market.

The aim of this study is to offer and test the lead-lag effect between CPS and construction by situating them in the international market. Granger causality tests will be conducted to identify the effect between contracting and CPS business by examining their performance in the ENR's top firm lists over the past 12 years. The rest of the paper is organized as follows. Section 2 elaborates several critical and relevant constructs including the construction industry, or the AEC industry; and production, services, or CPS. Section 3 develops the hypotheses with relation to the lead-lag effects between contracting and CPS, followed by Section 4 which has a discussion of the sample, measures, data, and procedures for testing the hypotheses. In Section 5 the analyses, discussions, and research findings are presented. Conclusions follow in Section 6.

Constructs

The construction industry or the AEC industry

In the previous section, the discussions on contracting and construction professional services (CPS) were conducted in a way without carefully considered the distinction between them. It is necessary to disentangle them from each other in this section. According to Dainty *et al.* (2007), precisely what constitutes the "construction industry" is subject to a range of different boundary definitions. Pearce (2003) distinguishes between narrow and broad definitions of the construction sector. The narrow definition focuses on on-site assembly and the repair of buildings and infrastructure as performed by contractors. This interpretation of the construction sector follows the UK Standard Industrial Classification (SIC) system that allocates economic activity to different divisions in accordance with a generic coding system (ONS, 2007). The narrow definition of construction excludes those involved in professional services, including those who provide design and engineering services (Dainty *et al.*, 2007). On the basis of his narrow definition of construction, Pearce (2003) suggests that construction contributes 5 percent of UK GDP.

However, if Pearce's broad definition is adopted, the boundary extends beyond on-site activity to include quarrying of raw materials, manufacture of building materials, sale of construction products and professional services (Dainty *et al*. 2007). This definition thus covers what have been included in the architecture, engineering, and construction (AEC) industry, the scope of which is more self-explanatory by the term it uses. At the risk of over simplification, the broad definition of construction, often used in UK literature, can be assumed as equivalent to the AEC industry which is more often seen in American literature. This broad definition echoes with Chartered Institute of Building's (CIOB) recent efforts of re-defining construction management where construction is recognized as the broadest sense of the term (Bale, 2010). On the basis of the broad definition, the contribution of the

construction industry to UK GDP could double to 10 percent (Dainty *et al.*, 2007).

Production, services, or construction professional services

The above discussions also delineate the three main business sectors in the construction industry as architecture, engineering, and construction. The former two are unequivocally recognized as professional services, while construction is often mistakenly perceived as a production sector. According to the GATT Services Sectoral Classification List (GNS/W/120), which is in accordance with UN's International Standard Industrial Classification (ISIC), construction is classified as services including (a) general construction work for buildings, (b) general construction work for civil engineering, (c) installation and assembly work, (d) building completion and finishing work, and (e) other. Several well-known traditional construction contractors have in recent years re-listed themselves on the stock exchange as service companies (Goodier *et al*., 2006). Referencing back to the discussions above, construction services herein belong to the narrow definition of construction.

Also noteworthy, in the WTO's list, is that construction-related services including (1) architecture, (2) engineering, (3) urban planning and landscape and architecture, coupled with other services such as accounting, auditing and bookkeeping, and tax consultancy, are classified as professional services. They differ from construction services in their industry classification, categorizing themselves as being in the Knowledge Intensive Business Services (KIBS) sector, in which services and business operations heavily reliant on professional knowledge instead of other tangible resources. Researchers and organizations have also used other specified terms such as construction professional services (e.g. CIC and DTI, 2003; Jewell *et al.*, 2010), or construction knowledge-intensive professional service

firms (KIPSFs) (Lu and Sexton, 2006). Although they fall into two distinct sectors according to the ISIC, construction and its related professional services are often discussed together as they are closely interrelated in materializing the built environment.

Research has attempted to numerate what CPS should cover in order to delineate the concept clearly. Jewell *et al*. (2010) define CPS as those services provided by firms under Section M, Activity 71 of the UK SIC 2007 (ONS, 2007): Architectural activities; urban planning and landscape architectural activities; engineering activities and related technical consultancy; engineering design activities for industrial process and production; and other engineering activities. Another perspective is the ENR's survey guidelines for ranking its top international design firms and top international construction firms. The guidelines say: (a) the top design firms are ranked on revenue for design and design-related services, excluding revenue for contracting, construction management, program management, procurement and other non-design services; and (b) the top construction firms will be ranked based on gross revenue derived from general contracting, construction management at-risk, the construction portion of design-build activities and equipment procurement and installation services as part of an overall construction contract. A word of caution: discussions on CPS should not ignore those construction-related accountancy, legal, or ICT services, which are often provided by firms outside the construction industry.

In summary, *contracting* in this study means general contracting, construction management at-risk, the construction portion of design-build activities and equipment procurement and installation services as part of an overall construction contract. *CPS* can be considered as including a wide range of knowledge-intensive realms such as architecture, engineering, environmental, geotechnical engineering, landscape architecture, urban planning, surveying,

and their combinations, as well as construction-related accountancy, legal, Information Communication Technology (ICT) services. Figure 1 illustrates the working concept of CPS adopted by this study and its relationship with other related services sectors.

<<Insert Figure 1 here>>

Hypotheses

The nexus between contracting and CPS is multifaceted. However, this research examines it from a business point of view. According to Lu et al. (2009), designers or engineers tend to nominate their trusted contractors or products, i.e. construction materials and mechanical and electrical systems from their own country. Moreover, an integration of CPS and contracting can lead to procurement innovations in realizing construction projects that are difficult using traditional procurement methods (Lu et al., 2013). As described previously, there are a growing number of examples of contracting firms purchasing CPS firms, or vice versa, through M&As. Intuitively, it is hypothesized that CPS (as a leading factor) will have a positive casual effect on contracting business (as a lag factor) within the same firm.

H_1: CPS have a positive casual effect on a contracting business

Here, we emphasize "the same firm" in that CPS and contracting integration can happen within the same single economic unit or firm (e.g. a design-build firm), where operations are normally governed by hierarchical relations, or in inter-firm consortiums (e.g. a special purpose vehicle in a public private partnership project), where the governance is mainly through contracts and other informal institutions such as relations, trust, and culture (Winch, 1989). The former is the focus on this paper.

Notably, CPS firms are increasingly interested in allying with contracting companies in

undertaking projects. A proposed design with proven buildability (in collaboration with the contractor) will be more convincing for clients. Moreover, this integration is even more advantageous with clients tending to demand integral design-and-build services for their projects. It is therefore hypothesized that:

H_2: Contracting has a positive casual effect on CPS business

Sample

The hypothesized nexus between contracting and CPS businesses will be tested in the international market. ENR began an annual survey in 1979 to collect data, including each firm's contracting revenue, and details of their sub-markets in different geographical locations or production segments, to form a list of top 225 international contractors (TIC 225). From the 1990s, ENR began a similar survey to collect data, such as design-related services, to form a top 200 international design firms (TID 200) list. It is noticed that a handful of companies appear on the both lists. Therefore, these companies are considered a good sample for testing the relationships between contracting and CPS in the international market. Ye et al. (2009) showed that contractors, other than the TIC 225, have negligible market power as their market shares are relatively very small.

Data collection

This research tests the hypotheses by using contracting and CPS revenues as the measure of their businesses. From the two ENR lists a set of panel data was derived as shown in Table 1.

<<Insert Table 1 here>>

There are 23 international companies that have been listed on both ENR's TIC 225 and TID 200 between 2000 and 2011. The longitudinal data set contains 276 firm-year observations. Greene (2002) suggested that a longitudinal data set that combines both time series and cross sections has the advantage of allowing great flexibility in modeling different behaviors of aggregate data across individuals. Thus, the panel data in Table 1 is considered a valuable data set for testing the lead-lag effects between contracting and CPS firms in the international market.

The revenues of contracting and CPS businesses of the 23 companies are plotted in Figure 2. This represents a graphical view of their rise and fall, and the interaction between the two business sectors within the same company. It can be seen that contracting and CPS in the same company largely follow the same trend in terms of their rise and fall. There might be some lead-lag relationship between the two sectors, but to unlock the nexus, more robust empirical analyses are desired.

<<Insert Figure 2 here>>

Procedures and empirical results

Step 1 Basic procedures for conducting panel data analysis

First, revenues of contracting and CPS are presented as $\{X_{it}\}$ and $\{Y_{it}\}$, where i=(1,2,…,23) and t=(1,2,…,12). Given the time-series nature of the data, the second step in the analysis is to determine the stationarity of panel data. This is tested by a unit root test (Levin and Lin, 1992; Maddala and Wu, 1999). If the panel data fail the stationarity test, a time series needs to be adapted by certain levels of differential until the rest requirement is fulfilled. The stationarity test results in Table 2 show that the panel data from Table 1 is stationary and

ready for further analyses.

<<Insert Table 2 here>>

Third, the basic equation for the panel data analysis, as a regression model, is developed and shown below:

$$y_{it} = x_{it}^T \beta + z_i^T \alpha + \varepsilon_{it} \quad \text{Eq. (1)}$$

Where y_{it} is the dependent variable, x_{it} the independent variable, $z_i^T \alpha$ the individual effect or heterogeneity term, and ε_{it} the error term. The subscript *i* indicates individual firm and *t* presents the time. z_i contains a constant term and a set of individual or group specific variables, all of which are taken to be constant over time *t*. The main objective of the panel data analysis is to test the consistent and efficient estimation of β, which indicates the correlation between contracting work (x_{it}) and CPS (y_{it}). Three basic models for the panel data analyses - a pooled regression model, a fixed effects model, and a random effect model, have be compared with a view to identifying the one that best fits the panel data. The comparison is conducted by employing a poolability test and a Hausman Test (Kunst, 2009).

Next, the balanced panel data of the 23 firms is analyzed by R, which is an open source statistical analytical software program. The results are shown in Table 3. The positive correlation between CPS and contracting revenue is confirmed.

<<Insert Table 3 here>>

Step 2: Lead-lag relationship between {X_{it}} and {Y_{it}}

However, correlation does not imply causation (Aldrich, 1995). To find out the likelihood of a true causal relationship between contracting and CPS businesses, as hypothesized in H_1 and H_2, this study further tests the lead-lag relationship between the two business sectors. Lagged models were adopted in this research. Eq.(2) and Eq.(3) are the models to test the bidirectional lead-lag relationships between contracting and CPS businesses:

$$y_{it} = \sum_{j=1}^{p} y_{i(t-j)}\beta_j + \sum_{j=1}^{q} x_{i(t-j)}\gamma_j + \alpha + \varepsilon_{it} \quad \text{Eq. (2)}$$

$$x_{it} = \sum_{j=1}^{q'} x_{i(t-j)}\gamma'_j + \sum_{j=1}^{p'} y_{i(t-j)}\beta'_j + \alpha' + \varepsilon'_{it} \quad \text{Eq. (3)}$$

Where $\boldsymbol{y_{it}}$ is the dependent variable; $\boldsymbol{x_{it}}$ the independent variable; p, q, $\boldsymbol{p'}$, and $\boldsymbol{q'}$ the maximum levels of lag in the analyses; $\boldsymbol{y_{i(t-j)}}$ is the CPS revenue of firm i in $(t\text{-}j)^{th}$ year, $\boldsymbol{x_{i(t-j)}}$ is the contracting revenue of firm i in $(t\text{-}j)^{th}$ year, $\boldsymbol{\beta_j}$, $\boldsymbol{\beta'_j}$, $\boldsymbol{\gamma_j}$, and $\boldsymbol{\gamma'_j}$ coefficients of lagged terms; $\boldsymbol{\alpha}$, and $\boldsymbol{\alpha'}$ constant terms, ε_{it} and ε'_{it} error terms. Eq. (2) is to test whether X has a lead-lag effect on Y, and Eq. (3) is to test whether Y has a lead-lag effect on X. If one or more significant coefficient(s) of $\boldsymbol{x_{i(t-j)}}$ in Eq. (2) exists, it means the hypothesized lead-lag relationship of $\boldsymbol{x_{it}}$ on $\boldsymbol{y_{it}}$ is supported. Similarly in Eq. (3), the existence of significant coefficient(s) of $\boldsymbol{y_{i(t-j)}}$ confirms the lead-lag relationship of $\boldsymbol{y_{it}}$ on $\boldsymbol{x_{it}}$. The effects of any lead-lag relationship depend on the estimated coefficient(s) and statistical tests of the lagged models.

Theoretically, the length of the lag varies from 1 year to the number of years that the data are available to a given company, i.e. 12 years in the panel data. However, increasing level of lags will lead to decrease of sample size for this test. For example, when the level of lags is 2, the sample size is 230; when the level is 3, the sample size decreases to 207. Therefore, to ensure sufficient sample size for this analysis, the maximum lag level of 3 is adopted. The

results of testing the lagged models are shown in Table 4.

<<Insert Table 4 here>>

Surprisingly, the analyses show that no lead-lag relationship between contracting $\{X_{it}\}$ and CPS $\{Y_{it}\}$ business is discovered from the panel data. This contradicts our belief and so both hypotheses H_1 and H_2 are not supported.

Analyses, discussions, and research findings

In-depth analyses of the business operations in the above listed companies were conducted to understand the non-existence of a lead-lag relationship between contracting and CPS. Research efforts have been made to collect annual reports of the companies over the past five years from 2008 to 2012, with the hope that they will give their business operation models and explain the "no relationship". The reports are scrutinized and interpreted in Table 5. Beyond the standard self-promoting information, there were some interesting findings.

<<Insert Table 5 here>>

These companies are often involved in more than one business. For example, Balfour Beatty in the report releases revenues from "construction services", "professional services", "support services", and "infrastructure investments". Jacobs provides "traditional field construction services", "operations and maintenance", and "project services", which are similar to the CPS defined in this study. These resonate with above argument that contracting is nowadays classified as services.

Most of the reports only release revenues in different regions (e.g. North America, Europe, the Middle East, or China), or in different market segments (e.g. oil and gas, infrastructure, or power). Few reports have elaborated contracting and CPS businesses individually, and even fewer reports have delineated how the two sectors operate within the same company (e.g. how they work in tandem to undertake an Engineering Procurement, and construction [EPC] project). This gives rise to the difficulty of interpreting the relationship as the primary aim of this study.

Companies seem well aware of the business opportunities brought about by clients' increasing preference to EPC or D&B, e.g. Balfour Beatty, and JGC Corporation. Nevertheless, as can be seen from the operations of the Shaw Group Inc, CH2M HILL, or Fluor Corp. in Table 5, the CPS and contracting subsidiaries, although within the same company, do not necessarily form a consortium amongst themselves to undertake an EPC or D&B project. Rather, they may collaborate with other companies' CPS or contracting counterparts in undertaking that project. In fact, the CPS and contracting subsidiaries are largely separated profit centers by themselves. They are "freelance" competitors in different projects. This resonates with the observation by Lu et al. (2013) that companies nowadays adopt a "co-opetition" strategy (e.g., Brandenburger and Nalebuff, 1996; Flanagan, 2009; Eriksson, 2008), which involves collaboration with other companies in one market segment, a region, or even a particular project, while competing fiercely against them in other segments, regions, or projects.

There is one exceptional case that Jacobs explains that their field construction activities have been focused primarily on those construction projects for which they perform much of the related engineering and design work. Also, Jacobs particularly emphasizes that they do not

maintain profit centers but encourage cooperation, not competition, across all of their offices in managing their business.

With such a "co-opetition" strategy, it may not be difficult to explain the test results in Table 4 that a contracting business in one particular year (X_t) is significantly impacted by its earlier terms' business (X_{t-1} and X_{t-2}) but not by their CPS counterpart in any term (Y_{t-1}, Y_{t-2}, and Y_{t-3}). Likewise, it is not difficult to explain why CPS business in one particular year (Y_t) is significantly impacted by its earlier terms' business (Y_{t-1} and Y_{t-2}) but not by their contracting counterpart in any term (X_{t-1}, X_{t-2}, and X_{t-3}). Jointly, the above analyses can explain why there is no significant lead-lag relationship between contracting and CPS business.

However, given the non-existence of lead-lag relationship between contracting and CPS, why do companies still strive to grow alongside the both directions, sometimes, even through aggressive mergers and acquisitions (M&A) strategies? In addition to the acquisition of Parsons Brinckerhoff by Balfour Beatty in 2009, Jacobs also reported a series of acquisitions since 2008. Jacobs clearly states that they favor acquisitions that allow them to (i) expand into a new client market; (ii) enhance the range of services we provide existing clients; and/or (iii) access new geographic areas in which our clients either already operate or plan to expand. These echo Balfour Beatty's acquisition strategy through which they can edge into the Group's target geographies, or target sectors. However, No clear clue, except for the claim by Balfour Beatty in Table 5, shows that the growth of contracting and CPS is by their integration, or for integration.

Conclusions

This research offers and tests the lead-lag effects between contracting and CPS business, with

a view to unlocking the complicated yet intriguing nexus between the two sectors in the international market. Unlike our belief that contracting and CPS within the same firm will mutually benefit from each other, an empirical analysis of a longitudinal panel data contributed by 23 top international contracting and CPS firms on ENR's top lists over the past 12 years shows that no significant lead-lag relationship was found between the two. In-depth analyses of the business operations in these companies show that CPS and contracting subsidiaries, although under the same company umbrella, do not necessarily form a consortium to meet clients' increasing demand of integral design and build services. By and large, they remain as individual profit centers, and thus they may collaborate with other companies' CPS or contracting counterparts in undertaking an EPC or D&B project.

This research has significant academic and practical values. Traditional theories of organizations and competition are frequently challenged by modern contracting and CPS business. In practical term, the research provides fresh perspectives on the operations of top construction companies in the international market. By arguing that the growth of contracting and CPS is not by their integration, or for integration, this research may divert researchers' interest to investigating the rationale and strategies of merger and acquisition, which are increasing seen in the international construction market.

Nonetheless, the research has its limitations. First, the evidence adopted to substantiate the non-existence of lead-lag relationship between contracting and CPS is mainly anecdotal. The argument will have a sounder ground if empirical data showing the portions of CPS or construction business in the same projects can be collected. Second, researchers had warned that the self-reported ENR data should be treated with caution and that the annual report data is more acceptable for research. Most of the companies are publically listed; to comply with

the law, they have to reveal data and maintain the integrity of the data for their shareholders. Serious research on the creditability of ENR data is thus desired.

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Table 1: Revenues of construction and CPS business of the 23 international companies listed on both TIC 225 and TID 200 (unit: m$)

Firm	Construction/CPS	Year											
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AMEC plc, London, U.K.	Con.	2472.3	2835.6	3017	3440	3219	3483	586	573.4	691.2	215	255.3	276
	CPS	974.9	802.2	689	704	1346	958	1221	845.5	2391.3	1946.7	2456	2291.1
Balfour Beatty, London, U.K	Con.	937	1183	1610	1254.5	1661	2202	2380	6469	6042	6461	5161.1	5805
	CPS	140	155	137	192	220	142	146	121	75	279	1461.8	2485.4*
Bechtel, San Francisco, Calif., U.S.A.	Con.	6811	3993	2920	6637	8105	7662	8931	11742	13984	14849	12500	16700
	CPS	758	761	735	573	582	770	1127	1332	1320	1114	1220	1599
Black & Veatch, Overland Park, Kan., U.S.A.	Con.	471.9	268.8	191.7	204	217.9	256.9	381.1	1023	723.3	516.5	465	573.7
	CPS	234.7	198.2	159.2	212.9	234.4	194.3	274.1	288.4	367.6	336.3	322.1	369.4
CH2M HILL, Englewood, Colo., U.S.A.	Con.	91.5	30.2	37.5	70.9	226.5	168.3	244.9	451.2	493.9	407.2	320.6	238.1
	CPS	170.9	207.5	177.5	161	201.9	249.9	326.2	504.2	718.1	904.8	891.3	1563.6
China HuanQiu Constructioning & Engineering Corp., Beijing, China	Con.	33.3	36.8	40.1	43.2	45.1	49.9	57.1	79.5	169	314.5	322.4	319.6
	CPS	8.6	9.7	5.4	8.6	11.9	11.2	16.2	20.5	25.4	39.2	40.6	76.3
China Int'l Water & Electric Corp. (CWE), Beijing, China	Con.	120.3	109.9	139.6	145.7	190.2	270	302	358.1	444.7	504.6	610.3	954.6
	CPS	9.5	20.4	25.5	29	26	29.3	30	30.9	31	35.1	37	49.8
Consolidated Constructionors Group, Athens, Greece	Con.	1390.7	1385.7	1460.1	1823.9	2119.8	2314.4	3941.2	5471	5466.1	5739.1	5264.7	5520.6
	CPS	25	25	35	40	50	50	60	50	25	30	30	48.5
CTCI Corp., Taipei, Taiwan	Con.	25.9	48.4	95.7	95.6	252.4	215.8	223.7	522.4	813.5	817.9	472.7	592.7
	CPS	13.7	10.7	16.6	21.8	26.3	64.1	24.8	121.3	97	73	259.6	88.2
Fluor Corp., Irving, Texas, U.S.A.	Con.	3280.2	2266.7	2696.6	3054.3	3635.6	7124.9	6338.5	7940.4	9140.7	9629.4	11565.6	13526.8
	CPS	381	725.9	730.8	1053.7	1794	1289.5	1733.5	2118.4	2331	2115.6	2057.6	3462.7
HOCHTIEF AG, Essen, Germany	Con.	9107	9516	10010	10252.3	12632	14733.3	17598.9	21313.4	26181.8	23769.5	27424.7	31870.7

	CPS	87	130	145	154.7	55.9	55.9	55.6	602.2	830.5	927.8	96	80.9
Jacobs, Pasadena, Calif., U.S.A.	Con.	515.6	1056.8	1134.8	1144.9	1198	1468	1886.7	2042.3	2212	1801.3	1243.9	1586.3
	CPS	403.2	489	543.8	564.2	590.4	723.5	929.8	1919.9	2080	1875.8	2256.3	2434.2
JGC Corp., Yokohama, Japan	Con.	1144	1051	1866	2098	2306	2961	3159	2845	2070	1842	3024	3866
	CPS	356	167	14	335	402	444	530	458	371	642	596	643
Kajima Corp., Tokyo, Japan	Con.	1373	1295	1126.8	1401	1935.4	1882.3	2150.6	3006.5	3727.8	2896.7	2106.3	2456.1
	CPS	18	18	12.7	10.3	22.5	13.5	28.7	29.6	27.2	17.7	25.8	48.1
KBR, Houston, Texas, U.S.A.	Con.	3955	4462	3888.4	6508.8	9830.8	7722.6	7426.4	6319	7972	7824.6	5863.5	5382.5
	CPS	483	696	459.7	975.3	1179.9	1517	1161.6	1390.1	1777.2	1504.6	1737.9	1884.7
Techint Group, Milan, Italy	Con.	803.2	695	1367	1648	1042	1006	1414.1	1924	2598.8	3410.3	2835.6	2875.2
	CPS	5.8	15	21	8	10.6	15	29	36	43.6	31.4	60.5	61.3
Tecnicas Reunidas, Madrid, Spain	Con.	157	123	319	486	547	510	1130	2547	2535	3093	3343	3253.8
	CPS	25	22	42	41	30	32	426	962	995	1205	1292	1182.1
The Shaw Group Inc., Baton Rouge, La., U.S.A.	Con.	194.6	133.8	273.6	335.1	322.9	193.7	160.2	172.6	192.7	446.9	472	333.9
	CPS	82.6	113.3	144	133.9	152.8	161.8	404.8	913.5	723.9	599.9	532.7	468.3
Energoprojekt Group, Belgrade, Serbia & Montenegro	Con.	60.5	121.3	127.5	105.6	57.4	85.5	96.8	145.4	173.8	177.2	172.85	168.5
	CPS	8.3	7.6	11.4	6.7	8.9	12	14.1	28.3	39.4	41.1	44.9	52.2
Parsons, Pasadena, Calif., U.S.A.	Con.	535.4	411.6	29.6	234.3	144	723.9	376.5	83.4	125.5	147.6	177.4	207.2
	CPS	141.4	153.9	241.5	491.6	127.4	196.6	305.5	289.2	179.3	228.4	246	171.5
TECHNIP, Paris, France	Con.	2700	2456	4618.7	5396.9	6377	6375	8084	9843	10701	8865	7940	9313
	CPS	125	649	714	446	413	462	407	741	824.5	908	910	972
China Metallurgical Group Corp., Beijing, China	Con.	116.1	151	143.7	137.1	197	284.4	307	625.7	1372.6	2965	1514.9	2623.3
	CPS	6.3	3.6	0.9	4.95	9	9	12	28.8	18.2	47	68.55	90.1
Chiyoda Corp., Yokohama, Japan	Con.	422	263	631	1219	1469	2256	3053	4606	3027	1558	1284	1467

	CPS	17	28	27	25	71	53	31	9	71	133	121	88

* is derived from the company’s annual report 2012

Table 2 Stationarity test of the panel data

Maddala-Wu Unit Root Test
data: X chisq = 14.0295, df = 2, p-value = 0.000899 alternative hypothesis: stationarity
data: Y chisq = 16.2079, df = 2, p-value = 0.000302 alternative hypothesis: stationarity

Table 3 Results of the correlation analyses between contracting and CPS businesses

Balanced Panel: n=23, T=12, N=276									
Dependent: Y & Independent: X					Dependent: X & Independent: Y				
Effects					Effects				
	var	std.dev	share			var	std.dev	share	
idiosyncratic	2575869	1605	0.184		idiosyncratic	69415	264	0.297	
individual	11424879	3380	0.816		individual	164399	406	0.703	
theta:	0.864				theta:	0.816			
Coefficients					Coefficients				
	Estimate	Std.	Error	Pr(>|t|)		Estimate	Std.	Error	Pr(>|t|)
(Intercept)	1894.933	722.950	2.621	**	(Intercept)	254.380	89.095	2.855	**
X	1.827	0.358	5.103	***	X	0.047	0.009	5.107	***
R2:0.0868		Adj. R2:0.0861			R2:0.0870		Adj. R2:0.0863		
p-value: 6.271E-07					p-value: 6.137E-07				

Significance codes: '***' 0.001; '**' 0.01; '*' 0.05.

Table 4 Results of the lagged models

			X_{t-1}	X_{t-2}	X_{t-3}	Y_{t-1}	Y_{t-2}	Y_{t-3}	Remark
H_1	X_t	Estimate	0.772	0.898					Nil
		Significance	***	***					
H_2	Y_t	Estimate				0.508	0.298		Nil
		Significance				***	***		

Significance code: '***' 0.001

Table 5 Operation strategies of major contracting & CPS companies

Firm	Operation strategies
AMEC plc, London, U.K.	Creating an asset-light, cash-generative business with a strong balance sheet and good growth prospects, diversified across markets and geographies (2012 Annual Report). AMEC has interests in a number of joint ventures and joint arrangements (2009 Annual Report).
Balfour Beatty, London, U.K.	We continue to achieve cost efficiencies and shift our business mix towards higher margin services. Typically these involve programme management roles and projects with design-build, PPP (public private partnership) and EPC (engineering, procurement, construction) characteristics.
CH2M HILL, Englewood, Colo., U.S.A.	In both the private and public sectors, acting either as a prime contractor or as a subcontractor, we may join with other firms that we otherwise compete with to form a team to compete for a single contract. Because a team can often offer stronger combined qualifications than any firm standing alone, these teaming arrangements can be very important to the success of a particular contract competition or proposal. Consequently, we maintain a network of relationships with other companies to form teams that compete for particular contracts and projects. (2010, 2011, 2012, Annual Report).
Fluor Corp., Irving, Texas, U.S.A.	As is very typical in our industry, we enter into various joint ventures and teaming arrangements as part of our engineering, procurement and construction businesses, including ICA Fluor and project specific joint ventures, where control may be shared with unaffiliated third parties (2011, 2012, Annual Report)
HOCHTIEF AG, Essen, Germany	Focus on our competencies of development, construction, and operation, notably in infrastructure projects (2012 Annual Report)
Jacobs, Pasadena, Calif., U.S.A.	Historically, our field construction activities have been focused primarily on those construction projects for which we perform much of the related engineering and design work. By focusing our construction efforts in this way, we minimize the risks associated with constructing complex projects based on designs prepared by third parties. As is common in the industry, we perform certain contracts as a member of joint ventures, partnerships, and similar arrangements. (2009, 2010, 2011, 2012 Annual Report).

JGC Corp., Yokohama, Japan	To minimize the effects on its businesses arising from these risks, the JGC Group continuously and reinforces its risk management system, carries trade insurance, recovers receivables as early in a project as possible, forms joint ventures, and takes various other steps (2012 Annual Report).
The Shaw Group Inc., Baton Rouge, La., U.S.A. *	Although we generally serve as the prime contractor on our federal government contracts, or as part of a joint venture acting as the prime contractor, we also may serve as a subcontractor to other prime contractors. With respect to bidding on large, complex environmental contracts, we have entered into, and expect to continue to enter into, joint venture or teaming arrangements with competitors (2009, 2010, 2011 Annual Reports).
TECHNIP, Paris, France	To mitigate its risks on a specific Project, Technip may decide to submit a bid in association with one or more companies through either a joint venture or a consortium. The type of association is carefully reviewed at the proposal stage by taking into account all relevant parameters, including client's requirements and needs, respective expertise of each member of the association, and interfaces. In general, the members of a joint venture or a consortium are jointly and severally liable towards the client (2008, 2009, 2010, 2011, 2012, Annual Reports).

* The Shaw Group was acquired by CB&I in 2012;

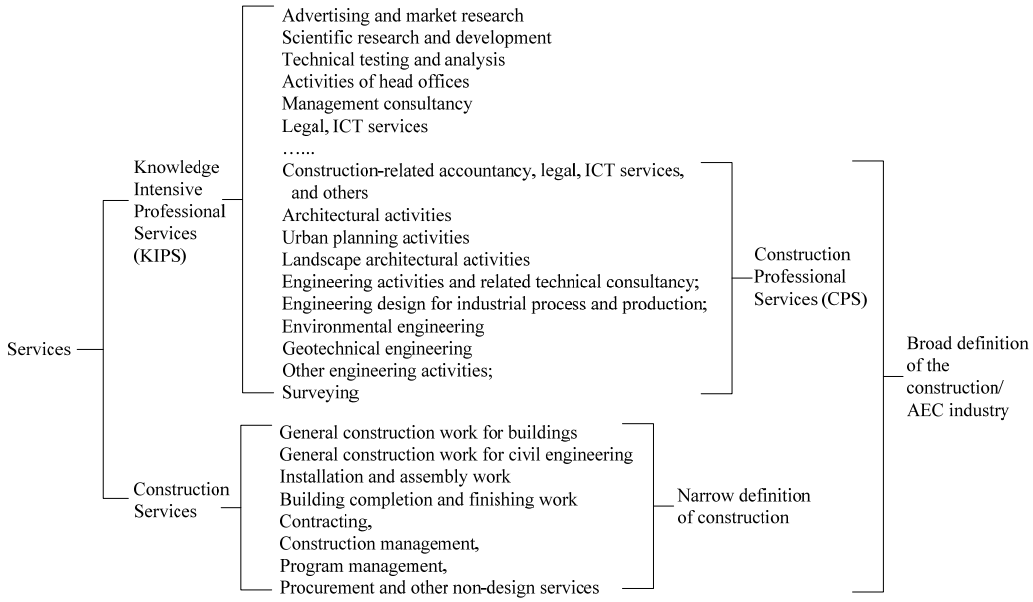

Figure 1 CPS and its relationships with other sectors

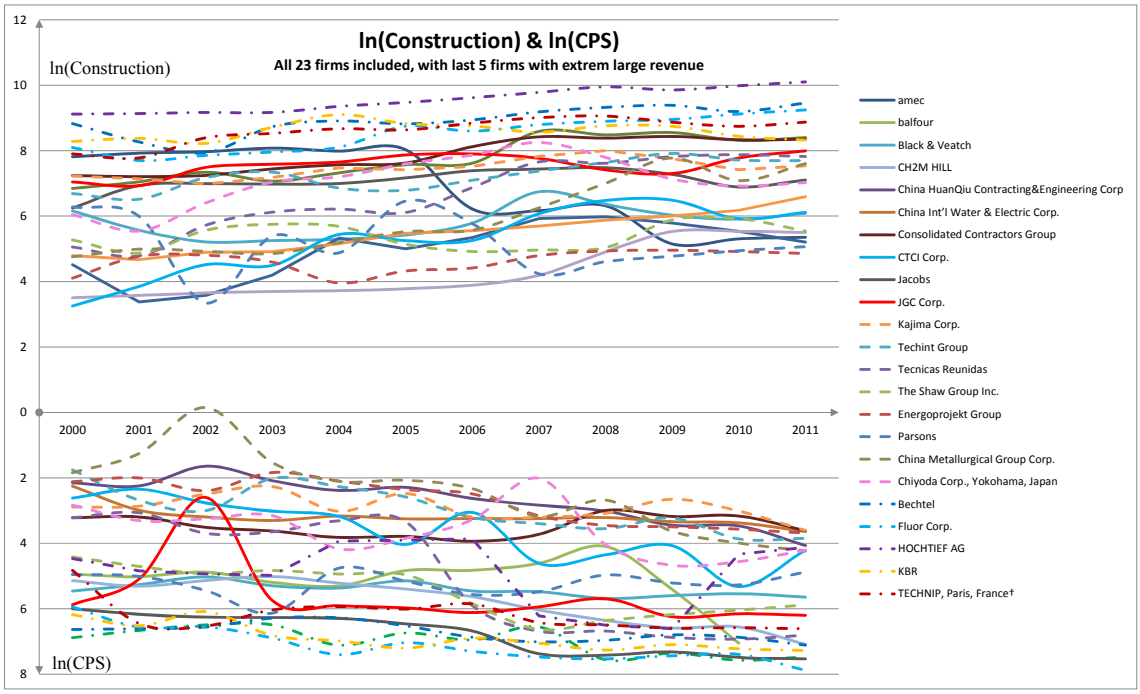

Figure 2 A graphic presentation of the contracting and CPS businesses of international companies (The units of the revenue of contracting work and CPS are million USD)