A COMPARATIVE ANALYSIS OF THE DESIRED AND ACTUAL BIDDING BEHAVIOUR OF CONSTRUCTION COMPANIES

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In the present paper, we quantify the desired and actual bidding behaviour of Japanese companies by analysing public procurement data from three regional development bureaus. Our study extends the findings of Iwamatsu *et al*. (2013), who use a survey questionnaire to determine the desired (but not the actual) bidding behaviour of major Japanese construction companies. To compare actual bidding behaviour with desired bidding, we model the probability of participation and the bidding ratio, both of which are regressed on the quantified values of the bidding data and other information. The results are then ranked, compared with those of Iwamatsu *et al*. (2013), and analysed. We focus on the factors on which firms concentrate when determining (i) whether they will participate in the bidding process and (ii) their pricing during bidding. Although both Iwamatsu *et al*. (2013) and our study include widely used high-ranking items, in our analysis, 'company circumstances' are highly ranked at the participation stage, while 'competition circumstances' are highly ranked at the pricing stage. This offers a practical justification for including competition circumstances when modelling real-world bidding behaviour.

Keywords: bidding, procurement, statistical analysis, price.

INTRODUCTION

In Japan, bidding systems for government procurement have been undergoing significant changes. For example, designated competitive bidding has been replaced by general competitive bidding, and the method used to select the winning bid has changed from automatic selection of the lowest bidder to a comprehensive assessment system. Under these circumstances, the bidding activities of firms have declined; indeed, firms no longer participate in bidding activities that do not benefit them.

The Japanese construction market saw somewhat of a downward trend during 2002 to 2011. Before the early 1990s, Japan's economic bubble created extensive domestic demand; thus, many construction companies did not need to develop overseas market strategies. After 1994, some prominent cases of bid rigging came to light and public investment dropped dramatically as procurement authorities changed their policies to improve input objectivity. However, this policy change may have resulted in decreasing product quality and a suspension of technical progress. The Japanese construction industry struggled with this situation from 2002–11. This is similar to what occurred in the United States and the United Kingdom during the 1980s. The

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Latham Report (1994) and the Egan Report (1998), for example, pointed out similar problems.

The most recent examination of bidding behaviour in Japan was conducted by Iwamatsu *et al*. (2013), who used a questionnaire survey to study the desired bidding behaviour of major Japanese construction companies. They obtained 283 responses on 36 factor keywords in two situations and compared these characteristics with perspectives from Japan, the United States, and the United Kingdom. Similarly, Laryea and Hughes (2008) conducted a review of questionnaire surveys, while a number of empirical studies—such as Ahmad and Minkarah (1988), Shash (1993), and Mochtar and Arditi (2001)—have addressed interview surveys, paying particular attention to two decisions: the decision to participate in bidding and the pricing decision at the bidding stage.

The present study aims to quantify the desired and actual bidding behaviour of Japanese companies by analysing public procurement bidding data. We use bidding data and other sources to represent each item keyword by an appropriate proxy value, and then compare this with the questionnaire responses. The questionnaire responses are thus compared effectively with the real intentions of the bidding companies based on regression estimation using actual bidding data. We aim to use this comparative analysis to understand the gap between the desired and actual bidding behaviours displayed by Japanese companies.

This study makes three contributions to construction management. First, a new method of analysis is used. In this research, it is very important for the method of analysis to reveal preferences about bid decisions. The analysis therefore includes (i) a discrete logit analysis of the participation decision, and (ii) an ordinary least squares regression of the bid or the winning price on factors such as the predetermined price and the number of participants. Such analysis of participation and/or bidding factors is important in the construction management field. Our method can accommodate bidding in the presence of environmental concerns, and is useful for the comparative analysis of factors that influence bidding.

Second, this research contributes to a new way of thinking. We study the similarities and differences between stated preferences and revealed preferences. Doing so is important for the implementation of institutional reforms, which requires understanding how actual bidding behaviour compares with intended behaviour. Our results indicate the importance of capturing the actual competitive situation in an industry. This study provides insight into the actual impact on the construction industry worldwide, allowing the design of a welfare-improving social system.

Third, this study yields unique results. Although we find very little difference between desired and actual bidding, an entity tailors its behaviour to its expectations of its competitors' actual (rather than desired) behaviour. This finding is similar to that found in the research on U.S. and U.K. markets. In this regard, competition is a more significant factor than entities are aware of. Conversely, preventing the restraint of competition by using a bidding system is more important than entities in the worldwide construction industry recognize. This is a common caveat for construction management practitioners and authorities.

Public procurement is a highly important issue for the global economy. While developed economies use private innovation and procurement to stimulate the economy, emerging economies use public accountability and procurement to obtain more investment. Our research aims to find ways to use public procurement to

improve the construction industry by shedding light on the tools that construction firms use and on their actual preferences. This will aid effective procurement design.

RESEARCH DESIGN

In their comparative study based on surveys of major construction journals and interviews with influential construction managers, Iwamatsu *et al*. (2013) found that Japan, the United States, and the United Kingdom share certain common bidding characteristics, indicated by relatively high scores for 'type of job' and 'competitiveness in your industry', as well as other features such as 'labour environment (union, non-union, cooperative)' and 'time of bidding (season)'. To describe desired bidding, we describe the conceptual outline of their study in Table I.

Table I: Keywords and Questionnaires in Iwamatsu et al. (2013)

		Participation stage					**Pricing stage**				
		Iwamatsu et al. (2013)		Ahmad and Minkarah (1988)	Shash (1993)		Iwamatsu et al. (2013)		Ahmad and Minkarah (1988)	Shash (1993)	
		Simple average	Weighted average	Simple average	Simple average	Weighted average	Simple average	Weighted average	Simple average	Simple average	Weighted average
Technical characterization of the project	Type of job	0.957	0.904	0.956	0.774	0.786	0.830	0.791	0.901	0.525	0.666
	Location of project	0.663	0.682	0.856	0.718	0.741	0.663	0.681	0.765	0.427	0.634
	Degree of difficulty	0.829	0.752	0.778	0.691		0.863	0.784	0.951	0.556	0.681
	Project duration	0.694	0.714	NA	0.318	0.514	0.824	0.781	NA	0.338	0.565
	Size of job	0.968	0.859	0.822	0.729	0.755	0.862	0.792	0.744	0.554	0.683
	Type and no. of equipment required/available	0.612	0.672	0.289	0.481	0.577	0.813	0.769	0.407	0.476	0.641
	Designer (A/E)/Design quality	0.668	0.701	0.678	0.614	0.687	0.852	0.809	0.752	0.550	0.688
	Project cash flow	0.496	0.642	0.556	0.602	0.692	0.564	0.648	0.683	0.549	0.661
	Rate of return	0.661	0.663	0.742	0.695	0.714	0.700	0.673	0.793	0.525	0.764
	Need for work	0.785	0.736	0.933	0.917	0.864	0.714	0.684	0.753	0.649	0.736
Procurement authority and method	Owner	0.662	0.701	0.910	0.824	0.788	0.595	0.654	0.775	0.626	0.706
	Type of contract	0.512	0.646	NA	0.647	0.716	0.529	0.636	NA	0.556	0.678
	Bidding method	0.786	0.775	NA	0.686	0.752	0.769	0.751	NA	0.367	0.563
	Duration	0.808	0.761	0.449	0.686	0.692	0.589	0.651	0.650	0.304	0.501
	Time of bidding	0.709	0.720	0.200	NA	NA	0.535	0.633	0.341	NA	NA
	Degree of hazard	0.751	0.739	0.878	0.452	0.617	0.807	0.760	0.963	0.474	0.619
	Future perspective of the similar project	0.832	0.761	NA	NA	NA	0.781	0.708	NA	NA	NA
Circumstances of competition	Number of competitors	0.675	0.703	NA	0.821	0.835	0.780	0.739	NA	0.420	0.603
	Competition	0.804	0.760	0.800	0.512	0.644	0.863	0.794	0.732	0.432	0.596
	Strength in the industry	0.901	0.807	0.833	0.857	0.832	0.775	0.731	0.707	0.531	0.665
	Previous owner	0.500	0.629	NA	NA	NA	0.543	0.603	NA	NA	NA
	Overall economy	0.658	0.696	0.822	NA	NA	0.665	0.662	0.744	NA	NA
	Labour environment	0.361	0.559	0.844	0.564	0.687	0.420	0.566	0.716	0.479	0.646
	Portion of work to be subcontracted	0.482	0.592	0.438	0.297	0.518	0.488	0.587	0.667	0.355	0.546
	Reliability of subcontractors	0.649	0.684	0.633	NA	NA	0.671	0.668	0.753	NA	NA
	Situation of the company	0.809	0.792	NA	NA	NA	0.800	0.768	NA	NA	NA
Circumstances of the company	Current workload	0.823	0.781	0.789	0.834	0.832	0.777	0.745	0.841	0.704	0.764
	Uncertainty in the estimate	0.815	0.769	0.724	0.513	0.598	0.796	0.778	0.890	0.462	0.634
	Availability of qualified staff	0.911	0.827	NA	0.608	0.716	0.665	0.699	NA	0.387	0.582
	Nnumber of supervisory persons required/available	0.979	0.908	0.700	0.529	0.652	0.750	0.738	0.654	0.346	0.677
	Cost of making the bid	0.605	0.667	NA	NA	NA	0.561	0.617	NA	NA	NA
	General overhead	0.818	0.772	0.352	0.299	0.540	0.834	0.792	0.525	0.269	0.531
	Capital requirement/availability	0.416	0.594	0.411	NA	NA	0.494	0.590	0.561	NA	NA
	Intuition	0.505	0.597	NA	NA	NA	0.551	0.601	NA	NA	NA
	Differences between predetermined total price and internal total price	0.890	0.840	NA	NA	NA	0.899	0.855	NA	NA	NA
	Mathematical model	0.424	0.544	NA	NA	NA	0.489	0.568	NA	NA	NA

Table II: Keyword Quantification in our Study

	Iwamatsu et al. (2013)	Quantification Method	Remarks
Technical characterization of the project	Type of job	Selecting general civil engineering projects of three regional development bureaus of the Ministry of Land, Infrastructure, Transport and Tourism	
	Location of project	No quantification	
	Degree of difficulty	No quantification	
	Project duration	No quantification	
	Size of job	Dummy of project level (Level A=1)	Considering the size of job as the size of the project-level dummy
	Type and amount of equipment required/available	Index of cement price	Representing the cement price index as the equipment required/available
	Designer (A/E)/Design quality	Ratio of the maximum and minimum bid to the value of the predetermined price	Considering the difference of recognition of the project value in the project bidding stage
	Project cash flow	No quantification	
	Rate of return	Gross income on sales	Excluding negative values
	Need for work	No quantification	
Procurement authority and method	Owner	No quantification	
	Type of contract	No quantification	
	Bidding method	Dummy of bidding method (WTO, selecting)	
	Duration	No quantification	
	Time of bidding	No quantification	
	Degree of hazard	No quantification	
	Future perspective of a similar project	Days to next winning bid	Considering days to next winning bid as the future perspective
Circumstances of competition	Number of competitors	Number of participants	Including a declining or invalid number of participants
	Competition	Basic and additional point in comprehensive bidding	Considering the evaluating points
	Strength in the industry	Days since last winning bid	Considering days since last winning bid as the past strength in the industry
	Previous owner	No quantification	
	Overall economy	Nikkei stock average	
	Labour environment	Wage index of construction workers	Considering the wage index of construction workers as the Labour environment
	Proportion of work to be subcontracted	No quantification	
	Reliability of subcontractors	No quantification	
	Situation of the company	Average value of completed general civil engineering works	
Circumstances of the company	Current workload	Days after last bid	
	Uncertainty in the estimate	Gross profit on sales	Considering the total amount of the winning bid benefit as risk-taking in lieu of uncertainty
	Availability of qualified staff	No quantification	
	Number of supervisors required/available	Number of first and second supervisors for civil engineering	Number of engineers
	Cost of bidding	No quantification	
	General overheads	General administration cost	
	Capital requirement/availability	No quantification	
	Intuition	No quantification	
	Difference between predetermined total price and internal total price	Difference between predetermined total price and internal total price relative to the value of predetermined price	
	Mathematical model	No quantification	

* Quantification Method: Selecting general civil engineering projects from three regional development bureaus of the Ministry of Land, Infrastructure, Transport, and Tourism

We quantify Iwamatsu *et al*.'s (2013) keywords and present them in Table II. Note that this study uses Japanese terms instead of U.S. terms, but the basic concept is common across the three study regions. Comparing the questionnaire results of Iwamatsu *et al*. (2013) with our quantified values based on bidding data and other information reveals similar characterization of stated and revealed preferences (for competing views, see Diamond and Hausman, 1994; Hanemann, 1994; and Portney, 1994). Critics of stated preference methods point to numerous potential sources of bias associated with these methods. According to Azevedo *et al*. (2003), for example, survey respondents may ignore or downplay their budget constraints when answering hypothetical questions (see also Arrow *et al*., 1993; Loomis *et al*., 1994; and Kemp and Maxwell, 1993). Moreover, stated preference-based willingness-to-pay estimates fail to vary sufficiently with the scope of the resource being valued, the so-called 'embedding effect' (Desvousges *et al*., 1993; Kahneman and Knetsch, 1992), while they are inordinately sensitive to the elicitation format used (McFadden, 1994; Diamond and Hausman, 1994).

In this analysis, we examine the firm's desired strategy based on the results of the questionnaire survey presented by Iwamatsu *et al*. (2013). This approach is similar to a stated preference-type method, in which the decision-making and conduct of the organization are likely to be more reasonable than those of individuals are because outlier preferences are balanced. However, in addition we consider three alternative viewpoints. According to the first viewpoint, no differences exist between the questionnaire survey and the quantified bidding data and other information. The second viewpoint is that stated preferences are upwardly biased because of an embedding effect reflecting altruism. According to the third viewpoint, the stated preferences display an additional embedding effect that arises from over-individualism. In consideration of these viewpoints, our analysis of quantified bidding data and other information is more akin to a revealed preference-type method.

DATA ANALYSIS

This study used bid data for Level A and B general public engineering works (>300 million yen) from the Shikoku, Kanto, and Kinki regional development bureaus of the Ministry of Land, Infrastructure, Transport, and Tourism (2002–2011). The study periods were as follows: FY2002–2011 for Shikoku, FY2004–2011 for Kanto, and FY2005–2011 for Kinki. The dependent variables were the probability of participation and the bidding ratio. The probability of participation was measured as the probability of an entity participating in a bid offered by the regional development bureau in a certain period. The bidding ratio was calculated by dividing the bidding price by a predetermined price. Taking the log of both bid numbers allowed us to overcome problems posed by price elasticity. The estimation equations for the probability of participation and the bidding ratio are, respectively,

$$\log(Profparticipation_i) = a_1 + \sum b_{1,i,t} \log(quantified\_data_{i,t}) + e_{1,i} \quad (1),$$

and

$$\log(bidratio_i) = a_2 + \sum b_{2,j,t} \log(quantified\_data_{j,t}) + e_{2,j} \quad (2),$$

where indicators i and j are the individual bidding indices, t is the factor of consideration index, Profparticipationi is the probability of participation, and quantified_datai is the factor of consideration. e is an error term. Ordinary least

squares regression analysis was then used to estimate the coefficients a1, a2, b1,i,t, and b2,j,t. Table III presents the results.

Based on these coefficients, we compared the ranking and statistical significance of our results with the ranking presented in Table III of Iwamatsu *et al*. (2013), as shown in Table IV. According to the comparison analysis presented in Table IV, we decided to examine (i) items determining a firm's participation in the bidding process, and (ii) items driving firms' pricing during the bidding stage.

Table III: Regression Results

Dependent variable method: ordinary least square	Pr of participation n=4586		Bidding ratio n=4586	
	Coefficient (standard err.)		Coefficient (standard err.)	
Size of job	0.587	*	-0.279	
	(0.3438)		(0.2861)	
Type and no. of equipment	0.182	***	0.897	***
	(0.0395)		(0.0328)	
Designer (A/E)/ Design quality	-0.016		-0.216	***
	(0.0131)		(0.0109)	
Rate of return	0.003		-0.002	
	(0.0023)		(0.0019)	
Bidding method (designated dummy)	0.011		0.135	***
	(0.0517)		(0.0430)	
Bidding method (WTO dummy)	0.074		-0.011	
	(0.0531)		(0.0442)	
Future perspective	0.002		0.000	
	(0.0024)		(0.0020)	
Number of competitors	-0.063	***	0.022	*
	(0.0157)		(0.0130)	
Competition	0.029		-0.143	***
	(0.0535)		(0.0446)	
Overall economy	-0.082		-0.158	
	(0.1403)		(0.1167)	
Labour environment	-0.190	***	0.219	***
	(0.0364)		(0.0303)	
Situation of the company	0.024		-0.072	***
	(0.0155)		(0.0129)	
Current workload	-0.008	***	-0.004	***
	(0.0012)		(0.0010)	
Uncertainty of the estimate	-0.453	***	0.071	
	(0.0576)		(0.0479)	
Number of supervisory persons	0.346	***	-0.003	
	(0.0170)		(0.0142)	
General overhead	0.365	***	0.003	
	(0.0549)		(0.0457)	
Differences between predetermined and bid	-0.084		0.795	***
	(0.1157)		(0.0963)	
C	-5.781	***	19.177	***
	(1.9563)		(1.6277)	
R-square	0.226		0.689	
adjusted R-square	0.223		0.687	
standard err. Of regressions	0.527		0.438	
Akaike Information Criteria	1.559		1.191	

Note: The upper values in the cell are the estimated coefficients and the lower values in parentheses are the standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels respectively.

Table IV: Comparing our Results with those of Iwamatsu et al. (2013)

	Iwamatsu et al. (2013)		The present study	
	Participation stage	Pricing stage	Participation stage	Pricing stage
1	Size of job	Difference between predetermined total price and internal total price	Size of job	Type and amount of equipment required/available
2	Number of supervisors required/available	Rate of return	Uncertainty in the estimate	Difference between predetermined total price and internal total price
3	Bidding method	General overheads	General overheads	Labour environment
4	Rate of return	Competition	Type and number of supervisors required/available	Designer (A/E)/Design quality
5	Current workload	Bidding method	Labour environment	Competition
6	Situation of the company	Size of job	Type and amount of equipment required/available	Bidding method
7	Competition	Uncertainty in the estimate	Current workload	Situation of the company
8	General overheads	Situation of the company	Number of competitors	Current workload

RESULTS

Items used to determine participation

Iwamatsu *et al*. (2013) and our study have some high-ranking items, such as 'size of job' and 'Number of supervisors required/available', in common. Therefore, both analyses are considered to have captured the actual industry situation. In other words, the stated and revealed preferences are similar for these items. Further, both analyses rank personnel issues such as 'type and number of supervisors required/available' and 'labour environment' highly. Personnel management issues may reduce the probability of participating in the bidding process.

However, there are some differences between the two studies. In our study, the 'uncertainty in the estimate' and 'general overhead' items, which fall into the 'company circumstances' category, are high-ranking, whereas they have a relatively low ranking in Iwamatsu *et al*. (2013). The reason for this difference is that the stated preference approach taken by Iwamatsu *et al*. (2013) relies on an analytical recognition of a person's own ex post behaviour, whereas our study, which uses revealed preferences, tends to capture people's real instincts during bidding.

Pricing items considered at the bidding stage

In their examination of pricing at the bidding stage, both analyses have a high-ranking item in common. This item is the difference between the predetermined total price and the internal total price. This suggests the absence of significant differences between stated and revealed preferences with respect to this factor. With regard to the 'type and amount of equipment required/available', once a large project has been started, it may affect the demand for and the supply of equipment. Thus, the high ranking of this item should be somewhat discounted.

Factors such as 'rate of return' and 'general overhead', which fall in the 'company circumstances' category, are highly ranked in Iwamatsu *et al*. (2013), unlike in our study. This finding may reflect the fact that a company cannot win bids due to 'company circumstances' alone, which companies recognize at the point of actual bidding. Therefore, firms may take a realistic approach by emphasizing other items such as 'competition' (in the 'competition circumstances' category).

Overall trends and comparison with the United States and the United Kingdom

No self-serving disclosure or non-disclosure tendencies were recognized either in our study or in Iwamatsu *et al*. (2013). In this regard, the findings of Iwamatsu *et al*.

(2013) are likely to reflect actual business practices. Nevertheless, we can still determine how competition plays a role during the pricing stage, which goes beyond the company's own circumstances. Companies may not fully recognize this themselves. Finally, the ranking presented in our study is closer to that of Iwamatsu *et al*. (2013) than it is to the results of the U.S. or the U.K. surveys. Neither our study nor Iwamatsu *et al*. (2013) found any evidence for an embedded effect or for any other inordinately sensitive effects (e.g., cultural competition avoidance).

REVISITING THE ANALYSIS OF A TYPICAL PRICING PATTERN

Iwamatsu *et al*. (2013) examined four typical bid-pricing patterns, adopting the process flowchart for bid pricing referred to by Mochtar and Arditi (2001). We describe them below.

In Model 1, pricing is based on cost accumulation. The bid price is determined using the accumulated benefit and the cost of the necessary factors based on a project's books.

Model 2, also called hybrid type 1, involves first accumulating costs and then considering competition. The preliminary price is set as in Model 1 above. Then, the bid price is determined based on the competition situation. If the winning price is higher than the preliminary price, it is reduced as much as possible.

Model 3, also called hybrid type 2, involves first considering competition and then accumulating costs. First, the preliminary price is set by considering the competition, and then the bid price is determined as in Model 1 above.

In Model 4, pricing is determined by competition. The bid price is determined by considering the competitive situation and the company's risk policy.

Iwamatsu *et al*. (2013) believe that Japanese firms behave according to Model 2. This is justified by the result that the difference between the predetermined total price and the internal total price was the highest ranked item in their study. Our results also support Model 2 for the same reason. However, during the bidding stage, companies recognize the fact that they cannot win bids solely based on 'company circumstances'. Therefore, a company may actually emphasize the competitiveness of the market, offering a strong justification for the belief that actual behaviour is approximated by models that include competition circumstances, such as Model 3 or Model 4.

CONCLUDING REMARKS

In this study, we quantified the desired and actual bidding behaviour of Japanese companies by analysing public procurement data from three regional development bureaus. Our results extend those of Iwamatsu *et al*. (2013), who used a survey questionnaire to determine the desired (but not the actual) bidding behaviour of major Japanese construction companies. Specifically, we contrasted the survey findings put forward by Iwamatsu *et al*. (2013) with companies' actual bidding behaviour, based on bid data and other information.

One contribution of this study is that we shed light on firm-level differences between stated and revealed preferences. While we show that no significant differences exist between these two, some factors related to competition are only exhibited during the analysis of revealed preferences.

We modelled the probability of participation and the bidding ratio, both of which were regressed on the quantified bidding data and other information, and then compared the ranking we obtained with the results of Iwamatsu *et al*. (2013).

Both our study and Iwamatsu *et al*. (2013) rank the factors 'size of job' and 'type and number of supervisors required/available' as important determinants of firms' participation decisions. Therefore, both analyses are considered to have captured the actual situation in the industry. However, in our study, the items 'uncertainty in the estimate' and 'general overhead', which are in the 'company circumstances' category, are high-ranking, whereas they rank relatively low in Iwamatsu *et al*. (2013).

Both analyses find that the difference between the predetermined total price and the internal total price is an important determinant of pricing during the bidding stage. However, Iwamatsu *et al*. (2013) finds that items in the 'company circumstances' category, such as the 'rate of return' and 'general overhead', are highly ranked, unlike us. Our results suggest that companies may take a realistic approach to the market and emphasize competition circumstances. In other words, a company cannot win a bid based on 'company circumstances' alone. This offers a strong justification for the real-world implementation of Model 3 or Model 4, as described by Iwamatsu *et al*. (2013).

Our findings add to the literature by accurately describing actual bidding behaviour in Japanese organizations. This is both important and novel in the construction management literature and beneficial for designing bidding institutions. To create a better bidding system, it is necessary to consider actual firm-level behaviour as well as the desires of the companies involved. Nevertheless, future research should aim to verify the findings of this study by using further questionnaire surveys as well as through interviews with both procurers and bidders. Doing so will help shed light on entities' behaviour and will be useful for optimal policymaking.

The contributions of this study lie in its method of analysis, in the new way of thinking it introduces, and in its findings. While we apply our method to Japanese public procurement, this method can also be applied to bidding in the presence of environmental concerns, or to a comparative analysis of bidding determinants. Such analysis of participation and/or bidding factors is significant for the construction management field. In addition, this study provides insight into the actual impact on the worldwide construction industry, enabling the design of a welfare-enhancing social system.

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REFERENCES

Ahmad, I. and Minkarah, I. (1988) Questionnaire Survey on Bidding in Construction, *"Journal of Management in Engineering"* **4**(3), 229–243.

Arrow, K., Solow, R., Portney, P., Leamer, E., Radner, R., and Shuman, H. (1993) Report of the NOAA Panel on Contingent Valuation, Federal Register **58**, 4601–4614.

Azevedo, C., Herriges, J., and Kling, C. (2003) Combining Revealed and Stated Preferences: Consistency Tests and their Interpretations, *"American Journal of Agricultural Economics"* **85**(3), 525–537.

Desvousges, W., Johnson, F., Dunford, R., Hudson, S., Wilson, K., and Boyle. K. (1993) Measuring Nonuse Damages Using Contingent Valuation: An Experimental Evaluation of Accuracy, in J. Hausman, ed., *"Contingent Valuation: A Critical Assessment"*. New York: North Holland, 91–164.

Diamond, P. and Hausman, J. (1994) Contingent Valuation: Is Some Number better than No Number? *"Journal of Economic Perspectives"* **8**(4), 45–64.

Egan, J. (1998) *"Rethinking Construction"*. Department of Environment, Transportation and the Region.

Hanemann, M. (1994) Valuing the Environment through Contingent Valuation, *"Journal of Economic Perspectives"* **8**(4), 19–43.

Iwamatsu, J., Morimoto, E., Namerikawa, S., and Endo, K. (2013) A Consciousness Analysis of a Construction Company's Bidding Behaviors. *"J. JSCE"*, **69**, 62–74. (In Japanese).

Kemp, M. and Maxwell, C. (1993) Exploring a Budget Context for Contingent Valuation, in J. Hausman, ed., *"Contingent Valuation: A Critical Assessment"*. New York: North Holland, 217–269.

Kahneman, D. and Knetsch, J. (1992) Valuing Public Goods: The Purchase of Moral Satisfaction, *"Journal of Environmental Economics and Management"* **22**, 57–70.

Laryea, S. and Hughes, W. (2008) How Contractors Price Risk in Bids: Theory and Practice, *"Construction Management and Economics"* **26**(9), 911–924.

Latham, M. (1994) CONSTRUCTING THE TEAM: Joint Review of procurement and Contractual Arrangements in the United Kingdom Construction Industry: Final Report. HM Stationery Office.

Loomis, J. Gonzales-Caban, A., and Gregory, R. (1994) Do Reminders of Substitutes and Budget Constraints Influence Contingent Valuation Estimates? *"Land Economics"* **70**(4), 499–506.

McFadden, D. (1994) Contingent Valuation and Social Choice, *"American Journal of Agricultural Economics"* **76**(4), 689–708.

Mochtar, K. and Arditi, D. (2001) Pricing Strategy in the US Construction Industry, *"Construction Management and Economics"* **19**(4), 405–415.

Ministry of Land, Infrastructure, Transport and Tourism (2005-2011) Announcement of Bidding and Contract Data (EXCEL) http://www.mlit.go.jp/tec/nyuusatu/datalink.html.

Portney, P. (1994) The Contingent Valuation Debate: Why Economists Should Care, *"Journal of Economic Perspectives"* **8**(4), 3–17.

Shash, A. (1993) Factors Considered in Tendering Decision by Top UK Contractors, *"Construction Management and Economics"* **11**(2), 111–118.