Determinants of the number of bidders and win-reserve ratio in open competitive tendering: Relationship-specific investments and incomplete contracts

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ABSTRACT

In open competitive tendering in Japan, one-party bid events where only one contractor submits a bid frequently occur. This situation has been criticized as hindering economic efficiency and fairness. This study uses bidding records to statistically analyze the factors that influence the number of bidders and cause one-party bids, which subsequently influence the win-reserve ratio. We found that fewer bidders participate in bidding for deals that require relationship-specific investments, resulting in a higher win-reserve ratio. In biddings with ambiguous specifications and incomplete contracts, more bidders participate, leading to a lower win-reserve ratio. Aside from these indirect effects mediated by the number of bidders, some factors directly influence the win-reserve ratio. Interestingly, indirect and direct effects conflict for follow-up deals and deal size. Thus, by highlighting deal-specific factors and differentiating between indirect and direct effects, this study brings new insights into the discussion on bidder behavior and its outcomes.

1. Introduction

Public procurement aims to maximize economic efficiency (Bergman and Lundberg, 2013) while ensuring *fairness*, that is, *transparency* and *equal opportunity* (Ballesteros-Pérez et al., 2015; Sorte, 2016). One of the means to satisfy these requirements is *open competitive tendering,* which allows all prequalified contractors to submit a bid. However, in open competitive tendering in Japan, *few-party bid* events, especially *one-party bid* events, in which only one contractor submits a bid, often occur. This situation has been criticized as hindering economic efficiency and fairness (e.g., Board of Audit (BOA), 2021) because biddings with fewer bidders tend to result in a higher *win-reserve ratio* (successful bid rate) (e. g., Arai and Morimoto, 2017; Iimi, 2006). However, although the Government of Japan (GOJ) has sought to increase the number of bidders, an effective measure has not yet been identified. Elucidating the determination mechanism of the number of bidders is a crucial step toward solving this issue.

Auction theory asserts that the number of bidders is influenced by various factors. However, previous studies mainly examined biddings for homogeneous deals such as timber, oil drilling rights, agricultural goods, treasury bills, and road construction work (Laffont, 1997). Although such homogeneity has strength in controlling conditions for analysis, it has limitations in examining the impact of attributes of objects—or deals—on bidder responses. Nevertheless, as this study highlights, deal attributes are important for exploring the determinants of the number of bidders.

To address this research gap, we use bidding result data involving a heterogeneous set of deals to statistically analyze how deal-specific factors influence the number of bidders and win-reserve ratio. In particular, we focus on *relationship-specific investments* required to carry out specific deals and *incomplete contracts* resulting from ambiguous specifications. These are important factors that influence contractor behavior (Milgrom and Roberts, 1992) and may form a barrier to bid participation; however, they have not been sufficiently addressed in previous studies.

We also consider that some factors can influence the win-reserve ratio through their effects on the number of bidders, whereas other factors influence this ratio without such mediation. Therefore, by distinguishing between these indirect and direct effects, we extend the current knowledge on the determinants of the win-reserve ratio and

offer policy implications for the one-party bid problem.

The remainder of this paper is organized as follows. First, as background, a brief history and current status of public procurement in Japan are explained, focusing on the one-party bid problem. Next, we review previous studies on the number of bidders and the win-reserve ratio to derive the hypotheses. Then, the applied method and data are described, and the results are presented. Based on the discussion, we identify the theoretical contributions, policy implications, and limitations of this study.

2. Social background: public procurement in Japan and the one-party bid problem

In Japan, in the 1990s, when several corruption cases involving politicians and gigantic general contractors came to light, the media became critical of public procurement and demanded reforms (Sorte, 2016). Mainstream *invitation-only tendering*, in which only contractors invited by the procurer can participate, was criticized as a breeding ground for collusion between procurers and contractors (Kusunoki, 2007). Thereafter, since 1994, invitation-only tendering has been gradually replaced by the more transparent open competitive tendering.

In the 2000s, it was found that high-priced contracts with firms that hire retired public officers—a practice known as *amakudari* in Japanese—through non-tendered *discretionary contracts* were utilized as financial sources for hiring retired officers (BOA, 2004). Hence, *amakudari* was blamed for distorting the appropriateness of public procurement (Black, 2004). As a result, since 2006, discretionary contracts have been restricted to exceptional cases. Thus, since the 1990s, open competitive tendering has been widely and strictly applied in public procurement in Japan.

However, as open competitive tendering is strictly applied, *one-party bid* events are frequently observed. In fiscal year (FY) 2019, 28,581 out of 78,586 deals (36.3%) resulted in one-party bids in open competitive tendering for the GOJ (Administrative Reform Council (ARC), 2020). In particular, for information systems, 313 out of 423 deals (73.9%) procured by the GOJ through open competitive tendering in FY2018 were one-party bids (BOA, 2021).

Causes of one-party bids include dogmatic application of open competitive tendering to specific deals for which competitive biddings are unsuitable. However, without considering such a background, one-party bids have been criticized for raising the win-reserve ratio and hindering economic efficiency (e.g., ARC, 2020; BOA, 2009, 2021; Tokyo Metropolitan Government (TMG), 2016), and governments have sought measures to prevent one-party bids (Administrative Evaluation Bureau (AEB), 2008). Nevertheless, effective measures to increase the number of bidders have not yet been identified. This study addresses this issue by exploring the determinants of the number of bidders and the win-reserve ratio.

3. Literature review and hypotheses

To derive our hypotheses, we review the literature concerning the determinants of the number of bidders and their impact on the win-reserve ratio.

3.1. The effect of the number of bidders on the win-reserve ratio

Previous studies have shown that the fiercer the competition, the more aggressive bidders become (e.g., De Silva et al., 2008; Haile, 2001; Paarsch, 1992). In procurement biddings, the win-reserve ratio decreases with more bidders (e.g., Arai and Morimoto, 2017; Estache and Iimi, 2012; Iimi, 2006). This tendency is observed both in private and common value settings (Brannman et al., 1987); however, a sufficiently large number of bidders weakens the effect in the latter (Haile, 2001; Paarsch, 1992). Suzuki et al. (2018) have argued that the number of bidders influences the win-reserve ratio in two ways. First, recognizing

fiercer competition with more bidders, bidders will lower their bid prices (competition effect). Second, even if no bidders know how many bidders have participated in total, expected winning bid prices stochastically decrease as more bidders participate (stochastic effect). Based on these findings, Hypothesis 1 is proposed as follows.

Hypothesis 1. *The lower the number of bidders, the higher the win-reserve ratio.*

3.2. Determinants of the number of bidders

Before the seminal work by McAfee and McMillan (1987) that shed light on bidder participation, "[t]raditional auction theory assume[d] that the number of bidders [was] fixed" (Estache and Iimi, 2011, p. 200; also see Hendricks et al., 2003). However, recognizing the importance of the endogeneity of bidder participation, auction theory treated it as an important issue (De Silva et al., 2008; Estache and Iimi, 2011; Ohashi, 2009; Paarsch, 1997). Potential contractors consider their expected profit when determining whether to participate in bidding (Harstad, 1990). Hence, various factors influence the number of bidders (De Silva et al., 2008) and, subsequently, the win-reserve ratio in both private and common value settings (Goeree and Offerman, 2003).

Among these factors, bidding procedures influence bidders' decisions. Ohashi (2009) argued that transparency in the procurement process encourages bidder participation. However, in biddings for highway construction, De Silva et al. (2008) found that disclosing engineers' estimates decreased the number of bidders. They inferred that such a disclosure would reduce bidders' expected profit, thereby preventing participation. Likewise, Yao and Tanaka (2020) argued that bidder participation is reduced when quality requirements are unambiguous; ambiguous quality requirements attract more low-quality bidders.

Characteristics of objects, or deals, also influence bidders' decisions regarding whether to participate. In biddings for offshore oil drilling rights, risks related to the amount of hydrocarbon reduce the likelihood of participation (Moody and Kruvant, 1988). In construction projects in developing counties, security risks can negatively influence bidder participation (Iimi, 2013). In auctions for timber, Li and Perrigne (2003) examined the impact of the characteristics of timber, such as the percentage of saw timber, timber volume per acreage, and appraisal value per cubic meter, and found the impacts of these characteristics on the number of bidders were not significant.

Thus, previous research has examined the determinants of the number of bidders. However, as Laffont (1997) has argued, bidding has been examined in limited domains such as oil drilling rights (Moody and Kruvant, 1988), road construction (Iimi, 2013), and timber (Li and Perrigne, 2003; Paarsch, 1997). In these domains, deals are relatively homogeneous. Although examining homogeneous deals has strength in controlling conditions during analysis, limitations exist in analyzing the impact of deal attributes, which, we believe, influences bidder behavior. For example, specific deals require investments that may be wasted if bidders do not win; thus, fewer contractors would participate in bidding for such deals. Hence, we believe that to refine our theory on bidder behavior, it is necessary to analyze such deal characteristics.

Among deal characteristics, we focus on *deal specificity*, which increases the relationship-specific investments needed to accomplish contracts, and *specification ambiguity*, which results in incomplete contracts. These factors are expected to influence bidder behavior (Milgrom and Roberts, 1992) and, consequently, the number of bidders. Although these factors have been frequently discussed in practical debates (e.g., Arikawa, 2016), they still require scientific analysis.

We developed our model and hypotheses based on the following principles. First, whereas our models primarily capture factors on the deal (object) side, such factors also inevitably involve bidder-related aspects. For example, while deal specificity is fundamentally a deal-related attribute, it is the relative balance between the deal's attribute

and the bidders' perceptions of their own skills and assets that determines bidding behavior. Second, while Paarsch (1997) identified two determinants of the number of bidders–the number of potential (technically feasible) contractors and their decision to participate in a particular bidding–our variables address both factors. For example, deal size influences both the range of potential contractors and their final decisions. However, some factors primarily influence one type of determinant; deal specificity mainly limits the population of potential contractors, while specification ambiguity primarily influences potential contractors' participation decisions. Third, determinants of the number of bidders ultimately influence the win-reserve ratio in two ways: an indirect effect mediated by the number of bidders and an unmediated direct effect. Although Nakanishi (2020) noted such a mechanism, further analysis is needed. For example, the effects of follow-up deals, which are frequently argued in practical debate, should be examined. We aim to refine current knowledge about the differentiation of indirect and direct effects.

3.2.1. Deal specificity

The average number of bidders differs among deal types, reflecting the number of technically capable contractors (Estache and Iimi, 2008; Suzuki et al., 2019). One factor that determines the number of feasible contractors is *relationship-specific investments* (Nakanishi, 2020), which are required for contractors to acquire *relationship-specific skills* and *relationship-specific assets*. These skills and assets are required to respond efficiently to major customers' needs but are difficult to divert to other deals. For example, to provide the government with specialist machinery for a very limited purpose, contractors need specific skills and assets which cannot be used to manufacture other machinery. To acquire and maintain such skills and assets, relationship-specific investments are necessary, which will be wasted if they lose a bid. However, whether a contractor can win a bid is generally uncertain. Therefore, owing to a fear of the *hold-up problem*, contractors may underinvest in relationship-specific investments (Milgrom and Roberts, 1992) and give up bidding for specific deals (Nakanishi, 2020). For example, in road construction biddings, the number of bidders is smaller for deals that require special skills than those that require less skill (Iimi, 2013). Contractors who have previous experience with similar deals participate more frequently, implying an effect of relationship-specific investments (Estache and Iimi, 2011). Thus, in specific deals, the number of potentially feasible contractors (Suzuki et al., 2019) and that of actual bidders decrease, resulting in a higher win-reserve ratio.

Hypothesis 2A. *(indirect effect): Deal specificity will raise the win-reserve ratio, mediated by the decrease in the number of bidders.*

We assume that contractors who participate in biddings for specific deals possess relationship-specific skills and experience, which will enable accurate estimation, stochastically leading to less variance and a subsequent higher average bid prices. Thus, deal specificity will raise the win-reserve ratio directly.

Hypothesis 2B. *(direct effect): Deal specificity will raise the win-reserve ratio without mediation through the number of bidders.*

3.2.2. Specification ambiguity

Contractors need sufficient information on the scope of a contract prior to bidding to judge the feasibility of the contract and estimate the cost. The information necessary for fulfilling a contract is stated in the specifications. However, for complex deals, it is difficult for procurers to clearly define the specifications, which results in insufficient information being provided to potential bidders (Goldberg, 1977). For example, in construction projects, it is often difficult to provide detailed specifications in advance because of unrevealed factors such as topographical conditions (Waara, 2008), resulting in ambiguous specifications. Ambiguous specifications cause incomplete contracts, where contractors cannot estimate costs accurately (Nakanishi, 2020). If bidders cannot expect *ex-post* renegotiation, such incomplete contracts can be risky for bidders, which deters potential bidders from participation (Moody and Kruvant, 1988). Hence, practitioners regard specification ambiguity as one cause of one-party bids (Arikawa, 2016).

Yao and Tanaka (2020) found that, in biddings with ambiguous quality requirements, the number of bidders increases, but high-quality contractors decline to submit bids. In other words, ambiguous specifications selectively attract low-quality contractors. Then, for biddings with prequalification, low-quality bidders will be eliminated, and the total number of bidders will decrease, resulting in a higher win-reserve ratio.

Hypothesis 3A. *(indirect effect): In the presence of prequalification, specification ambiguity will raise the win-reserve ratio, mediated by the decrease in the number of bidders.*

Incomplete contracts associated with ambiguity increase uncertainty, leading to inefficiency, which raises bid prices (Goeree and Offerman, 2003). Such contracts also cause financial and technical risks. To mitigate such risks, bidders must offer higher prices. Thus, specification ambiguity will also directly increase the win-reserve ratio.

Hypothesis 3B. *(direct effect): In the presence of prequalification, specification ambiguity will raise the win-reserve ratio without mediation through the number of bidders.*

3.2.3. Follow-up deals

For information systems, the original vendors who initially developed the systems frequently win biddings for *follow-up deals,* such as the operation, maintenance, and renewal of the systems. This situation is called *vendor lock-in* (BOA, 2021; Cao et al., 2017; Pellegrini et al., 2018).

The causes of the vendor lock-in are as follows. First, latecomers avoid the follow-up deals of other companies' systems to avoid risks. Second, procurers prioritize the reliable operation of their systems and wish to sign contracts with the original developer (GOJ, 2020). If the latecomers perceive a procurer's signal such as this, they will avoid entry. Third, even if latecomers submit a bid, the experienced original developer has both technical and cost advantages in follow-up deals (BOA, 2021). A latecomer who understands such a situation would likely give up entry.

Such a mechanism is applicable to other domains. To avoid risk (Moody and Kruvant, 1988), contractors tend to avoid deals for which they do not have similar experience (Estache and Iimi, 2011). Thus, for follow-up deals, latecomers hesitate to bid, and the number of bidders decreases, leading to a higher win-reserve ratio.

Hypothesis 4A. *(indirect effect): In biddings for follow-up deals, the win-reserve ratio will be higher than in other biddings because of the smaller number of bidders.*

Original vendors may expect fewer bidders for follow-up deals, as vendor lock-in is a common phenomenon (BOA, 2021; Cao et al., 2017; Pellegrini et al., 2018). Then, with a conviction that they will win the bidding award against fewer competitors, they will submit a higher price to gain more profit. In addition, they possess better knowledge about follow-up deals which enables accurate estimation, resulting in smaller variances and a higher win-reserve ratio. Meanwhile, latecomers will also submit higher prices to mitigate their risk under the uncertainty caused by their lack of knowledge about the original deal. Thus, follow-up deals will have a direct positive effect on the win-reserve ratio.

Hypothesis 4B. *(direct effect): In biddings for follow-up deals, the win-reserve ratio will be higher than for other biddings without mediation through the number of bidders.*

3.2.4. Deal size

The larger the deal, the higher the entry barrier, with increased relationship-specific investments (Estache and Iimi, 2012).

Furthermore, only large companies are likely to be able to handle large deals. Thus, the number of potential contractors will be smaller for larger deals. In addition, considering the increased risks for larger deals, potential contractors also become prudent (Moody and Kruvant, 1988). Furthermore, as preparing bids for larger deals is costlier, contractors forego submitting bids unless they are confident of winning. In road construction, it is observed that the project size negatively impacts the participation decision (Estache and Iimi, 2011). Hence, for larger deals, fewer bidders will participate, and the win-reserve ratio will be higher. In extreme cases, one-party bid events are more likely to occur with larger deals, resulting in a higher win-reserve ratio (e.g., TMG, 2016).

Hypothesis 5A. *(indirect effect): The deal size will raise the win-reserve ratio, mediated by the decrease in the number of bidders.*

The winning bid price unquestionably increases proportionally to the deal size. Aside from this effect, deal size will influence the win-reserve ratio as follows. For larger deals, bidders will behave conservatively and submit higher prices to mitigate the associated risks (Moody and Kruvant, 1988). In addition, they must be confident in their estimations; otherwise, they will hesitate to bid. Even in real-world bidding, a correlation between deal size and the win-reserve ratio has been observed (TMG, 2016). Thus, the win-reserve ratio will be higher for larger deals.

Hypothesis 5B. *(direct effect): The deal size will increase the win-reserve ratio without mediation through the number of bidders.*

3.2.5. Informal arrangements to facilitate the award of public interest corporations

Amakudari (i.e., the practice of hiring retired public officials) is often criticized because *amakudari* firms are given preferential treatment, distorting the competitive environment. Asai et al. (2021) found that *amakudari* firms achieve a higher winning probability in biddings. They also found that the higher winning probability is observed regardless of whether the retired officers were administrative or technical personnel; thus, informal inter-organizational coordination exists between the government and private sector to support *amakudari* firms' awards. Thus, it is also conceivable that a mechanism may exist that excludes non-*amakudari* firms or that these firms hesitate to bid for deals on which *amakudari* firms bid, reducing the number of bidders.

In Japan, typical *amakudari* organizations are public interest corporations (PICs). PICs are often established and operated as governmental initiatives with an informal objective of facilitating *amakudari*. PICs, in relation to *amakudari*, are criticized for hindering the competitive environment in public procurement. For example, the BOA (2009) pointed out that fewer bidders participate in biddings that PICs win.

It should be noted that by "PIC's award," we do not intend to capture the PIC's award itself as the bidding result but the *ex-ante* informal arrangement that facilitates such outcomes. This is informal coordination between governments and PICs to support the employment of government officers, as claimed by Asai et al. (2021). Procurers may manipulate the scope and specifications of deals to facilitate the bidding being awarded to a PIC. They may also imply to competitors that they want to award a bidding to a PIC and suggest they refrain from participation (Asai et al., 2021). In such situations, competitors may give up participation when there is a smaller possibility they will win or owing to a fear of being placed on a procurer's blocklist. Furthermore, the potential existence of such an opaque situation can itself discourage participation (Ohashi, 2009). Thus, we propose the following hypothesis that reflects such an arrangement influencing bidder participation.

Hypothesis 6A. *(indirect effect): In biddings won by PICs, the win-reserve ratio will be higher than in others because of the smaller number of bidders.*

Asai et al. (2021) have implied that informal arrangements exist that facilitate *amakudari*. If so, a mechanism to provide benefits to *amakudari* firms— including PICs—through higher prices may also exist, as described in Hypothesis 6B. Similar to what was noted above, this hypothesis does not address a PIC's award itself but an *ex-ante* arrangement to facilitate it.

Hypothesis 6B. *(direct effect): In biddings won by PICs, the win-reserve ratio will be higher than others without the effect of the smaller number of bidders.*

The study's hypotheses are summarized in Fig. 1.

4. Method

4.1. Setting and data

The data were obtained from the bidding result reports continuously published by the Civil Aviation Bureau (CAB) under the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) (Civil Aviation Bureau (CAB), 2022). Each report includes information such as the deal title, reserve price, all bidders' names, and the winner's name with the winning bid price. In the past, Japan's civil aviation administration was criticized for extensively constructing airports funded by taxes from airlines, which affected airlines' business. This funding scheme was abolished; however, the CAB is still under strict scrutiny from external groups, such as the media. Therefore, the CAB is suitable for observing government entities' actions, such as procurement process reform and their impact on bidder behavior.

We analyzed all CAB bidding events from FY 2019–2021 (N = 1349). All were sealed open competitive tendering with prequalification, with no invitation-only tendering. The bids were evaluated by price (first-price bidding) or by a combination of price and technical score (scoring auction). No rules were in place setting the lowest acceptable bids. Instead, abnormally low bids were subject to investigation to ensure quality and prevent damping. Our sample included some abnormally low bids; however, all of them passed the investigation. Subcontracting was limited to minor subtasks to prevent collusion. Neither *ex-post* renegotiation nor project period extensions were permitted, creating uncertainty and risk for bidders. When it is unclear whether some part of the work is included in the contract scope due to specification ambiguity, power asymmetry forces contractors to obey procurers' informal requests to conduct the part. Such a framework provides a unique setting to test the effects of incomplete contracts on the number of bidders and a win-reserve ratio.

The types of procurement objects were wide-ranging, including goods, service provisions, and information systems development and maintenance. Such heterogeneity enables us to analyze deal-specific variables. The types of goods and services provided are listed in Table 1. Since discretionary contracts are strictly restricted as a result of history, very specific deals unsuitable for competitive bidding are also subject to bidding. Thus, such a framework enabled us to examine the impact of deal specificity.

We assumed that the biddings in our sample included both common and private value (cost in procurement bidding) elements, with the latter prevailing. Theoretically, these elements are differentiated (e.g., Paarsch, 1992); however, real-world biddings include both elements, which are not exclusive of each other (Goeree and Offerman, 2003; Laffont, 1997). For example, bidders who buy artwork purely for fun also consider their common value for resale (Wolfstetter, 1996). Construction projects (Estache and Iimi, 2011; Wolfstetter, 1996) and oil drilling rights (Goeree and Offerman, 2003), which have common uncertain costs, involve private costs due to heterogeneity in bidder capability and unit costs. Thus, we assumed that the biddings in our sample included both cost elements. However, since subcontracting, which is equivalent to resale in sales auctions, is limited in our case, as
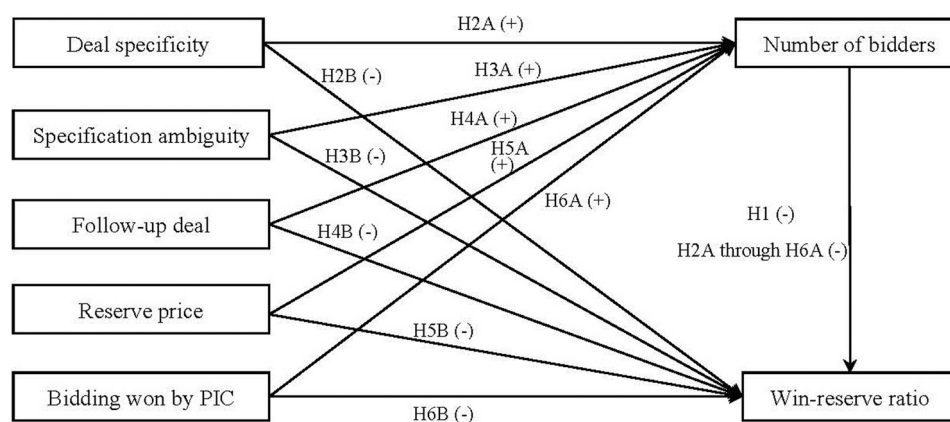
Fig. 1. Analytical framework.

Table 1
Deal specificity.

Value	Description	Deal Type
1	Commercially available goods or general services (relationship-specific investments are minor)	Purchase of commercial products, data input work; general personnel dispatch; general document translation; general health checks of employees; lease of general equipment and materials; video production; security guards; transportation of goods; general construction work; grass cutting; snow removal; house cleaning; reception of conference booths; checking and maintenance of general facilities and equipment
2	Provision of services or manufacturing of equipment that requires knowledge and experience in specific fields, where feasible contractors are not strongly limited (investments are required but can be diverted to a certain extent to other fields)	Work that requires a certain level of expertise (e.g., research, design, training, testing, professional examination, preparation of teaching materials, translation of technical documents); legal consultation; manufacturing and checking of objects that are not commercially available but not designated by type; general-purpose large-scale office information systems; checking and maintenance of facilities and equipment that require specific knowledge (e.g., aircraft fire extinguishing training facilities); purchase of electric power; lease of specific facilities
3	Provision of services or manufacturing of equipment that can be accomplished only by a very limited number of contractors (a considerable amount of relationship-specific investment is required that is difficult to divert to other fields)	Follow-up deals (e.g., maintenance, transition, parts, renewal, repair, adjustment, and user training of special-purpose information systems); manufacture of highly special-purpose information systems (e.g., air traffic controller training system); purchase of aircraft; lease of aircraft and flight simulators; goods that must be procured from designated agencies

explained above, the common cost element is reduced.

4.2. Variables

The variables entered into the models are as follows. The number of bidders (*BIDDERS*) is the number of contractors who submitted bids in each bidding event. Win-reserve ratio (*WIN*) for each bidding is the winning bid price divided by the reserve price (capped price) set by the procurer based on their estimation.

Deal specificity (*SPECIF*), which is the extent of required relationship-specific investments, was assigned to each deal type as a ternary variable (1, 2, or 3) in ascending order, as in Nakanishi (2020). The values were determined by two procurement experts in the CAB and the author in the following manner. First, we established a principle to assign a value to each deal category (type of procured object) rather than to an individual deal. This decision was based on the experts' experience that deal specificity tends to be similar within a category, whereas it varies between categories. Next, based on the experts' experience, we decided to set deal specificity as a ternary variable, with a value from 1 to 3. Thus, "1" was assigned to deal categories for which the relationship-specific investments were minor (e.g., commercially available goods or general services); "2" was assigned to deal categories that require an investment that can be diverted to other fields to a certain extent (e.g., either the provision of services or the manufacturing of equipment that requires knowledge and experience in specific fields, where feasible contractors are not strongly limited); and "3" was assigned to deal categories that require a considerable amount of relationship-specific investment that is difficult to divert to other fields (e.g., provision of services or manufacturing of equipment that can be accomplished only by a very limited number of contractors). Values were drafted by the author, and some were modified through discussions with the experts. Finally, the complete agreement was obtained for the values for all categories, which means Krippendorff's α (Krippendorff, 2003) equals 1. The final values are shown in Table 1. For analysis, the ternary variable *SPECIF* was converted into ordered dummy variables: *SPECIF1* (= 0 [if *SPECIF* = 1], 1 [if *SPECIF* = 2 or 3]) and *SPECIF2* (= 0 [if *SPECIF* = 1 or 2], 1 [if *SPECIF* = 3]).

Specification ambiguity (*AMBIG*) largely depends on the deal type (Waara, 2008). Hence, the *AMBIG* code was also assigned to each deal category in the same way as *SPECIF*, except that it was defined as a binary value. Specifically, "0" was assigned to unambiguous cases (deals with a scope of work that is clearly defined by the specifications), and "1" to ambiguous cases (deals with a scope of work that is difficult to define by the specifications). The decision to use a binary variable was made based on the experts' experience; they judged that it was natural to classify deal categories into two types in terms of specification ambiguity. The final values, agreed upon by all raters (Krippendorff's α = 1), are presented in Table 2.

Table 2
Specification ambiguity.

Value	Description	Deal Type
0	Unambiguous (scope of work is clearly defined by the specifications)	Purchase of commercial products and products with specified model numbers; operation support, maintenance, repair, renewal, and adjustment of information systems and equipment; purchase of equipment and parts; installation and removal of equipment; general training; data input work; translation; detailed design of equipment, etc.; general personnel dispatch; transportation of goods; security guards; equipment leasing; topographic survey; measurement
1	Ambiguous (scope of work is difficult to define by the specifications)	Research; manufacture of special-purpose information systems; basic design and performance improvement of information systems and equipment

To indicate whether a deal was a follow-up to some original deal, the follow-up deal dummy (*FOLLOW*) was entered (follow-up deals = 1, others = 0). Follow-up deals are related to the maintenance, inspection, testing, operation, management, adjustment, renewal, update, parts supply, and repair of information systems, networks, equipment, facilities, and devices. The experts made judgments based on the deal titles. The reserve price (*RESERVE*) was applied as deal size. The PIC dummy (*PIC*) indicated the winner's attribute for each bidding (biddings won by PIC = 1, those won by other private corporations = 0).

In addition, the following control variables were introduced. The value-added tax (VAT) rate increased from 8% to 10% on October 1, 2019, which may influence the bidders' cost estimation and behavior. Hence, we included the VAT increase dummy (*VAT*) (deals with 10% tax rate = 1, deals with 8% tax rate = 0). We also introduced the headquarters dummy *(HQ)* (contracts procured by CAB headquarters = 1, those procured by its branches = 0). This is because, as the CAB headquarters is subject to the direct influence of the top executives and the administrative unit of MLIT, it may be forced to take measures to increase the number of bidders. In addition, we introduced a scoring auction dummy (*SCORING*) (scoring auction = 1, first-price bidding = 0).

5. Estimation

The hypotheses were tested using ordinary least squares (OLS) regression. Possible concerns related to endogeneity are addressed in

Subsection 5.2. Table 3 shows the descriptive statistics and correlations between variables. The variance inflation factor values were less than 2.21, implying that there was no problem of multicollinearity.

5.1. Factors that influence the number of bidders

First, we conducted an analysis using the number of bidders as the dependent variable. The regression equation is shown in Eq. (1), and the results are shown in Table 4 (Models 1 and 2).

$$\ln BIDDERS_i = \alpha_1 + \beta_{11}VAT_i + \beta_{12}HQ_i + \beta_{13}SCORING_i$$
$$+ \beta_{14}SPECIF1_i + \beta_{15}SPECIF2_i + \beta_{16}AMBIG_i + \beta_{17}SUBSEQ_i$$
$$+ \beta_{18}\ln RESERVE_i + \beta_{19}PIC_i + \varepsilon_{1i} \qquad (1)$$

Here, $BIDDERS_i$ is the number of bidders for each bidding event i ($i = 1,., 1349$), α_1 is the constant term, VAT_i is VAT increase (dummy), HQ_i is the contract procured by headquarters (dummy), $SCORING_i$ is the scoring auction (dummy), $SPECIF1_i$ and $SPECIF2_i$ indicate deal specificity (dummy), $AMBIG_i$ indicates specification ambiguity (dummy), $FOLLOW_i$ is the follow-up deal (dummy), $RESERVE_i$ is the reserve price, PIC_i is the bidding won by PICs (dummy), and ε_{1i} is the error term. $BIDDERS_i$ and $RESERVE_i$ were logged to accommodate their non-linear relationship (Estache and Iimi, 2012). In Model 1, only control variables were entered. In Model 2, variables expected to influence the win-reserve ratio were added.

In Model 2, for deal specificity, while the effect of *SPECIF1* is not significant ($\beta = -0.056$, $p > 0.10$), that of *SPECIF2* is significant ($\beta = -0.131$, $p < 0.01$), suggesting a tendency for "very specific deals" to have fewer bidders. Follow-up deal ($\beta = -0.278$, $p < 0.01$) has a negative effect on the number of bidders. As predicted, a smaller number of bidders participate in bidding for follow-up deals. Specification ambiguity has a positive effect on the number of bidders ($\beta = .096$, $p < 0.05$), which is the opposite of our prediction. This point will be discussed in Subsection 5.2 below, together with its effect on the win-reserve ratio. Reserve price, or deal size, also has a positive effect on the number of bidders ($\beta = 0.031$, $p < 0.01$). Contrary to our hypothesis, more contractors tend to submit bids for larger deals. The effect of *PIC* was not significant.

5.2. Factors that influence the win-reserve ratio

Next, we conducted an analysis using the win-reserve ratio as a dependent variable. The regression equation is shown in Eq. (2) below, and the results are shown in Table 4 (Models 3–5). A concern may be raised about the endogeneity of the number of bidders. Public procurement practices in Japan show a general tendency of governments to try to increase the number of bidders in deals with an expected high win-

Table 3
Descriptive statistics.

	mean	s.d.	min	max	1	2	3	4	5	6	7	8	9	10	11
1. *BIDDERS*[a]	1.60	1.10	1	12	1										
2. *WIN* (%)	88.76	15.24	9.80	100.00	-0.50	1									
3. *VAT*	0.88	0.33	0	1	-0.02	-0.03	1								
4. *HQ*	0.84	0.37	0	1	-0.15	0.06	0.01	1							
5. *SCORING*	0.07	0.26	0	1	-0.08	0.05	0.04	-0.02	1						
6. *SPECIF1*	0.70	0.46	0	1	-0.19	0.16	0.20	0.23	0.16	1					
7. *SPECIF2*	0.40	0.49	0	1	-0.30	0.27	0.09	0.15	0.24	0.53	1				
8. *AMBIG*	0.18	0.39	0	1	0.12	-0.18	0.15	0.19	0.06	0.31	-0.15	1			
9. *FOLLOW*	0.42	0.49	0	1	-0.34	0.21	0.05	-0.03	0.13	0.31	0.51	-0.22	1		
10. *RESERVE*[a,b]	131.33	613.29	0.22	10,437.20	-0.11	0.13	0.03	0.23	0.44	0.33	0.45	0.09	0.33	1	
11. *PIC*	0.09	0.28	0	1	0.09	-0.02	0.01	0.05	-0.08	0.16	-0.22	0.31	-0.20	-0.06	1

N = 1349
[a] Value before being logged
[b] Unit: million yen

Table 4
Ordinary least squares regression results.

Dependent variables	Model 1 ln (BIDDERS)			Model 2 ln (BIDDERS)			Model 3 WIN (%)			Model 4 WIN (%)			Model 5 WIN (%)		
	β	S.E.	p	β	S.E.	P	β	S.E.	P	β	S.E.	p	β	S.E.	p
(Constant)	0.528	0.048	***	0.200	0.138		87.787	1.509	***	83.197	4.403	***	86.097	3.932	***
VAT	-0.030	0.040		0.000	0.038		-1.680	1.254		-1.998	1.222		-1.999	1.090	*
HQ	-0.201	0.036	***	-0.225	0.036	***	2.625	1.135	**	2.079	1.156	*	-1.171	1.046	
SCORING	-0.156	0.051	***	-0.116	0.053	**	3.120	1.581	**	0.215	1.691		-1.467	1.511	
SPECIF1				-0.056	0.038					3.239	1.203	***	2.426	1.074	**
SPECIF2				-0.131	0.037	***				4.876	1.187	***	2.979	1.064	***
AMBIG				0.096	0.038	**				-7.832	1.232	***	-6.443	1.101	***
FOLLOW				-0.278	0.030	***				2.157	0.972	**	-1.865	0.894	**
ln (RESERVE)				0.031	0.009	***				0.092	0.278		0.541	0.249	**
PIC				0.003	0.048					4.061	1.535	***	4.099	1.370	***
ln (BIDDERS)													-14.475	0.780	***
F	13.521			30.545			3.544			18.843			55.741		
Adjusted R^2	0.027			0.165			0.006			0.106			0.289		
Change in Adjusted R^2				0.138						0.100			0.183		

N = 1349, * p < 0.10, ** p < 0.05, *** p < 0.01

reserve ratio. If such efforts succeeded, the win-reserve ratio might have a positive effect on the number of bidders. However, regardless of the efforts of various government entities, no effective means have been identified to date (Administrative Evaluation Bureau (AEB), 2008; Administrative Reform Council (ARC), 2020; Board of Audit (BOA), 2009; Board of Audit (BOA), 2021; Tokyo Metropolitan Government (TMG), 2016). Hence, the endogeneity problem was determined to be limited.

$$WIN_i = \alpha_2 + \beta_{21}VAT_i + \beta_{22}HQ_i + \beta_{23}SCORING_i + \beta_{24}SPECIF1_i + \beta_{25}SPECIF2_i$$

$$+ \beta_{26}AMBIG_i + \beta_{27}SUBSEQ_i + \beta_{28}\ln RESERVE_i + \beta_{29}PIC_i$$

$$+ \beta_{2,10}\ln BIDDERS_i + \varepsilon_{2i} \qquad (2)$$

Here, WIN_i is the win-reserve ratio for each bidding event i ($i = 1,..,$ 1349), α_2 is the constant term, and ε_{2i} is the error term. The other variables are the same as those in Eq. (1). Model 3 is the base model with only control variables. Model 4 is the model with explanatory variables, except for the number of bidders. Model 5 is the full model with all variables. The coefficients in Model 5 correspond with direct effects, and those in Model 4 correspond with the sum of the indirect and direct effects.

As in Model 5, the number of bidders has a negative effect on the win-reserve ratio ($\beta = -14.475$, p < 0.01). Thus, Hypothesis 1 is supported. As predicted, the win-reserve ratio is significantly higher in biddings where the number of bidders is small. As mentioned previously, the possible endogeneity of the number of bidders is not addressed in our model (OLS). If such an endogeneity bias exists, the effect will be positive, as previously explained. Hence, if we subtract the effect of the bias, the coefficient of the number of bidders in Model 5 will become smaller (i.e., its absolute value becomes larger). Thus, we can infer that the possible endogeneity will not seriously affect our findings.

Next, we comprehensively analyzed the relationship between the number of bidders, the win-reserve ratio, and the factors behind them. For deal specificity, both *SPECIF1* ($\beta = 3.239$, p < 0.01) and *SPECIF2* ($\beta = 4.876$, p < 0.01) have positive effects on the win-reserve ratio in Model 4. This significant effect is also observed in Model 5 (*SPECIF1*: $\beta = 2.426$, p < 0.05; *SPECIF2*: $\beta = 2.979$, p < 0.01), supporting Hypothesis 2B. In addition, as shown previously in Model 2, *SPECIF2* has a negative effect on the number of bidders, which has a significant negative impact on the win-reserve ratio. These results imply that deal specificity has an indirect effect on the win-reserve ratio, as mediated by the number of bidders. Thus, Hypothesis 2A is supported.

Specification ambiguity has a negative effect on the win-reserve ratio in Model 5 ($\beta = -6.443$, p < 0.01). Contrary to our prediction, the more

ambiguous the specifications, the lower the win-reserve ratio. In addition, as shown in Subsection 5.1, specification ambiguity has a positive effect on the number of bidders, which negatively influences the win-reserve ratio. Taken together, these results show that specification ambiguity has both indirect and direct effects that lower the win-reserve ratio, contrary to our prediction. For incomplete contracts associated with ambiguous specifications, the number of bidders increases, and the win-reserve ratio decreases. Thus, neither Hypothesis 3A nor Hypothesis 3B is supported.

The win-reserve ratio is significantly lower for follow-up deals than for other deals ($\beta = -1.865$, p < 0.05) in Model 5. This finding implies that follow-up deals have a direct effect that will decrease the win-reserve ratio, contrary to Hypothesis 4B. As previously shown in Model 2, fewer bidders tend to bid in follow-up deals. As a smaller number of bidders will result in a higher win-reserve ratio (Hypothesis 1), these results imply that, for follow-up deals, the win-reserve ratio is increased, as mediated by a decreased number of bidders, indicating a positive indirect effect. This effect is also implied by the positive coefficient ($\beta = 2.157$, p < 0.05) in Model 4 before entering the number of bidders. Thus, Hypothesis 4A is supported. Notably, the indirect and direct effects influence the win-reserve ratio in opposite directions; follow-up deals directly lower the win-reserve ratio but indirectly raise it with fewer bidders.

The effect of the reserve price, or deal size, on the win-reserve ratio is significant in Model 5 ($\beta = 0.541$, p < 0.05) but not in Model 4. This result indicates the existence of a direct effect of deal size, supporting Hypothesis 5B. According to the results of Model 2, the number of bidders is larger in greater deals, which is opposite to hypothesis H5A. Thus, deal size also shows contradictory effects; it directly raises the win-reserve ratio but indirectly lowers it with more bidders.

The effect of (an informal arrangement to facilitate) bidding won by PICs was significant in both Model 4 ($\beta = 4.061$, p < 0.01) and Model 5 ($\beta = 4.099$, p < 0.01). Moreover, according to the results of Model 2, the effect of *PIC* on the number of bidders is not significant. That is, a PIC's award does not have an indirect effect on the win-reserve ratio, as mediated by an increase in the number of bidders, but it does directly increase the win-reserve ratio. Thus, Hypothesis 6B is supported, while Hypothesis 6A is not supported.

6. Sensitivity checks

We conducted sensitivity checks on variables that may influence the analysis results: the number of bidders, deal specificity, and biddings won by PIC (Table 5). Models 2x and 5x are derivatives of Models 2 and 5, respectively.

Table 5
Sensitivity check.

Dependent variables	Model 2A BIDDERS			Model 2B Multiple-party bid (dummy)			Model 2B_L (logistic) Multiple-party bid (dummy)			Model 2C ln (BIDDERS)			Model 2D ln (BIDDERS)		
	β	S.E.	p	β	S.E.	p	β	S.E.	p	β	S.E.	p	β	S.E.	p
(Constant)	1.352	0.309	***	0.246	0.134	*	-1.302	0.738	*	0.322	0.133	**	0.200	0.138	
VAT	0.028	0.086		-0.006	0.037		-0.020	0.191		0.002	0.038		-0.001	0.038	
HQ	-0.601	0.081	***	-0.147	0.035	***	-0.743	0.178	***	-0.224	0.036	***	-0.225	0.036	***
SCORING	-0.288	0.119	**	-0.074	0.051		-0.353	0.293		-0.118	0.053	**	-0.118	0.053	**
SPECIF1	-0.166	0.084	**	-0.055	0.037		-0.245	0.181					-0.052	0.038	
SPECIF2	-0.262	0.083	***	-0.094	0.036	***	-0.535	0.192	***				-0.135	0.037	***
SPECIF (ternary)										-0.094	0.019	***			
AMBIG	0.170	0.086	**	0.110	0.038	***	0.502	0.188	***	0.113	0.036	***	0.099	0.038	**
FOLLOW	-0.557	0.068	***	-0.260	0.030	***	-1.365	0.163	***	-0.279	0.030	***	-0.279	0.030	***
ln (RESERVE)	0.071	0.019	***	0.024	0.008	***	0.122	0.047	***	0.030	0.009	***	0.031	0.009	***
PIC	-0.014	0.108		0.012	0.047		0.027	0.222		0.018	0.046				
Won by PIC or IAA													-0.020	0.047	
ln (BIDDERS)															
BIDDERS															
Multiple-party bid (dummy)															
F	28.084			24.708			1513.925[a]			34.187			30.569		
Adjusted R^2	0.153			0.137			0.197[b]			0.165			0.165		

Dependent variables	Model 5A WIN (%)			Model 5B WIN (%)			Model 5C WIN (%)			Model 5D WIN (%)		
	β	S.E.	P	β	S.E.	p	β	S.E.	p	β	S.E.	p
(Constant)	91.616	3.992	***	86.461	4.036	***	83.191	3.793	***	86.066	3.931	***
VAT	-1.821	1.100	*	-2.076	1.119	*	-2.016	1.088	*	-2.010	1.090	*
HQ	-1.663	1.062		0.134	1.065		-1.178	1.045		-1.127	1.046	
SCORING	-1.575	1.525		-0.764	1.549		-1.455	1.510		-1.456	1.511	
SPECIF1	2.203	1.085	**	2.517	1.102	**				2.444	1.072	**
SPECIF2	3.244	1.072	***	3.626	1.089	***				2.977	1.063	***
SPECIF (ternary)							2.705	0.536	***			
AMBIG	-6.773	1.110	***	-6.370	1.131	***	-6.569	1.017	***	-6.447	1.101	***
FOLLOW	-1.312	0.897		-1.290	0.915		-1.856	0.893	**	-1.845	0.894	**
ln (RESERVE)	0.537	0.251	**	0.404	0.255		0.551	0.247	**	0.539	0.249	**
PIC	3.976	1.382	***	4.216	1.406	***	3.986	1.317	***			
Won by PIC or IAA										4.100	1.356	***
ln (BIDDERS)							-14.482	0.779	***	-14.444	0.780	***
BIDDERS	-6.226	0.351	***									
Multiple-party bid (dummy)				-13.241	0.822	***						
F	52.416			46.206			61.967			55.768		
Adjusted R^2	0.276			0.251			0.289			0.289		

N = 1349, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, [a] - 2 log-likelihood, [b] Nagaike R^2

The first variable to be addressed is the number of bidders. While the number of bidders was logged in the original analysis, it was applied without being logged in Models 2A and 5A. Among the explanatory variables, the effect of *SPECIF1*, which was not significant in Model 2, is significant (β = −0.166, p < 0.05) in Model 2A. *SPECIF2* remains significant in Model 2A (β = −0.262, p < 0.01). Taken together, the result indicates a consistent trend toward fewer bidders for specific deals. *FOLLOW*, which were significant (β = −1.865, p < 0.05) in Model 5, are no longer significant in Model 5A. However, this is the only salient change. Hence, in general, whether the number of bidders is logged or not does not seriously influence our result.

For the number of bidders, we further applied a "multiple-party bid dummy" (multiple-party bid = 1, one-party bid = 0) in Models 2B and 5B. As public administrations claim (e.g., ARC, 2020; BOA, 2009, 2021; TMG, 2016), there may be a marked difference in competitiveness between one-party and multiple-party bids. However, there is no change in the significance of coefficients between Models 2 and 2B. The effect of *FOLLOW*, which is significant in Model 5, is not significant in Model 5B. However, there is also no salient change in the significance of the other coefficients. Since the "multiple-party bid dummy" is a binary variable, logistic regression analysis was also applied as in Model 2B_L. The results indicate that the significance of the coefficients is consistent with those of Model 2, except for *SCORING*, which is a control variable. Hence, converting the number of bidders into a dummy variable does not seriously affect our findings.

Second, concerning deal specificity, ordered nominal measures (*SPECIF1* and *SPECIF2*) in Models 2 and 5 were replaced by the original ternary ordinal measure (*SPECIF*). The results show that the coefficient of *SPECIF* is significant (β = −0.094, p < 0.01) in Model 2C. The tendency for specific deals to decrease the number of bidders shows no change. The significance of the other coefficients is also unchanged. In Model 5C, the coefficient of *SPECIF* is significant (β = 2.705, p < 0.01). The significance of the other coefficients remains unchanged. Thus, the results are consistent even when *SPECIF* is applied for deal specificity.

Third, we replaced "bidding won by PIC" with "bidding won by PIC or incorporated administrative agencies (IAA)" (dummy variable) as in Models 2D and 5D. IAAs used to be divisions of the national government but were separated as incorporated agencies after 1999. They still have strong government ties and are often targets of criticism regarding issues such as *amakudari* along with PICs. The results show no change in the significance of the coefficients in either Models 2D or 5D compared with Models 2 and 5.

In summary, no salient changes are present in the significance of the coefficients, except that *FOLLOW* is no longer significant in Models 5A and 5B. The original Models 2 and 5 indicate almost the same or better levels of R^2 and F compared with the derived models, except for Model 2C, for which these indices are not applicable. Therefore, we conclude that the results of Models 2 and 5 are reliable.

7. Discussion

Society often criticizes one-party bids as they cause problems in both the process and consequences of public procurement. However, the results of this study show that the situation is not straightforward and that various factors must be considered when addressing one-party bids.

As evidenced in Model 2, the fewer the bidders, the higher the win-reserve ratio. This is in line with the basic laws of economics, and the points made by the BOA (2009), ARC (2020), and TMG (2016) have some validity. However, the win-reserve ratio is both directly and indirectly influenced by various factors with different influential mechanisms.

In terms of deal specificity, our findings support the existence of both indirect and direct effects on the win-reserve ratio. For specific deals, the win-reserve ratio rises not only because fewer bidders participate but also because contractors with relationship-specific skills and experience offer higher prices.

Contrary to our prediction, both direct and indirect effects of specification ambiguity can decrease the win-reserve ratio. Regarding a possible explanation for the indirect effect, Yao and Tanaka (2020) asserted that ambiguous quality requirements increase the number of bidders. We predicted that even with ambiguous specifications, the prequalification process would exclude low-quality contractors and that the number of bidders would decrease. However, our prediction was not supported, and our results agreed with Yao and Tanaka. Clearly, prequalification processes do not always function effectively. There are cases in which incompetent contractors qualify and receive orders, leading to problems. For example, in 2006, an information system project of the Japan Patent Office was disrupted because the contractor's limited competency prevented them from completing it, thereby wasting a 5451-million-yen expenditure (BOA, 2012). As in this case, the screening of low-quality contractors might not have been effective in our data. As a result, a situation like Yao and Tanaka's (2020) case might have occurred, leading to a larger number of bidders and, consequently, a lower win-reserve ratio.

The direct effect of specification ambiguity on lowering the win-reserve ratio can be explained as follows. Ambiguous specifications hinder accurate cost estimation, resulting in larger errors, and a bidder with unintentionally low estimates wins the bid. Alternatively, an optimistic contractor may intentionally submit a bid at a low price within the range of interpretation of the specifications. However, after signing the contract, such a contractor may face a "winner's curse" when they confront higher quality or workload demands than expected. Procurers are also at risk. With ambiguous specifications and quality requirements, they cannot sue an incompetent contractor even if the deliverable quality fails to meet their implicit expectations as long as it satisfies "literal" specifications (Tanaka and Hayashi, 2016). Thus, a larger number of bidders and a lower win-reserve ratio due to ambiguous specifications are not always welcome. As in Yao and Tanaka's (2020) case, the majority of bidders under ambiguous specifications may be low-quality contractors.

For follow-up deals, we observed that the indirect and direct effects conflicted; fewer bidders participated, but the win-reserve ratio was lower. Thus, although a vendor lock-in-like situation (BOA, 2021; Cao et al., 2017; Pellegrini et al., 2018) was observed in the present data, such a situation did not lead to a higher win-reserve ratio. This is possibly because, unlike our prediction, original vendors might have hesitated to place high-price bids in preparation for competitors' bids. Simultaneously, the latecomers might have bid somewhat aggressively rather than avoided risk.

For a large deal, a larger number of bidders submitted bids, but the win-reserve ratio was still higher. This is different from the assertions of Estache and Iimi (2012) and TMG (2016). Specifically, while deal size directly increases the win-reserve ratio, it also indirectly decreases it by increasing the number of bidders. As such, these two effects are in opposite directions, which will require careful treatment when applied to policymaking.

While the number of bidders was not significantly smaller in deals won by PICs, the win-reserve ratio was higher. This result implies that no situations discourage other contractors from participating in biddings where PIC awards are expected; however, some mechanisms do increase the win-reserve ratio. As asserted by Asai et al. (2021), an inter-organizational mechanism may facilitate *amakudari* firms being awarded deals at higher bid prices. The high win-reserve ratio of deals won by PICs should be examined further.

8. Conclusions

Through statistical analysis using bidding result data, this study analyzed the mechanism by which various deal-specific factors influence the number of bidders and win-reserve ratio. It comprehensively analyzed the relationships among these variables, differentiating between direct and indirect effects.

8.1. Theoretical contributions and implications

Our theoretical contributions are as follows. First, while previous studies have examined homogeneous deals in limited settings (Laffont, 1997), we examined the impact of deal-specific variables in a heterogeneous set of deals. The novelty of this study is that it operationalized, coded, and examined the effects of deal specificity and specification ambiguity, which cause relationship-specific investments and incomplete contracts, respectively. While they are key factors that determine bidders' decisions (Milgrom and Roberts, 1992), they have not been sufficiently analyzed in previous bidding research. Our study addresses this gap. Second, we refined Nakanishi's (2020) argument on the differentiation between indirect and direct effects. Deal specificity and specification ambiguity had both effect types, while PIC's award had a direct effect only. Notably, follow-up deals and deal size indicated conflicting indirect and direct effects. Third, we elaborated on the discussion on informal arrangements that support *amakudari*. In addition to the higher winning probability of *amakudari* firms (Asai et al., 2021), we found evidence of a higher win-reserve ratio for biddings where awards by PICs–typical *amakudari* organizations–are expected. This extends the current knowledge on the mechanism of *amakudari*.

Our study also has implications for future bidding research. In particular, we demonstrated the importance of differentiating between the indirect and direct effects of various factors on the win-reserve ratio. To refine our analysis of the win-reserve ratio, future research should consider this finding.

Moreover, our findings are not specific to Japan and can be generalized to some extent. First, as relationship-specific investments and incomplete contracts are ubiquitous, the mechanism through which these factors influence bidder behavior is not specific to our context. For example, underinvestment in relationship-specific assets and skills is a widely known problem (Milgrom and Roberts, 1992). Second, our discussion captures a common facet of public procurement. In Japan, the one-party bid problem has resulted from the excessive application of open competitive tendering to pursue accountability for fairness in the procurement process. As an excessive emphasis on procedural fairness is a global trend in public procurement (Sorte, 2016), similar phenomena will be observed in other countries.

8.2. Policy implications

Our policy implications are as follows. First, when discussing the one-party bid problem and associated high win-reserve ratio, those involved in public procurement should note that the mechanisms by which factors influence the win-reserve ratio differ. In particular, direct and indirect effects should be distinguished. Notably, these effects can conflict, as we observed, for follow-up deals and deal size. It would be unsurprising if such phenomena occurred for other factors. Deliberate

consideration is needed when formulating policies to avoid unintended consequences.

Second, it would be difficult for procurers to intervene in some of the determinants of the number of bidders. A typical example is deal specificity. Reducing the specificity of procured objects means that procurers must bear the specificity themselves. Arikawa (2016) argues that combining too many work units into one contract leads to a one-party bid. However, if one contract deal is divided into smaller sub-deals with low specificity, then the procurer must coordinate among the contractors' work for sub-deals. This requires additional project management skills and increases total costs (Ashenfelter et al., 1997; Estache and Iimi, 2008).

Specification ambiguity is also difficult to address. In some fields, such as construction, it is intrinsically difficult to define detailed work in advance, and specifications inevitably become ambiguous, leading to incomplete contracts (Waara, 2008). Further, bidding hinders information exchange between procurers and contractors (Bajari et al., 2009; Goldberg, 1977). Therefore, contractors cannot accurately understand procurers' intentions for deals under ambiguous specifications. Moreover, for such deals, an effective *ex-post* check of the deliverable quality is difficult. Even if the deliverable fails to meet the procurer's expectations, the procurer must accept it as long as it meets the "literal" specifications (Tanaka and Hayashi, 2016). A smaller win-reserve ratio resulting from ambiguous specifications may simply be a sign of low quality. Alternatively, the flexible application of discretionary contracts should be considered.

8.3. Limitations

The limitations of this study are as follows. First, this study was based on CAB data; thus, the results must be generalized with caution. In particular, our sample does not cover large-scale deals, such as infrastructure construction. The dataset has a maximum reserve price of 10.4 billion yen, mean of 131 million yen, and a median of 8.9 million yen. The results might have differed if the sample had included large-scale construction projects. However, as discussed previously, our findings can be generalized, to a certain extent, to other contexts.

Second, our treatment of the endogeneity of the number of bidders is limited, although this did not seriously affect our results. Incorporating its effect would likely improve our estimation.

Third, some deal-specific factors that influence the number of bidders and win-reserve ratio were not examined. For example, this study did not address factors such as insufficient performance periods, insufficient public notice periods, and restrictedness and ambiguity of prequalification criteria (Arikawa, 2016). The effects of these variables should be examined.

Fourth, the values of deal specificity and specification ambiguity were assigned to deal categories, and follow-up deals were judged from the deal titles. Such category-based assignment is effective in preventing bias caused by raters' subjectivity but limits accuracy. A possible alternative would be to develop variables through operationalizing bidders' perceptions, for example, on specification ambiguity. However, as it requires careful validation, we would like to address this issue in a future study.

Declaration of Interest

There are no conflicts of interest to declare.

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