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The seemingly collusive 95% rule in public procurement: the case of local governments in Japan

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Abstract

Purpose – This paper aims to examine a unique form of coordinated behavior in public procurement: the 95% rule. Although it has been recognized by some experts and researchers, the extant literature has not systematically analyzed this phenomenon.

Design/methodology/approach – This study identifies and quantifies the impact of the 95% rule, showing a sharp drop in the winning probability at 95% of the reservation price; bidders deliberately avoid exceeding this threshold to evade suspicions of collusion. Using regression discontinuity analysis, the authors examine over 13,000 bids for approximately 2,500 pavement contracts awarded by Ehime Prefecture, Japan, from 2014 to 2022.

Findings – The results show that winning bids accumulate just below the 95% threshold in certain market conditions while losing bids exceed this level consistently. If the winner and loser are predetermined, they only need to set their bid prices based on this threshold. This simple pattern effectively sustains collusive agreements, such as bid rotation and regional division.

Social implications – The coordinated behavior among firms identified in this paper is easy to understand and may help both experts and the public strengthen bid-rigging oversight.

Originality/value – This study contributes to the literature on Japanese procurement by elucidating the structural mechanism underlying bidding patterns. The 95% rule also provides a unifying explanation for various observed facts – such as the significant gap between winning and runner-up bids and the stickiness of certain high bid price levels – that were separately identified in previous studies based on Japanese data.

Keywords Collusive behavior, Public procurement, Regression discontinuity analysis, 95% rule, Japanese local governments

Paper type Research paper

1. Introduction

In developed countries, public procurement data – including bid prices, contract awards and bidder identities – is typically well-structured and publicly accessible. This availability allows for systematic academic research, contributing to understanding collusive behavior and enhancing monitoring mechanisms. Previous bid-rigging research can be broadly classified into ex-post models, which analyze collusion based on detected cases (Porter and Zona, 1993; Bolotova *et al.*, 2005; Harrington and Jehle, 2015; Ishii, 2014; Clark *et al.*, 2018;

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Lundberg, 2025) and ex ante models, which scrutinize data where collusion has not been formally identified (Bajari and Ye, 2003; Conley and Decarolis, 2016; Imhof *et al.*, 2018; Barrus and Scott, 2020).

This study adopts an ex ante perspective to examine public procurement by local governments in Japan. This approach is closely related to Ishii (2009), Ohashi (2009), Chassang and Ortner (2019), Chassang *et al.* (2022), Kawai and Nakabayashi (2022) and Kawai *et al.* (2022), who examine bid-rigging in Japan from an ex ante perspective, primarily relying on data from the 2000s. Gradual institutional reforms were implemented during this period to combat corruption and bid-rigging that had been exposed in the 1990s and 2000s; however, collusive practices persisted. In contrast, this paper uses procurement data from the 2010s and beyond, as numerous reforms implemented before 2010 to diminish collusion and promote fair competition must be verified.

The above studies clarified signs of bid-rigging as systematic patterns unlikely to occur in a competitive market without bidder collusion. These patterns include phantom bids, frequent withdrawals, bid price stability (low variance), individual bid price deviations (e.g. a significant price disparity between the winning bid and the runner-up), the simplicity of bid prices (facilitating the enforceability of price cartels) or the rigidity of bid price rankings (e.g. a persistent ordering pattern in consecutive re-bids). Tóth *et al.* (2015) proposed a mixed indicator incorporating the characteristics of these diverse measures; however, collusive players continuously adapt strategies to evade detection, deliberately avoiding well-known and established patterns. Therefore, existing studies may not fully capture these evolving collusive tactics.

This paper proposes an alternative indicator, the 95% rule. This approach involves strategically setting winning bid price ratios below 95% of the reservation price to conceal signs of collusion (such as high prices). At the same time, losing bids consistently exceed this threshold by a sufficient margin. This collusive practice helps reduce suspicion of bid-rigging by suppressing the winning price and avoiding explicit communication regarding precise price coordination. It aids in maintaining collusive agreements, such as bid rotation and territorial allocation [1]. Furthermore, the 95% rule provides additional insight into recent studies using Japanese data. Chassang *et al.* (2019) and related studies focus on disparities in bid ratios – specifically, the missing mass of close-losing bids, which they interpret as indicative of coordinated behavior inconsistent with competitive bidding [2]. Chassang *et al.* (2022) identified another suspicious pattern from a case study: a mere 2% bid reduction significantly increases demand; however, instead of discussing why this occurs, they show that it does not happen in a competitive market. In addition, Figure 3 in Ishii (2008) showed that the winning bid ratios cluster just below 95% of the reservation price, even though the floor price was around 77%–85%. If bidders can increase their winning probability by lowering their bids or deviating from the 95% crowd of bids, why do they not do so? The author does not explain the cause of this disparity. Through the 95% rule, this paper provides a consistent explanation for these phenomena and links their findings.

This study uses a data set of 2,500 contracts for paving works awarded by Ehime Prefecture between June 2014 and March 2022 for empirical analysis [3]. These contracts involved 13,000 bids. The regression discontinuity (RD) analysis shows a large unnatural gap in winning probability around 95% of the reservation price, indicating that winning bidders intentionally adjust their bids to remain below this threshold. This potentially intentional behavior does not occur in a competitive market; however, not all such acts by tender participants represent an attempt to deceive the government, nor are they necessarily inefficient (Hendricks and Porter, 1989).

This paper is structured as follows. Section 2 defines key concepts and lays out the theoretical foundation for the 95% rule. Section 3 introduces the data set, describing fundamental factors – bidding formulas, the number of bidders and competitiveness. Section 4 tests the 95% rule using an RD analysis and verifies its validity. Section 5 extends the analysis by examining two factors (regional market competitiveness and shocks from nationwide collusion cases) as a robustness check for the 95% Rule. Finally, Section 6 summarizes the findings.

2. Definition of terms and mechanisms of the 95% rule

The concepts of bid price ratio and winning bid price ratio (the winning bid ratio) are crucial for this study. In a procurement auction, the bid price is the amount each company proposes; the winning bid price is the amount that successfully competes against other bids.

In a public procurement auction a, let r_a denote the reservation price, b_{ia} is the bid price of company i and w_a is the winning bid price, which belongs to the set of b_{ia}. The bid price ratio $B_{ia} = b_{ia}/r_a$ and the winning bid ratio $W_a = w_a/r_a$ normalize bid amounts by the reservation price. This reservation price (as the engineer's estimated cost) represents the maximum contract amount and is legally required to be determined before each procurement. The government also formalizes the framework for calculating the reservation price [4]. In Ehime Prefecture, the reservation price is disclosed in advance, ensuring $0 \leq B_{ia} \leq 1$ [5]. In what follows, if the identities of the auctions or companies are unimportant, each bid price ratio is termed B_j.

Economic theory posits that a higher bid price ratio involves a tradeoff between increasing the profit margin and reducing the winning probability. Figure 1 illustrates the relationship between the bid price ratio and the winning probability for consultancy and other outsourcing contracts awarded by Ehime Prefecture from 2014 to 2022 (based on almost 75,000 observations). The winning probability represents the proportion of winning bids out of the total bids at each bid price ratio [6]. Figure 1 shows that the proportion of winning bids exceeds 70% when the bid price ratio falls below 0.9. Conversely, once the bid price ratio exceeds the mid-0.9 range, it drops to nearly 3%. This continuous negative correlation aligns with the theoretical expectation; however, the 95% rule introduces an unexpected distortion to this anticipated curvature.

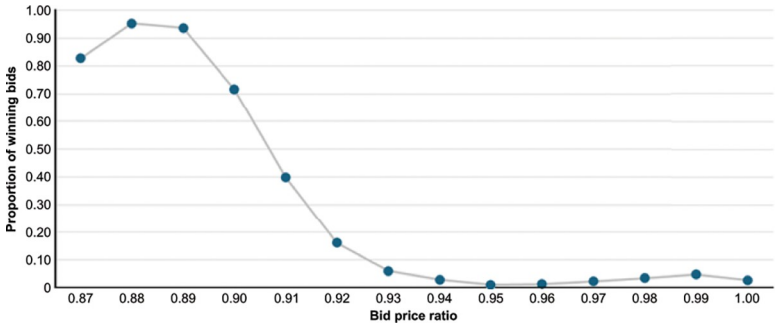


Figure 1. Relation between the bid price ratio and the proportion of winning bids

Note(s): The bidding result data pertain to outsourcing contracts for consulting services and others in Ehime Prefecture from June 2014 to March 2022. The horizontal axis omits bid price ratios of 0.86 or lower due to the small number of observations. The total number of observations used is 74,288

Source: Author's own work, using official bid data disclosed by Ehime Prefecture

2.1 The 95% rule

The 95% rule was first identified in 2006; however, the public and regulators largely ignored it. In 2001, the Japan Federation of Bar Associations reported that, since the 1990s, the average winning bid ratio had consistently exceeded 0.95 across many public entities amid widespread bid-rigging cases. In response, the National Citizens' Ombudsman Liaison Conference began collecting data on winning bid ratios in 2002 and, despite lacking any scientific basis, defined a winning bid ratio exceeding 0.95 as a strong indication of collusion. Naturally, this 0.95 threshold has become broadly perceived as a straightforward sign of possible collusion, given the decline in civic trust in the government and the lack of sufficient monitoring measures for complex public procurement [7].

A winning bid ratio exceeding 0.95 in public procurement will likely raise suspicions of collusion; thus, rational bidders avoid submitting bids with ratios above 0.95. A notable example is the 2006 bid-rigging case in Nagoya City, where only the preselected successful bidder submitted a bid with a ratio below 0.95. At the same time, others bid above this threshold, ensuring that the winning bid ratio stayed below 0.95 of the reservation price. The National Citizens' Ombudsman Liaison Conference referred to this behavior as the "95% rule." Such conduct was also observed in Saga Prefecture's port development projects (2005–2006) and a tender in Tagawa City in Fukuoka Prefecture (2008). At the time, "If it is less than 0.95, it will not be noticed" was a pragmatic approach for bidders. For example, Ishii (2009) uses a winning bid ratio of 0.95 as a benchmark for analyzing collusion. While Padhi and Mohapatra (2011) criticized the lack of rigorous analysis behind the 95% threshold, by the mid-2000s, it had already become a well-known benchmark among specialists in Japan. If the 95% rule had been monitored after its initial recognition in 2006, collusive bidders should have been deterred from using it; however, they might have continued to use the 95% rule if they believed it was difficult for outsiders to judge whether bids below 0.95 were illegal collusion or not.

To confirm the 95% rule, we consider public procurement in Ehime Prefecture, where the reservation price is announced publicly in advance. Under this pre-announcement condition, the only required ability for collusion is basic multiplication. We can formalize the 95% rule as follows:

a. Bidders who intentionally lose submit bids with a bid price ratio above 0.95.
b. The single bidder chosen to win submits a bid with a bid price ratio below 0.95, but it will not deviate significantly from 0.95 to maximize profit.

Action (a) is known as "phantom bids," which will be discussed later. Action (b) prevents the winning bid ratio from exceeding 0.95, driven by a forecast of public criticism held by the bidders. This action likely results in clustering just below the 0.95 threshold to maximize profit. This coordinative method only requires selecting the winner without detailed discussions about bid prices. The following outcomes are likely if this coordination is effectively executed:

c. There are no winners when the bid price ratio exceeds 0.95 (the winning probability approaches 0).
d. The proportion of winners with a bid price ratio below 0.95 increases (the winning probability approaches 1).
e. Based on (c) and (d), a significant discontinuity arises in the winning probability around the 0.95 threshold.

When feature (e) occurs in the real world, it is a manifestation of the 95% rule. This situation allows us to infer the presence of coordinated behavior among bidders (possibly indicating

collusion) through abductive reasoning; however, this inference is not accepted without a careful understanding of the background. This approach involves the fallacy of affirming the consequent – observing feature (e) does not necessarily indicate collusion [8].

2.2 Bidding patterns and observations

The bid price ratio will decline in a competitive market with sufficient competitors. When the floor price is set at a sufficiently profitable level, the bid price will converge at that threshold and the winner will be determined by lottery. In contrast, in a noncompetitive market where the winner is effectively predetermined (whether by a natural monopoly or collusion), the winning bid price will reach the reservation price, regardless of the apparent number of rivals. This outcome is the simplest.

Conversely, this paper suggests that a winning bid ratio exceeding 95% may invite third-party scrutiny due to concerns about over-inflated costs arising from monopoly power or suspicions of collusion and corruption. In this case, firms will be incentivized to keep their winning bid ratio below 95% to avoid high opportunity (penalty) costs. Therefore, observed winning bid ratios cluster around 95% of the reservation price; however, in practice, information uncertainty, variations in market competitiveness and other factors introduce some deviations.

Using Kernel density estimation, Figure 2 illustrates the distribution of three price ratios for paving works in Ehime Prefecture. The bold solid line represents the winning bid ratio, the bold dashed line represents the losing bid price ratio and the thin dashed line represents the floor price ratio (i.e. the floor price divided by the estimated price). The distribution of winning bid ratios concentrates just below 0.95, forming a significant peak and a smaller concentration is observed below 0.9. The reservation price is announced in advance in public construction projects commissioned by Ehime Prefecture. This practice makes it relatively easy for bidders to target a winning bid ratio of 0.95 if they intend to follow the 95% rule. In

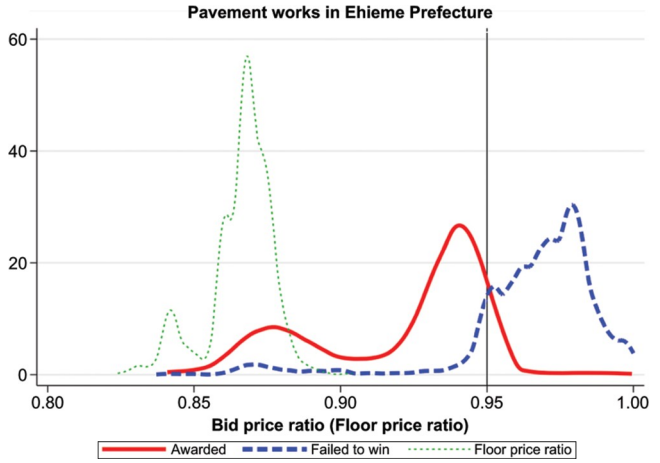


Figure 2. Distribution of bid price ratios for all paving work tenders procured by Ehime Prefecture

Note (s): The vertical axis represents kernel density. Bold solid, bold dashed and thin dashed lines represent winning bid ratios, losing bid ratios and floor price ratios, respectively. The sample excludes unsuccessful cases and outliers in bid price ratios (those below 0.80 or above 1)

Source: Author's own work, using official bid data disclosed by Ehime Prefecture

contrast, the floor price is disclosed only after bidding. This practice discourages bidders from closely approaching the floor price due to the risk of disqualification, making it unlikely that they can lower the bid price to the limit (as occurs in an ideal market). Consequently, the left peak of the winning bid ratio appears to the right of the peak in the floor price ratio distribution. The relatively smaller shape of this peak does not negate the widespread adoption of the 95% rule, but rather suggests the possibility of competitive market coexistence.

Moreover, the distribution of losing bid ratios centers around 0.98, suggesting that many losing bids are placed despite bidders' recognition that they are unlikely to win based on experience and disclosed information, as most winners bid significantly lower. These bidders still submit high bids, suggesting they do not intend to compete seriously. Observed bidding patterns are not inconsistent with the predictions of the 95% model.

3. Bidding formulas, number of bidders and competitiveness

This study summarized – by construction type – approximately 22,000 public works contracts (with 113,000 bids submitted by around 1,300 businesses) ordered by Ehime Prefecture between June 2014 and March 2022 and the distribution of winning bid ratios was confirmed. This summary reveals an interesting pattern in paving works (totaling 2,536 cases), where bids with winning ratios ranging from 0.93 to less than 0.95 comprised 55.5% (2,536) of all winning bids. In contrast, only 74 successful bids had a winning ratio exceeding 0.95. This significant difference, shown in Figure 2, implies the possibility of the 95% rule. Moreover, paving works comprise a relatively large number of observations, making them suitable for empirical analysis. Previous studies also examined pavement work and simple road construction (Barrus and Scott, 2020; Bosio *et al.*, 2022; Conley and Decarolis, 2016; Porter and Zona, 1993), as such projects exhibit lower technical variation, allowing for the assumption of consistent construction quality. The quality variance is slight; thus, we can assume that minimizing price and schedule benefits the buyer while maximizing price benefits the supplier. Given these advantages, this study focuses on paving works.

3.1 Bidding formulas

The procurement characteristics of Ehime Prefecture are largely common to those across Japanese prefectures. Table 1 shows that paving work contracts use only two bidding formulas – designated competitive bidding (designated bidding) and post-bid review general competitive bidding (general competitive bidding). The table displays the distribution of the number of bids, with the corresponding number of contracts shown in parentheses [9]. In

Table 1. Paving work contracts ordered by Ehime Prefecture

	Winner selection criteria	
No. of observations for paving work	Lowest price criterion	MEAT
Bidding formula		
Designated bidding	9,225 (1,591)	.
Post-bid review general competitive bidding	.	4,248 (945)

Note(s): This table presents the number of bids (not participants) and the number of contracts (shown in parentheses) in a cross-tabulation format. Bidding formulas are arranged in rows and winner selection criteria are displayed in the columns for paving works contracts in Ehime Prefecture covering the period from June 2014 to March 2022
Source(s): Author's own work, using official bid data disclosed by Ehime Prefecture

designated bidding, the procurement officer selects the participants; in general competitive bidding, a form of open bidding, participants are not preselected but must meet financial stability, expertise and business scale requirements. In paving work projects, Ehime Prefecture sets a ten-million Japanese yen (JPY) threshold in the reservation price for selecting the bidding formula; designated bidding applies below this amount and general competitive bidding applies above [10].

Differences in winner selection criteria must also be addressed when considering the 95% rule. The upper left of Table 1 shows 1,591 instances where designated bidding was combined with the lowest price criterion. Unexpected participants do not enter in these cases, and the winner is determined solely by price; therefore, the 95% rule can be executed more effectively and reliably. Conversely, the lower right of Table 1 presents 945 cases where general competitive bidding was combined with the most economically advantageous tender (MEAT). This formula is typically used for larger contracts that likely include room for technical ingenuity. Thus, predicting the participants becomes challenging in an open auction. Moreover, slight uncertainty arises in the technical evaluation scores for MEAT, making the auction outcomes less foreseeable. These differences in executing cooperative behavior mean that separately analyzing designated bidding with the lowest price criterion and general competitive bidding with the MEAT criterion is beneficial.

3.2 Number of bidders and phantom bids

During the analysis period, 31 companies won paving contracts awarded by Ehime Prefecture. Table 2 cross-tabulates successful bids by company (rows) and municipality (columns), with municipal names (classified as work locations) in the second-row headers. Eight municipalities were selected from 20 to illustrate market conditions (details in Section 5). Matsuyama and Imabari are densely populated and have high total contract value, while Ikata, Matsuno and Ainan are smaller, more remote towns. Figure 3 shows that Ikata is a peninsula and Matsuno is a mountainous area.

Regarding individual firms, Table 2 shows that company M-6 won all 77 bids in Matsuyama, matching the “Total” column, indicating that M-6 has only won in one area. Furthermore, Sa-4 secured only 4 wins in Imabari, but 118 won across Ehime Prefecture, suggesting activity in areas not listed in Table 2. Although Ehime Prefecture uses a uniform procurement format for pavement works regardless of location, local firms tend to be more efficient than outside firms due to lower transportation costs and strong local networks, which contribute to market segmentation. The fifth row from the bottom of Table 2 indicates that the average number of bidders per tender is five, suggesting that market competitiveness is similar. However, the cities of Matsuyama and Imabari have a diverse range of winners, while the towns of Ikata, Matsuno and Ainan each have a single firm winning all bids over eight years. Therefore, the apparent number of bidders (around five) may not accurately reflect actual market conditions. Especially in these latter towns, many “phantom bids” could be submitted with no intention of winning.

In Japanese procurement, phantom bids sometimes serve a social function rather than being mere fabrications. Some procurement officers must encourage participation, even from bidders with little intention of winning. Participants are discretionarily selected in designated bidding; a minimum number of participants is required by regulation to preserve competitive conditions. Even in general competitive bidding, procurement officers aim to avoid having too few bidders to maintain the appearance of competition and reduce suspicions of government-led collusion (which may involve corruption). In the Japanese centralized system, MLIT and the Ministry of Internal Affairs and Communications (MIC) request the disclosure of bidding data in a standardized format, enabling comparisons across different

Table 2. Number of successful bids by contractor for paving works commissioned by Ehime Prefecture

Market condition		Competitive (low *HHI*)		Nearly monopoly		Oligopolistic		Monopoly		Total successful bids (by contractor)
Headquarters location of contractor		Matsuyama city	Imabari city	Uwajima city	Yawatahana city	Uchiko town	Ikata town	Matsuno town	Ainan town	
Matsuyama city	M-1		16							16
	M-2	62		2	23	54	65		80	564
	M-3		12							15
	M-4	4								4
	M-5	48	1							50
	M-6	77								77
	M-7	19								27
	M-8	10								19
	M-9	72		2						406
Imabari city	I-1		89							92
	I-2		93							96
	I-3		78							97
Uwajima city	Uw-1			154				30		250
Yawatahama city	Y-1				63					98
Uchiko town	Uc-1					41				80
Ozu city	O-1					23				113
	O-2					16				94
Saijo city	Sa-1									6
	Sa-2									9
	Sa-3									40
	Sa-4		4							118
Niihama city	N - 1									8
	N - 2									8
	N - 3									10
	N - 4									47
Shikoku-chuo city	Sk-1									108
	Sk-2									40
Toon city	To-1	1								13
Takamatsu city	Ta-1									29

(*continued*)

Table 2. Continued

Market condition Headquarters location of contractor	Competitive (low *HHI*) Matsuyama city	Imabari city	Nearly monopoly Uwajima city	Yawatahana city	Oligopolistic Uchiko town	Ikata town	Monopoly Matsuno town	Ainan town	Total successful bids (by contractor)
Total (by municipality)	293	293	158	86	134	65	30	80	2,535
Average bidders per bid	5.222	5.457	5.430	4.570	5.231	5.000	5.500	5.263	
Average withdrawals per bid	0.075	0.061	0.082	0.058	0.015	0.108	0.033	0.038	
Average winning bid ratio	0.889	0.925	0.946	0.943	0.934	0.929	0.943	0.938	
HHI (calculated over 8 years)	0.244	0.269	0.947	0.565	0.347	1	1	1	
Percentage of designated biddings	0.51	0.61	0.70	0.53	0.73	0.55	0.80	0.78	

Note(s): This table lists all contractors with winning bids for paving works awarded by Ehime Prefecture during the data period, including those with unsuccessful bids in the eight selected municipalities (indicated in gray). The number in each cell represents the number of successful bids and totals 2,535, excluding 1 with an unspecified construction site – the last 6 lines at the bottom show statistical summaries
Source(s): Author's own work, using official bid data disclosed by Ehime Prefecture

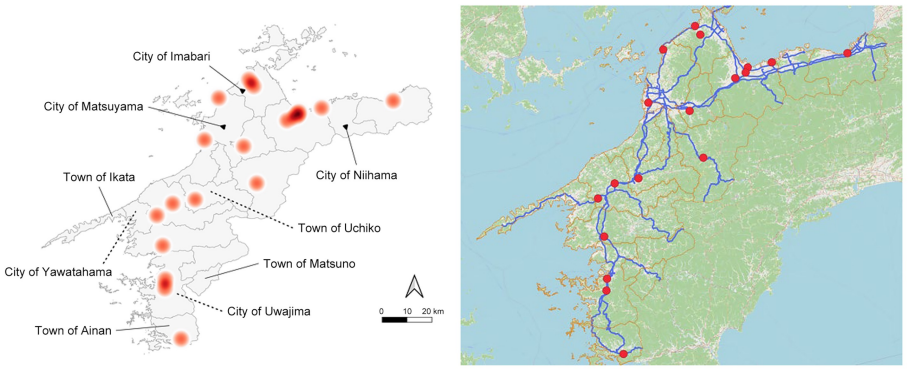


Figure 3. Map of asphalt mixing plant locations in Ehime Prefecture
Note(s): Ehime Prefecture officially recognizes 18 asphalt mixing plants. The left panel presents a heatmap of their locations (red points) and municipal boundaries. The right panel illustrates geographic information and the major road network (blue lines)
Source: Author's own work

public entities. This situation intensifies pressure on procurement officers to ensure competitive environments.

Ehime Prefecture's designated bidding guidelines explicitly state that businesses not actively participating in bidding may be excluded from future designated biddings [11]; thus, firms risk losing future bidding opportunities if they opt out. Procurement officers can leverage this rule to encourage bids, even from firms uninterested in winning [12]. Table 2 also shows that withdrawals are relatively rare, occurring in less than one in ten bids. Porter and Zona (1993) suggested that withdrawal could indicate collaborative behavior, which is infrequent in Ehime's paving works. Consequently, the appearance of competition, which benefits procurement officers, is maintained [13].

3.3 Competitive landscape

Competition is often measured by counting firms based on headquarters location (Bajari and Ye, 2003; De Silva *et al.*, 2003; Padhi and Mohapatra, 2011; Porter and Zona, 1993); however, this approach overlooks firms operating through regional branches and subcontractors. For example, Table 2 shows that the only paving contractor headquartered in Uchiko, Uc-1, competes with three firms from other regions: O-1 and O-2 from Ozu and M-2 from Matsuyama. In Yawatahama, only Y-1 is headquartered locally, but M-2 has also won several contracts. In Ainan, no local businesses secured bids ordered by Ehime Prefecture. Uw-1, the nearest large paving company (based about 40 km away in Uwajima), also did not win any contracts there. Furthermore, M-2 (headquartered roughly 130 km away in Matsuyama) owns an asphalt mixing plant and a branch office in Ainan and has exclusively won all contracts. These cases demonstrate that competition depends more on operational presence than headquarters location alone, necessitating a different approach.

This study uses the Herfindahl–Hirschman index (HHI) to assess each municipality's market conditions. We focus on paving works to calculate the total contract value (z_{im}) measured by reservation price, won by company i in municipality m over approximately eight years. Dividing this by the total contract value won by all contractors in municipality m,

$G_m = \sum_i z_{im}$, provides the market share of company i in municipality m: $Z_{im} (= z_{im}/G_m)$. We then calculate HHI_m ($= \sum Z_{im}^2$), whose reciprocal value represents the equivalent number of firms.

Barrus and Scott (2020) examined the transportation time constraint for asphalt materials in paving works. In Japan, this limit is typically 120 min, which likely affects regional market concentration (HHI_m). Figure 3 shows a concentration of asphalt plants in urban areas (e.g. Matsuyama and Imabari) or along major roads (e.g. Uchiko and Ozu), with red dots marking the plants and bold lines indicating major roads. These strategic locations are primarily chosen due to the high demand for asphalt and logistical advantages. Though competition intensity (HHI_m) is only one factor among many, it is partly shaped by these spatial dynamics. Therefore, it is reasonable to consider that competition may be at least partially determined by exogenous factors rather than solely by stakeholders' collusive or competitive behavior.

4. Hypothesis testing: is there a 95% rule?

This section tests the hypothesis regarding the presence of feature (e) – a manifestation of the 95% rule – in pavement construction projects contracted by Ehime Prefecture. Feature (e) is where a bid price ratio of 0.95 acts as a threshold, leading to a significant discontinuity in winning probabilities around this threshold. We use a sharp RD analysis to analyze this. The running variable is the bid price ratio and each bid observation (B_j) is divided into two groups ($T_j = 1$, $T_j = 0$) based on the 0.95 cutoff point. Members with $T_j = 1$ are, in a sense, assigned the role of bids that must never win:

$$T_j = \begin{cases} 1 & if \quad B_j \geq 0.95 \\ 0 & if \quad B_j < 0.95 \end{cases}$$

The outcome variable (simply the winning dummy variable) Y_j is a binary, where $Y_j = 1$ if B_j wins the bid; otherwise, $Y_j = 0$. The observed outcome can be represented as $Y_j = Y_j(0) \cdot (1 - T_j) + Y_j(1) \cdot T_j$. $Y_j(0)$ and $Y_j(1)$ are the outcomes when the bid price ratio is below 0.95 and at or above 0.95, respectively. The estimated gap at the 0.95 threshold, $\tau_{0.95}$, is described as $\tau_{0.95} = E\left[Y_j(1) - Y_j(0) | B_j = 0.95\right]$. We estimate $\mathrm{E}\left[Y_j(1) | B_j = 0.95\right]$ using observations where $0.95 \leq B_j \leq 0.95 + bw$. For $\mathrm{E}\left[Y_j(0) | B_j = 0.95\right]$, we use observations where $0.95 - bw \leq B_j \leq 0.95$. The bandwidth bw for the estimation is chosen using the mean squared error optimal bandwidth selector for RD (mserd). We address heteroscedasticity by using municipality dummies, representing the construction site location (21 categories comprising 20 municipalities and one "others" category) as cluster variables. If the 95% rule exists, the probability of the $T_j = 1$ group winning will be significantly lower than for the $T_j = 0$ group; thus, we expect $\tau_{0.95}$ to be significantly negative.

RD designs have been used to analyze thresholds in procurement (Coviello *et al.*, 2018). However, as Szucs (2024) states, such designs do not permit causal inference in contexts like this study, where the random assignment required under a randomized controlled trial (RCT) condition is absent. In the case of the 95% rule, participants strategically adjust their bids, knowing that a bid price ratio below 0.95 will likely secure a win. This strategic behavior diverges from RCT-like conditions. Nevertheless, if this limitation is acknowledged correctly, RD-based empirical work provides a scalar estimate of the vertical distance

between the regression functions at the cutoff. This situation allows us to statistically detect a discontinuity at the 0.95 threshold of the bid price ratio.

4.1 Verification results

We verify the 95% rule by estimating the size of $\tau_{0.95}$ and testing its statistical significance. Table 3 reports the estimation results using the rdrobust method (Calonico *et al.*, 2017). We exclude three observations with a bid price ratio below 0.84 due to the absence of winners attributed to the floor price system. Four observations with ratios exceeding unity are excluded as procedural errors. Consequently, the total number of observations for B_j is 13,466. Local polynomial regression is used for estimation. Table 3 details the bandwidth selection. In Models 1 (general competitive bidding) and 2 (designated bidding), the polynomial order is set to one, often the optimal choice for estimation [14].

Model 1 estimates a −0.076 discontinuity at 0.95, with no statistically significant difference from zero. Conversely, Model 2 finds a statistically significant −0.454 discontinuity, supporting the 95% rule. Figure 4 illustrates the distribution of bids; the horizontal axis represents the bid price ratio, and the vertical axis shows the proportion of winning bids. The approximation line is a fourth-order polynomial fit, while the estimation is based on a first-order (linear) model within a specific bandwidth. The top of Figure 4 displays the estimated discontinuity and the *z*-value testing its significance derived from the estimation results in Table 3.

To verify the robustness of the estimation results for $\tau_{0.95}$, Model 3 in Table 3 expands the polynomial regression order to two, specifically for designated bidding, where $\tau_{0.95}$ was statistically significant in its previous estimation. The estimated discontinuity decreases from −0.454 to −0.444 but remains significant, confirming the stability of the estimation result. These results suggest that the 95% rule is more likely in designated bidding, where price competition is simple and participants are restricted. This condition facilitates coordinated behavior, making it easier for bidders to maintain bid price ratios below 0.95. As discussed in Section 3.1, the bidding formula is crucial in whether coordination strategies emerge.

4.2 Distinctiveness of 0.95

A greater discontinuity in winning probability ($\tau_{0.95}$) strengthens support for the 95% rule; however, verifying 0.95 as the unique threshold is more important than the discontinuity size. Therefore, we set pseudo-thresholds other than 0.95 to determine whether they function as thresholds that lead to discontinuities in winning probabilities. Given the previous analysis, we examine designated bidding; only the threshold is changed in Table 4, while the estimation procedures from Models 2 (polynomial regression order of one) and 3 (polynomial regression order of two) are applied. Table 4 presents 14 estimation results using the RD framework, with thresholds ranging from 0.935 to 0.965 in increments of 0.005.

As expected, alternative thresholds cause no significant discontinuities; the discontinuity size does not statistically differ from zero. The only exception outside of 0.95 is the 0.940 threshold, whose $\tau_{0.94}$ statistical significance varies depending on the polynomial order. Model 2 estimates a significant −0.142 drop, while Model 3 estimates an insignificant −0.110 drop. This instability does not appear in the 0.95 case, indicating that the 0.94 results are not robust. These findings suggest 0.95 uniquely functions as a threshold, while other values exhibit no threshold-like characteristics.

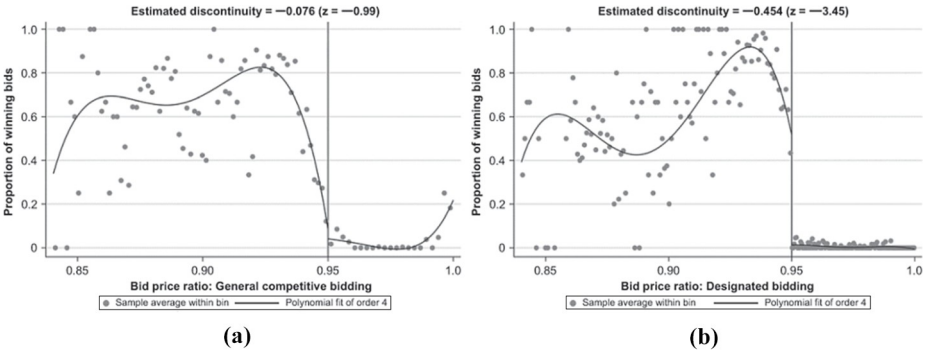
4.3 Inferred coordinated behavior

These results reveal a significant discontinuity in winning probability at the 0.95 threshold in designated bidding, confirming feature (e) and supporting the 95% rule. This sharp jump in

Table 3. Estimation results for RD analysis

Depended variable: winning dummy variable	Model 1: general competitive bidding Coef.	Std. Err.	Robust P > z	Model 2: designated bidding Coef.	Std. Err.	Robust P > z	Model 3: designated bidding Coef.	Std. err.	Robust P > z
Estimated discontinuity (robust)	−0.076	0.077	0.322	−0.454	0.132	0.001	−0.444	0.134	0.001
Cutoff c = 0.95	Left of c	Right of c		Left of c	Right of c		Left of c	Right of c	
Number of obs.	1,552	2,692		2,218	7,001		2,218	7,001	
Effective number of obs.	557	973		1,139	1,486		1,451	2,781	
Order est. (p)	1	1		1	1		2	2	
Order bias (q)	2	2		2	2		3	3	
BW est. (h)	0.015	0.015		0.012	0.012		0.020	0.020	
BW bias (b)	0.019	0.019		0.016	0.016		0.025	0.025	
Rho (h/b)	0.810	0.810		0.759	0.759		0.821	0.821	
Number of clusters	21	21		21	21		21	21	
Number of obs.	4,244			9,219			9,219		
BW type	mserd								
Kernel	Triangular								
VCE method	Cluster (municipality dummy)								

Note(s): The coefficients, standard errors and significance levels are robust estimates. One bidding process (with three bids) was excluded due to the lack of municipality dummies, reducing the number of observations. The polynomial order is set to one for estimation in Models 1 (general competitive bidding) and 2 (designated bidding). Model 3 extends the polynomial regression order to two for designated bidding to confirm the robustness of Model 2's results
Source(s): Author's own work



(a) **(b)**

Figure 4. Discontinuity in winning probability at the 0.95 bid price ratio threshold for paving work
Note(s): Left panel: general competitive bidding. Right panel: designated bidding. The figure illustrates the distribution of winning probabilities. The horizontal axis represents the bid price ratio, while the vertical axis shows the proportion of winning bids. The top of the figure displays the estimated discontinuity and the *z*-value, testing its significance
Source: Author's own work

winning proportion is unlikely under competitive conditions; bidders have no reason to adjust their strategy to 0.95. If winning probabilities increase abruptly just below 0.95, bidders planning to bid above 0.95 may lower their ratio to improve their winning chances despite a slight profit reduction. Conversely, bidders initially aiming well below 0.95 may shift closer to 0.95 to maximize profits, heightening competition and lowering success rates. Conceptually, this should result in a smoother curve, as shown in Figure 1.

Therefore, the discontinuity in feature (e) suggests coordinated behavior rather than a naturally occurring competitive outcome. This inference is based on abductive reasoning, which does not provide deductive certainty, although plausible. This clustering may also be strengthened by other mechanisms, such as risk aversion and reputational concerns, and their influence may not operate in isolation but rather in combination. Nonetheless, we argue it plausibly avoids the "fallacy of affirming the consequent" by carefully addressing the low likelihood of such a discontinuity emerging without coordination.

Moreover, the 0.95 rule can provide a structural explanation for the disparity in bid price ratios between the winner and the second-lowest bidder – a disparity highlighted by Chassang *et al.* (2019). The winning bid ratio is distributed to the left of 0.95, while the loser's bid price ratio is distributed to the right of 0.95, explaining the reason behind the missing mass of close-losing bids. On the other hand, Chassang *et al.* (2022), using a simulated analysis, found that a 2% reduction in bid price significantly increased demand. Under the 95% rule, most winners are positioned just below 0.95; therefore, many bidders who lost with bids above 0.95 could have won by lowering their bid price ratios by 2% – had they wanted to.

5. Factors disrupting the 95% rule

Despite controlling for the differences in bidding formulas (whether general competitive or designated bidding), $\tau_{0.95}$ is around 0.45 rather than close to 1. This outcome suggests that the 95% rule may be weaker or depend more on other factors than expected. The following sections explore two additional factors to assess the robustness and conditionality of the 95% rule. First, we analyze regional differences in market competitiveness from a cross-sectional

Table 4. Validity of thresholds other than 0.95

	Estimation Model 2					Estimation Model 3				
	Estimated discontinuity (robust)			Effective number of observations		Estimated discontinuity (robust)			Effective number of observations	
Cutoff	Coef.	Std. Err.	P > z	Left	Right	Coef.	Std. Err.	P > z	Left	Right
0.935	0.032	0.064	0.618	239	497	0.034	0.067	0.610	303	899
0.940	−0.142	0.066	0.032	426	694	−0.110	0.078	0.157	466	861
0.945	0.160	0.165	0.331	644	1,127	0.178	0.170	0.294	826	1,693
0.950	−0.454	0.132	0.001	1,139	1,486	−0.444	0.134	0.001	1,451	2,781
0.955	0.047	0.040	0.241	796	818	−0.062	0.056	0.268	1,015	1,076
0.960	0.002	0.012	0.899	723	1,014	0.005	0.013	0.724	813	1,158
0.965	−0.006	0.005	0.232	851	837	−0.003	0.004	0.461	1,046	1,092

Note(s): This is a summary of the 14 estimated results for Models 2 and 3 in Table 3, with only the cutoff values changed. Only the "estimated discontinuity" and the "effective number of observations" are presented for each estimation model. The highlighted line at 0.950 is reproduced from Table 3 as a benchmark. The effective number of observations is the number of observations within the range of 0.95±bw
Source(s): Author's own work

perspective. Second, we use a time-series approach to examine the exogenous shock of nationwide collusion exposures.

5.1 Monopoly and competitive markets

Based on Tables 2 and 3, we define the towns of Ikata, Matsuno and Ainan (where the *HHI* is unity and areas are exclusive) as a "monopoly market" for comparative purposes. Notably, Masaki Town's *HHI* is also unity and it is omitted from Table 2 for simplicity; however, it differs from the other monopoly cases due to its average winning bid ratio being below 0.9 [15]. Therefore, Masaki Town is initially excluded from the monopoly market category (it will be reconsidered later). For comparison, we focus on the cities of Matsuyama and Imabari, which have multiple bidders with prior winning experiences (Table 2); their *HHI*s are 0.244 and 0.269, respectively. Among the cities in Ehime Prefecture, only 3 meet the *HHI*< 0.3 benchmark, including Niihama City (*HHI* = 0.252), which is omitted from Table 2. These three low *HHI* areas are classified as "competitive markets" for comparison purposes; however, these may be oligopoly markets.

We then use estimation Models 1 and 2 to differentiate between general competitive and designated bidding within monopoly and competitive markets, respectively [16]. The upper portion of Table 5 presents the estimation results classified by market type and bidding method. In designated bidding, the estimated discontinuities in winning probability at the 0.95 threshold (−0.729 and −0.887) are statistically significant in both market types, confirming the 95% rule. These also show a more pronounced discontinuity in monopoly markets (0.887) than competitive markets (0.729).

With general competitive bidding, estimated discontinuity coefficients are not statistically significant in either market type; however, upon examining the observed values, the winning probability is unity when the bid price ratio is below 0.95, indicating characteristic (d) of the 95% rule. Even in general competitive bidding, partial indications of the 95% rule still occur in monopoly markets.

The small sample size of general competitive bidding in monopoly markets could lead to instability in the estimation results; therefore, we conduct additional verification by including Uwajima City and Masaki Town, where the *HHI* exceeds 0.9. Table 5 (with high *HHI*) presents the results. As mentioned, Masaki Town has an *HHI* of unity; however, its market is relatively competitive. Including Masaki and Uwajima weakens the evidence for the 95% rule, with the estimated discontinuity decreasing to −0.865, compared to 0.887 in the monopoly baseline sample, nonetheless, signs of the 95% rule remain in designated bidding. Even with a cross-sectional division of the sample, the results are consistent with previous findings, supporting the robustness of the 95% rule in designated bidding.

5.2 Exogenous shock: discovery of collusion cases

In February 2017, during fiscal year (FY) 2016, suspicions of a nationwide cartel involving asphalt mixtures for road paving surfaced, leading to approximately JPY 40bn in fines for major companies (JFTC, 2019). Given these considerable fines, this exogenous shock may have influenced paving contractors and the implementation of the 95% rule in Ehime Prefecture. To investigate, we conducted RD analysis by dividing the sample into pre- (FY 2014–2015) and post-incident (FY 2017–2021), with FY 2016 as the boundary. The lower portion of Table 5 presents the results based on the time-period classification.

It shows that in general competitive bidding, the estimated discontinuity coefficients are minor in magnitude (−0.017 and −0.111) and statistically insignificant before and after 2016. In contrast, in designated bidding, estimated coefficients show apparent discontinuities at 0.95 before

Table 5. Verification of discontinuity in winning probability at the 0.95 threshold

		Estimated discontinuity (robust)			Effective number of observations	
	Bidding formula	Coef.	Std. err.	P > z	Left	Right
Market type						
Competitive (low *HHI*) market	General competitive bidding	−0.0006	0.136	0.996	188	714
	Designated bidding	−0.729	0.258	0.005	318	942
Monopoly market	General competitive bidding	0.178	0.848	0.833	13	14
	Designated bidding	−0.887	0.088	0.000	77	73
High *HHI* market	General competitive bidding	−0.322	0.395	0.416	77	177
	Designated bidding	−0.865	0.131	0.000	194	293
Before and after the Incident						
FY 2014–15	General competitive bidding	−0.017	0.096	−0.179	91	219
	Designated bidding	−0.696	0.119	−5.848	202	403
FY 2017–	General competitive bidding	−0.111	0.086	−1.286	405	658
	Designated bidding	−0.425	0.130	−3.274	811	856

Note(s): This is a summary of six estimations that control for the market environment or the time period while accounting for differences in bidding formulas. The estimation procedure, excluding sample restrictions, is the same as in Table 3; the table format is the same as in Table 4
Source(s): Author's own work

and after the incident (−0.696 and −0.425), which are statistically significant. This pattern aligns with earlier results, showing that the 95% rule is most apparent in designated bidding.

This outcome broadly suggests that paving work was largely unaffected by the collusion revelations; nonetheless, the 95% rule appears to have weakened postincident (estimated discontinuity coefficients declines from −0.69 to −0.42). This modest reduction implies that heightened scrutiny may have led some participants to avoid cooperative behavior, including adherence to the 95% rule. This situation illustrates another instance where the awareness of being observed (or a fearful forecast of public criticism) can influence behavior.

6. Conclusion

A nongovernmental organization introduced the 0.95 threshold as a benchmark for monitoring public procurement. Over time, bidders adjusted their winning bid ratios below 0.95 to avoid public criticism linking higher ratios to collusion. This practice came to be known as the 95% rule, under which the probability of winning is low above 0.95 but rises sharply below it, creating a substantial gap at the threshold.

This study uses RD analysis for pavement contracts in Ehime Prefecture to reveal a significant discontinuity in winning probability at the 0.95 bid price ratio in designated bidding, demonstrating the 95% rule. In contrast, we found no significant effects in general competitive bidding. This tendency remains robust even when controlling for market competitiveness using the *HHI* or dividing the sample into periods before and after 2016 to account for broader collusion exposure. Moreover, adherence to the 0.95 rule consistently explains the disparity in bid price ratios between the winner and the runner-up loser (Chassang *et al.*, 2019; Chassang *et al.*, 2022) and the large gap between the winning bid ratio and the floor price (Ishii, 2008).

This study demonstrates that the 95% rule is a detectable form of collusive coordination, although its existence may not necessarily constitute an illegal act. In future research, the determinants of the 95% rule's prevalence across different market conditions should be examined, including varying procurement authorities and institutional settings.

Moreover, considering the potential for strategic adaptation in response to scrutiny, the following policy implication may be considered: For the Ehime Prefectural Government, a reservation price could be determined based on regional variations in winning bid ratios for fair and appropriate pricing. It could be based on bid outcomes from areas such as Matsuyama or on an analysis of the overall distribution of bid price ratios across the prefecture. In Matsuyama, winning bid ratios tend to be consistently low, likely reflecting a competitive market. Using information from other areas, such an adaptive pricing strategy would help avoid wasteful efforts to trace tacit bidding coordination and thus foster a credible and transparent procurement process.

Data availability

The data underlying this paper will be shared on reasonable request to the corresponding author.

Notes

[1.] Appendix 2, section A illustrates that bid rotation and territorial allocation were likely implemented by applying the 95% rule in procurement by Ehime Prefecture.

[2.] Aaltio *et al.* (2025) demonstrated that in the asphalt procurement markets of Finland and Sweden, a bimodal distribution reflecting disparities in bid prices emerged during the cartel period, though it disappeared after the investigation began.

[3.] Arai and Morimoto (2023) reported that the 2012 antitrust investigation into a national government branch office in Shikoku revealed a modest decline (1%–2%) in bid rates across the Shikoku region. This study focuses on Ehime, one of its four prefectures, where indirect effects on procurement may have remained.

[4.] In national government procurement, the reservation price is not disclosed before bidding as mandated by the Cabinet Order on Budgets, Settlement of Accounts and Accounting. Local governments, governed by the Local Autonomy Act, are exempt from this disclosure rule. As of July 1, 2024, among Japan's 47 prefectures, 13, 18 and 16 use the "pre" system (disclosure before bidding), "post" system (after bidding) and "both" system (contract-dependent), respectively. Similarly, among over 1,700 municipalities, 649, 654 and 303 follow the pre, post and both system, respectively; the remainder adopt non-disclosure or other formats.

[5.] There are a few outliers (errors). In 62 cases, the bid price exceeded the reservation price ($1 < B_{ia}$); in 8 cases, the bid price ratios were less than 0.01; in 26 cases, they fell below 0.8.

[6.] The observed bids B_j were divided into subgroups according to the rule $B \leq B_j < B + 0.01$, where B takes values from zero to one in increments of 0.01 (i.e., $B = 0, 0.01, \cdots, 0.99, 1$). The winning probability for each subgroup was then calculated as the ratio of successful bids to the total number of bids in that subgroup.

[7.] Nishikawa (2025b) provided a more detailed historical context.

[8.] Collusion can still occur even if the 95% rule is not observed. For instance, the Chubu Morning Edition of the Mainichi Shimbun (January 25, 2007, page 23) raised suspicions that the 95% rule was deliberately broken in one of the auctions related to the Nagoya City subway bid-rigging case.

[9.] Ehime Prefecture also uses standard general competitive bidding and negotiated contracts for public procurement; however, neither of these bidding formulas has been used to pave work contracts in our dataset.

[10.] There are also many exceptions to this threshold. This threshold was set at 8 million JPY until April 2021, when it was raised to ten million JPY. Further details can be found in Nishikawa (2025b).

[11.] This kind of local rule or similar tacit conventions is not uncommon. However, some local governments stipulate that disadvantages must not be imposed on participants solely due to their withdrawal from bidding.

[12.] This interpretation implies that phantom bids partially align with the concept of "passive waste" proposed by Bandiera *et al.* (2009); this concept refers to inefficiencies arising from institutional processes, which are either difficult to avoid or do not privately capture rents by public officials.

[13.] As Tanaka and Hayashi (2016) discussed, a close relationship between bidders and the procurement authority may provide fertile ground for government-led collusion.

[14.] Appendix 2, section C applies this approach to types of work other than pavement to assess the applicability of the 95% rule.

[15.] Appendix 2, section B provides a more detailed discussion of Masaki's market conditions.

[16.] The figures related to Section 5 are compiled in Appendix 1 to allow seamless reference alongside the main text.

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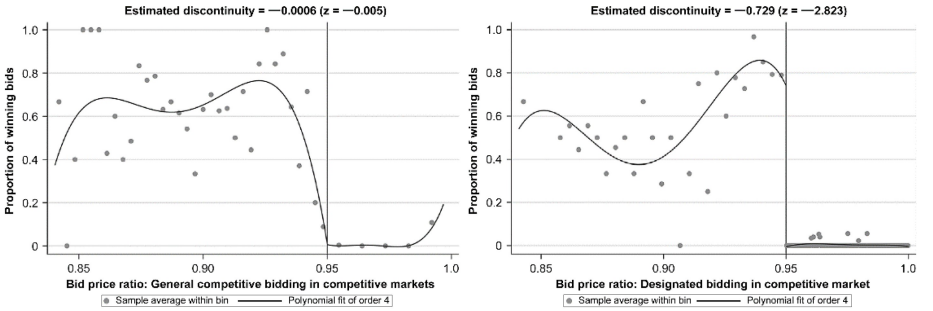
Appendix 1

This Appendix 1 contains five figures, numbered Figures A1–A5. These figures were originally inserted after Figure 4 in the main text to support the expanded discussion that follows. However, due to word count limitations, they were removed from the main body. Readers can easily follow the sequence of these figures in connection with the main argument.

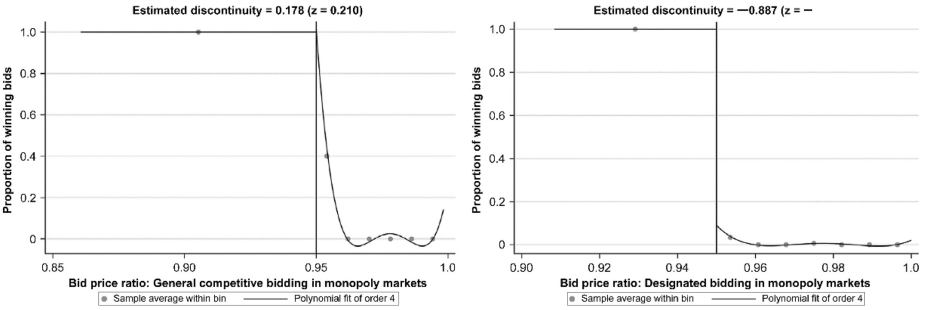


(a) **(b)**

Figure A1. In competitive markets: verification of the discontinuity at 0.95 rule

Note(s): Left panel: general competitive bidding. Right panel: designated bidding. The interpretation of the figure is the same as in Figure 4

Source: Author's own work

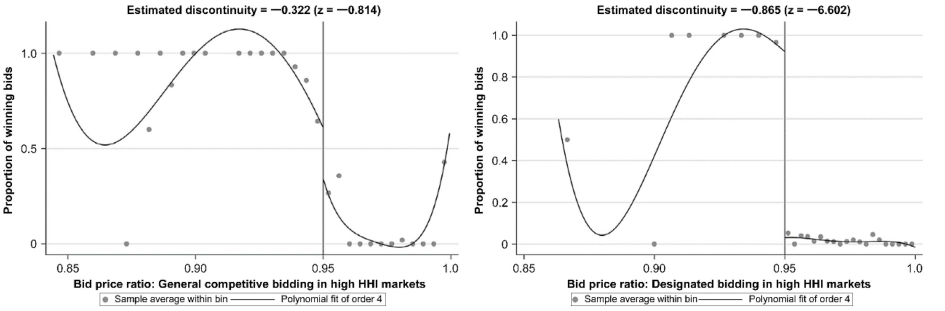


(a) **(b)**

Figure A2. In monopoly markets: verification of the discontinuity at 0.95

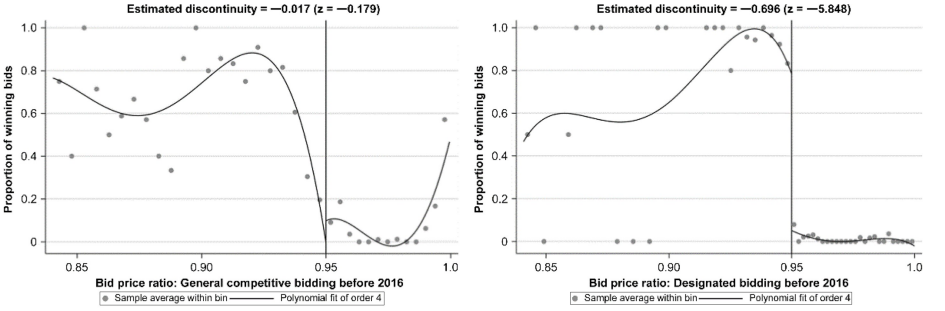
Note(s): Left panel: general competitive bidding. Right panel: designated bidding. The interpretation of the figure is the same as in Figure 4

Source: Author's own work



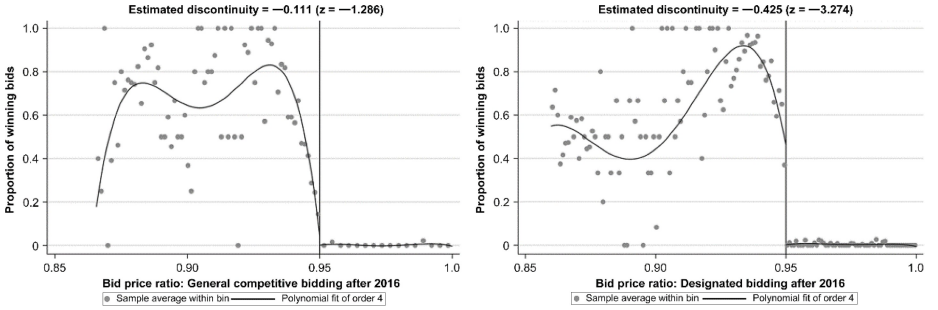
(a) **(b)**

Figure A3. High *HHI* markets (*HHI* > 0.9): Verification of the discontinuity at 0.95
Note(s): Left panel: general competitive bidding. Right panel: designated bidding. The interpretation of the figure is the same as in Figure 4
Source: Author's own work



(a) **(b)**

Figure A4. Before FY2016: Verification of the discontinuity at 0.95
Note(s): Left panel: general competitive bidding. Right panel: designated bidding. The interpretation of the figure is the same as in Figure 4
Source: Author's own work



(a) **(b)**

Figure A5. After FY2016: verification of the discontinuity at 0.95

Note(s): Left panel: general competitive bidding. Right panel: designated bidding. The interpretation of the figure is the same as in Figure 4

Source: Author's own work

Appendix 2

This Appendix 2 aims to corroborate the empirical validity of the 95% rule by using three complementary strategies: firm-level behavioral analysis (section A), a contextual case study of a seemingly monopolistic market (section B) and robustness testing across different work types (section C). These approaches jointly strengthen the interpretation that the 95% threshold plays a pivotal role in tacit bidder coordination.

A. Bid rotation, territorial allocation and the 95% rule

This appendix provides empirical evidence consistent with the 95% rule discussed in Sections 2.1 and 2.2 of the main text, particularly as it relates to bid rotation and territorial allocation. From the perspective of this appendix, these sections suggest that pavement firms face three strategic bidding options, particularly in contexts where the reservation price is disclosed before bidding. (a) Although their loss is guaranteed in a noncompetitive (i.e. collusive) market, they deliberately submit a bid with a bid price ratio (i.e. bid amount divided by the reservation price) above 0.95. Such a bid is commonly referred to as a phantom bid. (b) Although their victory is assured in a noncompetitive market, they intentionally submit a bid with a price ratio just below 0.95. (z) In a competitive (i.e. non-collusive) market, outcomes are uncertain and bidders tend to submit bids close to the floor price to increase their chances of winning.

Options (a) and (b) constitute the 95% rule, which plays a central role in understanding firms' strategic behavior in noncompetitive markets. Alternatively, options (b) and (z) represent the strategic behavior of firms aiming to win contracts in noncompetitive and competitive markets, respectively. Option (a) may also be used by such firms, particularly for projects that are exceptionally costly or technically challenging, although most pavement works do not fall into this category. Therefore, option (a) is typically executed only by firms that do not intend to win. By examining individual firms' behavior, we find that the 95% rule will likely facilitate tacit agreements, such as bid rotation and territorial allocation, which function as one of several possible coordination mechanisms.

Table 2 of the main text shows that company M-2 had the most winning bids (564) for paving projects procured by Ehime Prefecture during the research period. Furthermore, M-2 participated in procurements across all 20 municipalities as well as in the "Other" category that includes unidentified or multiple locations. Variation in competition across districts causes M-2 to adjust its bidding strategy according to local market conditions. Figure A6 summarizes the outcomes of M-2 by areas. The histogram represents the number of bid participations (right axis). The dots show M-2's average bid price ratio (left axis) for each of the 21 districts, categorized by winning or losing outcome. The light blue and light red bars indicate the number of losses and wins, respectively. Similarly, the blue and red dots indicate the average bid ratio for unsuccessful and successful bids, respectively. The districts are arranged from left to right by the lowest M-2 winning bid ratio and then by the lowest bid ratio in losing bids.

M-2 did not win any bids in the 10 municipalities on the far right of the figure (as indicated by the absence of red dots), despite participating multiple times (as shown by the light blue bars). The average unsuccessful bid ratios ranged from 0.970 to 0.990, reflecting strategic option (a). These bids are considered phantom bids that do not interfere with the consistent winning of another firm (or firms). In contrast, M-2 recorded no losses in Ikata and Ainan (as indicated by the absence of blue dots) and its winning bid ratios remained below 0.95, indicating strategic option (b). Other firms in these municipalities may have submitted consistent phantom bids based on a pattern similar to M-2's phantom bidding behavior observed in other areas. Therefore, M-2 used the 95% rule and bidders, including M-2, engaged in a form of tacit coordination that may reflect "territorial allocation" (with additional evidence presented below).

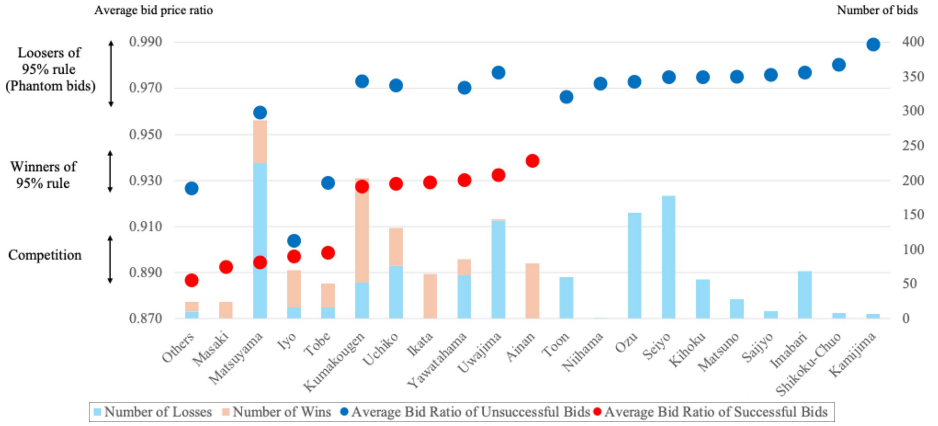


Figure A6. Company M-2's average bid price ratios and the number of successful and unsuccessful participation counted separately by municipalities in Ehime Prefecture during the research period
Source: Author's own work

M-2's average unsuccessful bid ratio in Uwajima exceeded 0.97, whereas its average winning bid ratio was approximately 0.93. The discontinuous distribution of bid ratios is consistent with the employment strategic options (a) and (b) following the 95% rule. M-2 may have adjusted its bidding behavior depending on the role (win or lose) assigned to it. This possibly suggests the operation of a "bid rotation" scheme in Uwajima. The bidding patterns in Yawatahama, Uchiko and Kumakogen exhibit similar characteristics. Matsuyama, Tobe, Iyo, Masaki and Others exhibited different strategic behaviors. Company M-2's average winning bid ratios in these municipalities were consistently low, at approximately 0.90 and close to the floor price. In Iyo, Tobe and Others, the average unsuccessful bid ratios were below 0.93. This pattern differs from the 95% rule and is regarded as the strategic bidding option (z). This pattern is typically observed in competitive markets.

Similar to Figure A6, Figure A7 illustrates the bidding behavior of a different firm, namely, company Uw-1. Uw-1 achieved 250 successful bids commissioned by Ehime Prefecture, ranking third in the number of wins. Uw-1's strategy is clear: submit bids with a ratio just below 0.95 when it wins, and above 0.97 when it does not (with only 3 exceptions in Kihoku Town). This pricing pattern reflects strategic bidding options (a) and (b) and clearly follows the 95% rule.

A comparison of the two figures confirms a notable pattern. As shown in Table 2 of the main text, M-2 and Uw-1 dominated paving work in Ainan Town and Matsuno Town, respectively. Their average winning bid ratios were below 0.95 in their respective dominant districts. Although they were certain of winning, they avoided high winning bid ratios. In monopolistic markets, the presence of other participants are needed to maintain the appearance of competition, likely in response to procurement regulations and social expectations requiring multiple bidders. In Ainan, Uw-1 submitted phantom bids at around 0.97 (Figure A7), whereas M-2 placed similar bids in Matsuno as the losing bidder (Figure A6). They have alternated roles in these areas, providing evidence that the 95% rule was used to implement "territorial allocation."

There is no direct evidence of collusive agreements. However, the nature of the bid price ratios — marked by a clear gap between winners and losers—, together with obvious patterns of territorial allocation and bid rotation, suggest coordinated behavior. The 95% rule represents an easily executable strategy, particularly under Ehime Prefecture's procurement system, where the reservation

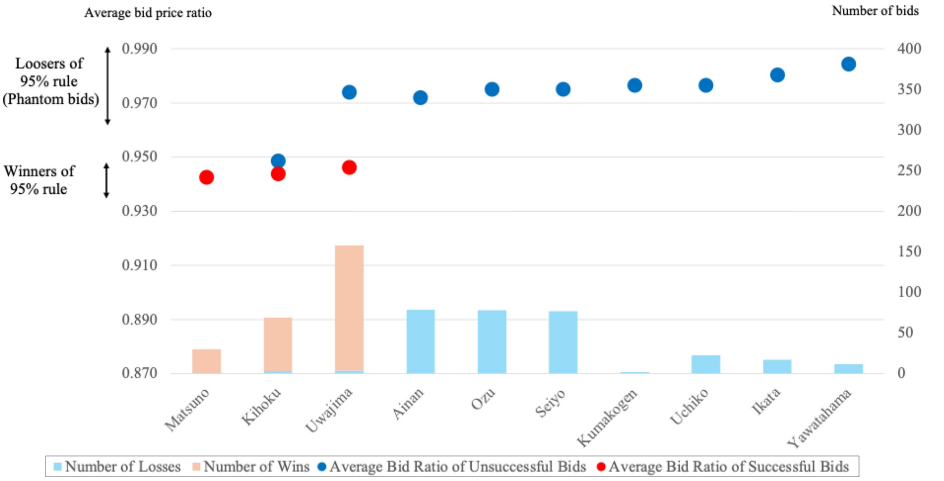


Figure A7. Company Uw-1's average bid price ratios and the number of successful and unsuccessful participations counted separately by municipalities in Ehime Prefecture during the research period
Source: Author's own work

price is disclosed before bidding. This disclosure reduces the need for explicit communication among bidders. Moreover, by following the 95% rule, firms can maintain moderately low winning bid ratios, thereby minimizing external scrutiny. Collectively, these practices enhance the stability of coordination.

B. Competition in Masaki Town

This appendix provides insight into the pavement market conditions in Masaki Town, where procurement outcomes for pavement works awarded by the Ehime Prefectural Government may appear monopolistic. During the analysis period (2014–2022), Ehime Prefecture awarded 24 paving contracts in Masaki Town, all of which went to company M-2. However, M-2 repeatedly faced competition from rival firms, often submitting bids close to the predetermined floor price. The floor prices, which are disclosed after bidding, can be estimated with a certain degree of accuracy based on experience in standard pavement works. Competitive pressure from rival bidders has caused company M-2's average winning bid ratios in Masaki to remain below 0.90, as shown in Figure A6. Although the bids reflected relatively lower price levels than other cases in Ehime, they could have resulted in losses under slightly different circumstances.

Figure A8 illustrates the 24 bidding results, with red dots indicating the winning bid ratios (all submitted by M-2) and blue circles representing the lowest bid price ratios among unsuccessful bidders. The general competitive and designated bidding results are distinguished, and the bid outcomes (series G and D) are chronologically arranged from left to right. The short green horizontal lines in the figure indicate the floor price ratios, which are calculated as the floor price divided by the reservation price.

Bid outcomes can be categorized into two types in designated bidding. One pattern follows the 95% rule: M-2 places a bid price ratio below 0.95, whereas other participants (phantom bidders) submit bid price ratios above 0.95, allowing M-2 to win the contract. The other pattern (seen in D4, D5 and D8) involves aggressive competitors submitting extremely low bid price ratios, forcing M-2 to lower its bid price in response. Due to the limited number of potential rivals, designated bidding in rural areas increases the likelihood of participants' ability to estimate the competing firms. Accordingly, M-2 is expected to have adjusted its bidding strategy when facing aggressive competitors.

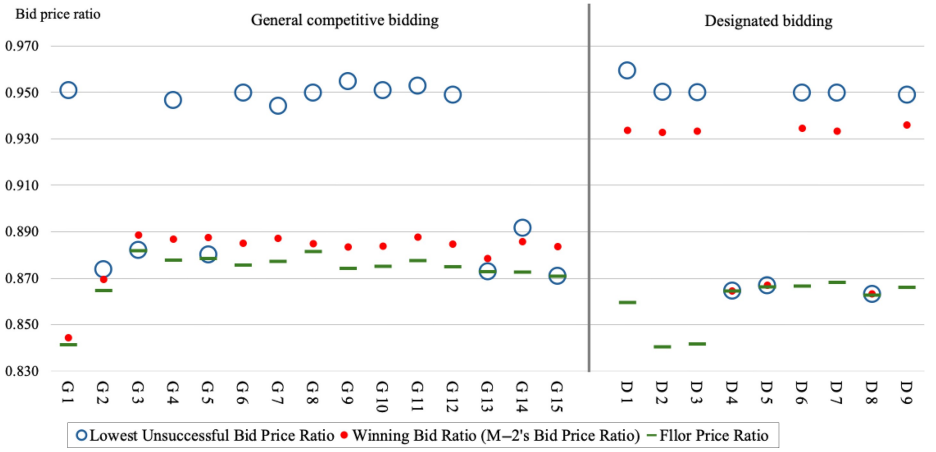


Figure A8. Company M-2's bid price ratios, the lowest unsuccessful bid price ratio and the floor price ratio for pavement works in Masaki Town
Source: Author's own work

By contrast, in general competitive bidding, rival bidders' identities are not easily predictable. As a result, M-2 had to assume the presence of aggressive bidders at all times and was compelled to maintain low bid prices. The red dots in Figure A8 indicate that M-2's bid price ratio (representing its winning bid ratio) remained around 0.88–0.89, close to the floor price. Nevertheless, competitors placed bids lower than M-2's bid price ratio (e.g. in G3, G5, G13 and G15). These bids are represented by blue circles positioned below the red dots; however, M-2 still won the contract. Possible explanations include disqualification due to the low bid price investigation system, a low technical evaluation score under the most economically advantageous tender system and documentation-related errors.

In general competitive bidding, although M-2 was the dominant contractor in Masaki Town in terms of contract awards, it was compelled to bid close to the floor price due to pressure from potentially low-price offers by unseen competitors. This situation constitutes a contestable market.

C. Applicability of the 95% rule to different types of public works

This appendix extends the pavement work analysis presented in Section 4 by examining the applicability of the 95% rule to other types of public works. The regulatory framework and information structure related to procurement, including the disclosure of the reservation price before bidding, are consistent across all work types commissioned by Ehime Prefecture. However, market conditions may vary depending on factors such as the volume of public works, new entrants or demand shocks, number of potential participants, specialization degree required for each type of work (e.g. the need for heavy machinery) and geographic mobility constraints between construction sites (e. g. because of the handling properties of asphalt).

This appendix focuses on two types of specialized work: electrical work and scaffolding and earthwork. Each of these categories contains more than 5,000 bids (across more than 1,000 contracts) in our data set, which helps ensure the stability of the analytical results. Although general civil engineering work also comprises over 70,000 bids, it is categorized as an integrated type of work, separate from other specialized categories. Therefore, it is not suitable for comparative analysis with specialized works such as pavement construction and is thus excluded.

The analytical procedures are consistent with those described in Section 4 of the main text. They include the use of the rdrobust and rdplot commands in Stata. Estimations are stratified using two procurement formulas: general competitive and designated bidding. Figures A9 and A10 present the

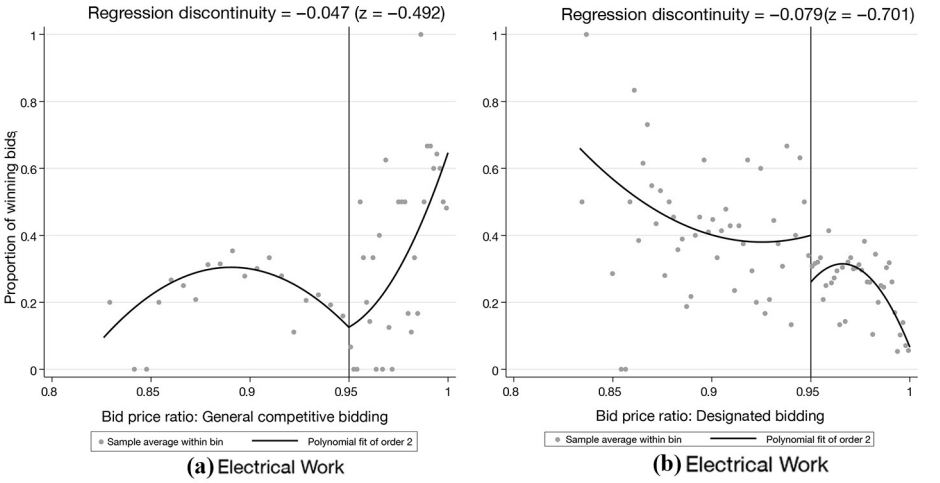


Figure A9. Electrical work procured by Ehime Prefecture

Note(s): The graph, generated using the rdplot command in Stata, illustrates the regression discontinuity (RD) analysis, displaying estimated discontinuities and fitted lines. A second-order polynomial is used for visual approximation, whereas the discontinuity and corresponding *z*-value at the top of each panel are estimated using a linear model within the selected bandwidth

Source: Author's own work

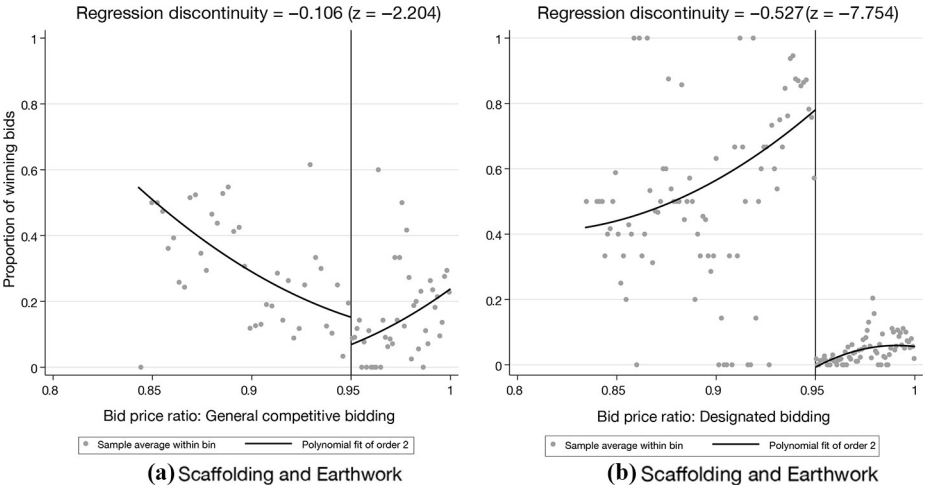


Figure A10. Scaffolding and earthwork procured by Ehime Prefecture

Note(s): Same as in Figure A9

Source: Author's own work

visual results. The estimated discontinuity and corresponding *z*-value are reported at the top of each panel. The approximation lines in the graphs are a second-order polynomial fit, whereas the estimation and z-test of coefficients are based on a first-order (linear) model within a specific bandwidth. No clear discontinuity is observed in the graph for electrical works procured by the Ehime Prefectural Government under either procurement formula. This indicates that a discontinuity at 0.95 is not necessarily present in other types of work. In contrast, for scaffolding and earthwork, the designated bidding data exhibit a discontinuity, whereas the general competitive bidding data, though less pronounced, still show a statistically significant discontinuity. This pattern is consistent with the findings for pavement work as noted in the main text.

Placebo tests using alternative cutoff points were conducted to assess the robustness of the observed discontinuity at the 0.95 threshold in designated bidding (Table A1). The left column of Table A1 reports estimates using a first-order polynomial, whereas the right column uses a second-order specification. The results show that the negative coefficients at the 0.95 threshold are consistently large and stable across both model specifications. These quantitative results are consistent with the visual pattern illustrated in the right panel of Figure A10.

In contrast, the positive discontinuity at 0.945 yields stable coefficients in both specifications (Table A1). Although statistically significant, this finding is unexpected and likely represents a methodological artifact, possibly driven by localized or unstable factors. The exact source of this result is beyond the scope of this supplemental note. At the very least, the right panel of Figure A10 provides no visual indication of such a trend.

In conclusion, a discontinuity at the 0.95 threshold in the bid price ratio is observed in the probability of winning, not only for pavement works but also for scaffolding and earthwork. In our framework, such discontinuities suggest the presence of the 95% rule as a form of bidder coordination. In contrast, no such pattern is evident in electrical work, indicating that, the 95% rule does not consistently emerge across all work types, even under a common regulatory framework. Nevertheless, this finding does not preclude the possibility of other forms of coordinated behavior in electrical work.

Table A1. Regression discontinuity estimation results testing the validity of alternative thresholds for scaffolding and earthwork projects through designated bidding only

	Estimation model 2 (first ordered) Estimated discontinuity (robust)			Estimation model 3 (second ordered) Estimated discontinuity (robust)		
Cutoff	Coef.	Std. err.	P > *z*	Coef.	Std. err.	P > *z*
0.935	−0.038	0.172	0.826	−0.109	0.199	0.585
0.940	0.137	0.085	0.106	−0.127	0.120	0.291
0.945	**0.259**	**0.077**	**0.001**	**0.350**	**0.085**	**0.000**
0.950	**−0.527**	**0.068**	**0.000**	**−0.515**	**0.069**	**0.000**
0.955	−0.007	0.039	0.867	**−0.104**	**0.049**	**0.033**
0.960	**−0.027**	**0.015**	**0.069**	−0.021	0.018	0.255
0.965	0.015	0.020	0.447	−0.018	0.027	0.506

Note(s): This table presents the results of 14 RD estimations applied to scaffolding and earthwork projects conducted exclusively through designated bidding. The analysis tests for potential discontinuities in the proportion of winning bids at seven different threshold values. The estimation follows models 2 and 3 from Table 3 of the main text, which differ in polynomial order: model 2 uses a first-order (linear) regression, whereas model 3 adopts a second-order (quadratic) specification. Statistically significant discontinuities at the 10% level (based on the *z*-test) are shown in bold format. When estimated discontinuities are statistically significant in both models, the corresponding cells are shaded in light gray

Source(s): Author's own work