Geographic market size and low bid competitiveness in construction companies

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Abstract

Purpose – The purpose of this study is to determine the relationship between the geographic market size of businesses and the competitiveness of being able to bid at low prices.

Design/methodology/approach – The design of this study is based on a natural experiment approach. Firstly, after controlling for the firm size and other factors, the author sees that firms participating in bidding in a large region are more competitive to bid at lower prices than firms doing business in a smaller region. The author then tests for causality in a natural experiment of the exogenous event.

Findings – The results show that firms participating in the bidding process in a large area are more competitive to bid at lower prices than firms doing business in a small area. This is tested in a natural experiment, and the result is that they are more competitive because they do business in a larger area.

Practical implications – The practical implication is that, when aiming for competitiveness, it is most important to consider the nature of the business and to see the essence of the business, for example, that networks are important in the construction industry, and that doing business over a wide area is the way to become competitive.

Social implications – The social implications are that to make firms more competitive, we must look at the characteristics of the industry and come up with policies that fit the reality, such as encouraging them to do business in a wide area.

Originality/value – The originality of this study is that this study viewed competitiveness as being able to bid low prices for public procurement and found that doing business in a wide area is competitive. Furthermore, the causal effect of the study was to test the fact that doing business in a wide area does not mean doing business in a wide area because it is competitive, but that doing business in a wide area creates a competitive advantage.

Keywords Public procurement, Geographic market size, Hokkaido, Natural experience

Paper type Research paper

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1. Introduction

This study examines public procurement data in Japan to explore the relationship between a construction company's focal geographic area and its bidding behaviour. The conventional assumption is that large-scale construction companies have efficiency advantages for public procurement bidding in terms of their geographic business areas (see the Conference Minutes of the Long Term Committee, 17 December 2010, Japan's National Land Council, Ministry of Land, Infrastructure, Transport and Tourism [MLIT]). Consequently, Japan has established incentives aimed specifically at small and medium-sized enterprises (SMEs). However, few studies have examined the relationship between a construction company's geographic market area and the efficiency of its public procurement bidding behaviour.

This study aims to define construction firm characteristics from the perspective of their geographical markets. We define efficiency as the ability to bid at a lower price than that of similar companies. Our study investigates the relationship between the geographic markets of construction companies and the efficiency of their public procurement bidding behaviour and clarifies the characteristics of construction firms via causal reasoning. In other words, the main objectives of this study are to verify whether economies of scale exist in geographic markets, and, if they do, to identify the causal relationship. This research was conducted using natural experiments analysis, an econometric method that uses coincidental events to identify endogenous relationships, as described in detail below. Several points have been made about the need for construction firms to be active in various markets. See, for example, Chen (2008) on the factors of activity in international markets. See also Garnett and Pickrell (2010) on the reality of international mergers and Akpinar (2020) on the perspective of advantages in the choice of manufacturing locations.

There have been very few studies of the competitive capabilities of construction companies in relation to their geographic area of operation, and consideration of the geographic scope of business has focused exclusively on the study of economies of scale and economies of scope of the firms. The motivation of this study is to bridge the gap between the recognition of the need for the above-mentioned activities and the paucity of research on geographic scope in the study of competitiveness in the activities of construction firms in the market for public procurement. In addition, one of the motivations of this paper is to be able to apply empirical analysis using causal inference techniques in the study of competitiveness, where the correlation between economies of scale and efficiency has only been vaguely recognized.

Although it is not easy to show such a causal relationship, we find that the efficiency of companies operating in multiple markets enables them to set lower bid prices. Inductive regression analysis can be used to demonstrate a correlation and find a significant relationship between two variables. However, the fact that we were able to adequately demonstrate the causal relationship we wanted to find in a natural experiment is one of this study's important contributions. Demonstrating the causal relationships we want to see in these natural experiments is one of the key steps in making competitive ability research a scientific study. This is an efficient and effective way of basing policy formulation on evidence and improving economic welfare in practice, which is very important.

Moreover, this study goes beyond just confirming a causal relationship, as establishing this causal relationship could have important policy implications. Prior research has focused on development of a measure that directly seeks to improve firm efficiency; as a result, it is expected that improved efficiency will enable a business to grow and expand to many business areas. In some instances, this has been the case. However, in practice, operational efficiency can only be achieved by operating in numerous areas. In other words, instead of protecting SMEs, they should be supported in taking on business opportunities, which can be sufficient for industrial promotion. In this sense, this study's findings are potentially very important.

The rest of this paper is structured as follows. Section 2 highlights and analyses the key literature. Section 3 explains the study's methodology and data. In this section, we also formulate an equation to outline our general thinking and describe the study's data structure. Section 4 presents our benchmark estimation research, the causal inference and strategy used to identify the causality effect from the Ishikari integration, and the estimation results. Section 5 discusses the results. Finally, Section 6 concludes the paper.

2. Literature review

Many aspects of the geographic business of construction firms have been analysed from various viewpoints. For example, the global strategies of British construction firms are analysed by Whitla *et al.* (2006), and the business performance of Belgian construction firms is described by Houthoofd (2009). Among geographic market analyses, Cuervo and Pheng (2004) develop an index that includes geographic affairs and measures the performance of transnational construction corporations. Ye *et al.* (2018) show that international construction companies (rather than smaller businesses) prefer to diversify and that market demands drive such diversification into different geographic markets. Distance research has recently been summarized by Beugelsdijk *et al.* (2018).

The background and implications of the globalization of construction firms have been considered by several scholars. Abdul-Aziz (1994) addresses the adoption of global strategies, including using specific countries as springboards for entering other national markets. Ahmad *et al.* (1995) discuss information technology and organization, including decentralization, while Cuervo and Pheng (2004) explore information, brand power and management capability. Jewell *et al.* (2014) examine economies of scope and scale, and Apa and Sedita (2017) explain investments in high-level project management capabilities, business networks and growth strategies. However, no definitive theory has been established for geographic market expansion in the construction industry. Al Qur'an (2020) is also helpful with regard to the selection of profitable foreign markets for Arab international firms.

Current studies are lacking in two areas. Firstly, in terms of methodology, although the extant research considers qualitative and quantitative information, it does not address causality. That is, prior studies do not identify whether efficient firms extend their geographic business areas or firms with extended geographic business areas become more efficient. Secondly, these studies do not use the full strength of available objective evidence, such as public procurement data. We bridge the gap between existing studies and causal thinking by using official procurement data.

It is difficult to identify whether a firm's ability to offer lower (or higher) bid prices is the causative factor for its choice of geographic market area. Management studies often mention the endogenous strategic choice problem (Shaver, 1998; Brouthers, 2002; Miller *et al.*, 2016). However, we identified a valuable opportunity to examine this exogenous factor using randomized controlled trial methodology based on an event that occurred in 2010: the integration of two procurement offices, the Ishikari Development and Construction Department (Ishikari Department) of the Hokkaido Regional Development Bureau of the MLIT and the neighbouring Sapporo Development and Construction Department (Sapporo Department). We use this event to analyse firm behaviour, comparing firms that do business in both markets with those that do business in only one of the markets.

Among studies on the Japanese construction industry, Natsuyama *et al.* (2013), Taketani and Ohashi (2013) and Minami *et al.* (2014) focus on construction firms' market areas and the role of local construction firms in disaster prevention and reestablishment. These studies only provide a business strategy viewpoint. Analysing the relationship between bidding and work performance data taken from the Shikoku Regional Development Bureau, MLIT, covering 2002–2005, Morimoto *et al.* (2008) suggest that a firm doing business in a limited area tends to have high quality work. Although such studies point out various aspects of the relationship between construction market areas and firm performance, they also imply that a high-performing firm that focuses on a local area has an advantage in bidding competitions. The implication is that a firm that does business in a local area may have a competitive advantage with respect to information available near the project area as well as in terms of business management agility. The MLIT adopts general competitive bidding and a comprehensive evaluation bidding system, including local contribution points and knowledge. Therefore, information and knowledge about the project area and assistance from local activities are competitive advantage factors. However, firms that bid repeatedly in a neighbourhood are often linked to implicit borrowing and expected coordinated behaviour by fixed members.

Among studies that have analysed market area performance, including cross-border (regional borders) business, some have provided interesting insights. Jewell *et al.* (2014) investigate the scope and scale dilemma among professional construction service firms. They identify five key factors that influence the scope and scale of a professional construction service, including the importance of localization. In a comparative analysis, Ye *et al.* (2009) address concentration issues in the international construction market. They point out that the construction business is both local and international and that moderate competition intensity is good for contractors. These studies imply that there is a link between larger geographic areas and efficient firm performance; however, they capture area as an exogenous factor of a construction company's business to characterize the business or market situation. The determinants of the geographic area a business has chosen and the relationship between this market area and bidding should be analysed to better understand this situation.

Considering the findings of existing studies, our research aim is to explore the relationship between a construction company's geographic market area and its bidding behaviour. We thus fill the gap in the literature on the relationship between the geographic market areas of construction companies and their efficiency. Our results indicate firms that do business in multiple areas tend to offer lower (more competitive) bid pricing. These results are significant for construction industrial policy and managerial strategy. They can help frame management strategies for expanding a company's business area, guide policies for enhancing a construction company's productivity by promoting geographic market expansion and develop a construction management theory regarding geographic areas and bidding behaviour based on empirical evidence.

Statistical analysis in regional studies can be divided into three categories. The first seeks the determinants of regional concentration and specialization in several activities, including business service agglomeration economies (Francois, 1990; Raspe and van Oort, 2007; Meliciani and Savona, 2015). The second category seeks the economic fundamentals of a region-related industry such as housing and construction (Hwang and Quigley, 2006). The third applies economic models and explores region-related issues, such as those within the construction industry (Jewell *et al.*, 2014; Liu *et al.*, 2014). This study can be placed in the third category; however, our approach is novel and is more effective not only in applying the economic model but also in estimating the causal relationship through the use of our natural experiment. Furthermore, it differs from a mere discussion of firm boundaries (Nagaoka *et al.*, 2008).

3. Method and data

3.1 Related market

Hokkaido is located in northern Japan and has an area of 83,457 km^2 (including 5,036 km^2 in the northern territories), accounting for 22% of Japan's total area in October 2013. According to the National Census, its population was 5,506,419 in 2010, which was approximately 4.3% of Japan's total population at the time. The area's gross regional product in 2014 was yen 18,484.6bn, which included yen 1,504.8bn from the construction industry (6.6%). A total of ten development and construction departments located in different areas in Hokkaido manage regional development projects. The borders of the department markets are generally defined by natural boundaries, such as mountain ranges and rivers. These departments are significantly involved in promoting local community-related development. There are 20,175 licensed construction companies and 8,187 qualified public procurement companies in the study area. We selected Hokkaido because of data availability and area-specific features (e.g. it is an isolated block of Japan lumped together as a single area; see Table 1 and Figure 1).

Japan's construction industry is licensed, meaning that a license is required for a person/firm who intends to run a construction business. There are two types of licenses, "permission from the governor" and "permission from the Minister". However, not only a single prefecture but also multiple offices require the minister's permission, and construction across the whole country can be carried out with the permission of the governor. Construction in the business locations covered in this study can be carried out as long as the license is either "permission from the governor" or "permission from the Minister". Business can be conducted in any region within the scope of this study, including Sapporo and Hakodate.

The Japanese public procurement system has some notable features. When the public procurement authority decides to undertake a project, a contract officer puts the contract out to tender in principle. The procurement authority uses a predetermined price that is like an engineer's budget. This upper price limit is calculated in public procurement requests for

Population	5,506,419	2020 National Census
Area	83,457 km^2	(including 5,036 km^2 of the northern territories)
Industry		Sightseeing, agriculture and fishery

Table 1.
Profile of Hokkaido

Figure 1.
Map of Hokkaido and departments

construction bids in Japan before bidding based on the work specifications, design specifications and construction drawings take place (Article 29–6, the Public Accounting Act).

One method of determining a bid award that has been used in Japanese procurement is to base the award solely on price and automatically accept the lowest bid, single-year budget and total budget contract following the institutional mechanism of the bidding decision-making system. More recently, a comprehensive evaluation is performed whereby price and other elements are assessed inclusively, allowing companies (which may operate as joint ventures) the possibility of obtaining more work if they have excellent technical strength (Arai and Morimoto, 2017).

3.2 Hypothesis based on general thinking

We begin with the following hypothesis based on general thinking:

H1. A construction company that operates in a large geographical market is efficient; therefore, its bidding and winning prices are low.

To consider this hypothesis, we construct an estimation equation with a dummy variable and background information variables as follows:

$$\mathrm{Rate_i} = \alpha_1 + \beta_{1,1}\mathrm{crossborder_i}\left(+\beta_{1,2}\mathrm{log}Bidlast_i + \beta_{1,3}noofparticipants_i\right) + \varepsilon_1, \tag{1}$$

or

$$\mathrm{WinRate_i} = \alpha_2 + \beta_{2,1}\mathrm{crossborder_i}\left(+\beta_{2,2}\mathrm{log}Bidlast_i + \beta_{2,3}noofparticipants_i\right) + \varepsilon_2, \tag{2}$$

where i represents each company's bid on each project, *Rate* is the bidding rate (bidding price over the predetermined project price) and *WinRate* is the winning rate (winning price over the predetermined project price). The *crossborder* variable is a dummy variable for cross-border activity between two development and construction departments; this variable equals 1 when there is activity across the border and 0 otherwise. Note that a firm located in one area or multiple areas in Hokkaido can participate in any area without registering in that specific area. *Bidlast* is the bidding price (the lowest price) to control for the project's size effect, which is estimated by natural logarithmic conversion. *Noofparticipants* is the number of bid participants, which can influence favourability in the bid, and ε is an error term. The coefficients to be estimated are α_1, α_2, $\beta_{1,1}$, $\beta_{1,2}$, $\beta_{1,3}$, $\beta_{2,1}$, $\beta_{2,2}$ and $\beta_{2,3}$ in equations (1) and (2).

When examining the reach of previous studies, there is a lack of consideration of causality. To demonstrate this, we first show the correlation, and then show in the test of the above hypothesis the necessary and sufficient conditions to show that geographic expansion caused efficiency, and that there was no efficiency in the absence of geographic expansion. This is on the subject of causal inferences that cannot be derived solely from endogenous references in previous studies. In addition, the test is based on real-world objective data, as follows. The use of this objective data is the same as in the following previous studies. Drew and Skitmore (1997), Chen (2008), Oo *et al.* (2010) and Arai and Morimoto (2019), all use this type of bid data in their research. Mochtar and Arditi (2001) examine several issues related to pricing in construction and explain that the three internal pricing variables with the largest statistically significant contingency coefficients for pricing strategy are “marketing intelligence capabilities”, “annual contract value” and “the type of client in most projects”. In principle, our study uses bid data similar to the data used in these studies.

3.3 Basic concept

The term “natural experiment” as used here refers to a change in the studied entity’s economic environment driven by an external factor not related to that entity’s activity. This approach allows us to deal with endogeneity problems that should be considered in the empirical analysis. If an endogeneity problem appears, it is described, but it is often difficult to identify its causal relationship. Therefore, this study verifies the causal relationship naturally through the results of an experimental event.

Rosenzweig and Wolpin (2000) summarize 20 previous studies that estimate an economic treatment effect in a natural experiment using twin births and irregular weather as examples. Heckman (2000) reviews the development of econometrics and points out that this approach has superior methods, transparency, reliability and reproducibility when used with natural experiments.

3.4 Data

The estimation is based on public procurement bidding and winning data for each of the development and construction departments of the Hokkaido Regional Development Bureau from financial year 2006 to financial year 2012. For each project, the data include a predetermined price, bidding price, winning price and firm names. Bids are limited to general engineering work. There are 7,031 contracts with a total of 45,806 bids. Table 2 shows the descriptive statistics. The data are drawn from www.hkd.mlit.go.jp/ky/jg/koujikanri/ud49g70000002230.html (in Japanese).

The software used in the estimates in this paper is EViews 10 (IHS Global Inc.).

4. Estimation results

4.1 Benchmark estimation

We conduct a benchmark estimation using the simple ordinary least squares method. Table 3 presents the results. This benchmark estimation is then compared with the extended

STATISTICS	*PREDETERMINED*	*BIDLAST*	*CROSSBORDER*	*NOOFPARTICIPANTS*
Mean	179,000,000	162,000,000	0.535	6.517
Median	124,000,000	113,000,000	1	6
Maximum	8,390,000,000	8,380,000,000	1	43
Minimum	2,810,000	1,590,000	0	1
Std dev.	331,000,000	306,000,000	0.499	4.476
Skewness	13.579	14.591	−0.141	1.383
Kurtosis	252.120	294.467	1.020	6.117
Observations	7,031	7,031	7,031	7,031

Notes: The variable *CROSSBORDER* is a dummy variable and others are actual values; *PREDETERMINED* and *BIDLAST* are expressed in yen. *PREDETERMINED* is the basis for determining the amount of the winning bid by the ordering party in competitive bidding. *BIDLAST* is the final bid price of the firm participating in that bid. *NOOFPARTICIPANTS* is the number of firms that participated in that bid

Table 2. Descriptive statistics for the public procurement data of the Hokkaido Regional Development Bureau

Table 3.
Effect of *crossborder* variable

Dependent variable	*RATE*	*log*(*RATE*)	*RATE*	*log*(*RATE*)	WINRATE	WINRATE
Method: least squares	n = 45,806	n = 45,806	n = 45,806	n = 45,806	n = 7,031	n = 7,031
	Coefficient	Coefficient	Coefficient	Coefficient		
	(Std error)	(Std error)	(Std error)	(Std error)	(Std error)	(Std error)
C	0.944***	−0.059***	1.164***	0.160***	0.941***	0.958***
	(0.0014)	(0.0019)	(0.0075)	(0.0061)	(0.0025)	(0.0145)
CROSSBORDER	−0.003***	−0.003***	0.000	0.000	−0.007***	−0.006***
	(0.0006)	(0.0007)	(0.0006)	(0.0007)	(0.0013)	(0.0013)
LOG(BIDLAST)			−0.011***	−0.011***		0.000
			(0.0004)	(0.0003)		(0.0008)
NOOFPARTICIPANTS			−0.002***	−0.002***	−0.003***	(0.0001)
			(0.0001)	(0.0001)		Yes
Department dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	0.297
R-squared	0.287	0.306	0.331	0.348	0.238	0.295
Adjusted R-squared	0.287	0.306	0.331	0.348	0.236	0.049
S.E. of regression	0.064	0.066	0.062	0.064	0.051	−3.194
Akaike info criterion	−2.661	−2.595	−2.724	−2.658	−3.114	

Notes: *C* = constant; *RATE* = bidding rate; *WINRATE* = winning rate; *CROSSBORDER* = dummy variable for cross-border activity; *BIDLAST* = bidding price (the lowest price) to control for the project's size effect; *NOOFPARTICIPANTS* = number of bid participants. *** $p < 0.01$ and ** $p < 0.05$

research that follows. The *crossborder* dummy equals 1 for enterprises that cross the border at least once and 0 for firms that do not cross the border even once.

As Table 3 shows, the *crossborder* coefficients in the models using *Rate* and *WinRate* as the dependent variable are negative and statistically significant in principle. The coefficient values and signs are negative and statistically significant in their effects on project size and favourability. These coefficients are the same with or without the other project size variable [*LOG*(*BIDLAST*)] and the competitive situation variable (*NOOFPARTICIPANTS*). Therefore, *H1* is supported, indicating large-scale construction companies that efficiently manage their public procurement bidding in terms of geographic areas tend to offer lower bid/winning prices. We estimate using both the original value and logarithmic value of *Rate*; the results are similar. Therefore, we use the original value of *Rate*. We also include a year dummy (2006–2011) and a department dummy.

The following example shows that the treatment effect correctly reflects the actual condition. Prior to the integration of the two departments, companies on the outskirts of Ishikari found it more difficult to participate in auctions held in other regions than did those on the border between Ishikari and Sapporo. However, integrating Ishikari and Sapporo seems to have produced participation in auctions beyond the borders. If only Ishikari is considered (the *crossborder* dummy equals 0), there is participation in two bids for Ishikari and Sapporo (the *crossborder* dummy equals 1). By comparing those who voluntarily participate in more than two places with those who appear to participate unwillingly, the characteristics of those participating unwillingly become clear. This is different from the question of whether firms who are located near the border are likely to cross it. For example, we assume that firms located near the border are still located in that location at the time of all our estimates. Therefore, the ease of crossing the border is not different before and after the department consolidated. For this reason, it is not necessary to add to the estimates whether the companies are located close to the border.

Just before this period, there was the Hokkaido Regional Department Bureau collusion case in 2008. Because of this, the severity of sanctions for violations of the law was being reported and felt by businesses. There was a heightened awareness of legal compliance. Therefore, it is reasonable to assume that there was no collusion at this time. Therefore, the collusion issue is not an omitted variable in the estimation. Regarding possible sample selection bias, because the data represent national-level public procurement, the firms are likely to be larger than local firms, and large firms may have several branches in Hokkaido. Thus, there may be some bias in the cross-border results. However, the bias is likely small because it is not easy for a firm to do business in a larger area given the efficiency factor. There are no time intervals in the procurement data; thus, sequence correlation is not an issue.

4.2 Causal inference

Attention should be paid to proving causation. This study's argument is that expanding a firm's business area will cause efficient bidding. However, there are four potential types of relationships between expansion of the project area (A) and efficient bidding (B):

- A to B;
- B to A;
- C to A and B; and
- A and B are unrelated and just happen to show the same movement.

First, we examine (iv) to see if the relationship found in the benchmark estimation between A and B is simply the result of two independent variables that just happen to move in the same way. A spurious correlation is where two events are unrelated, but happen to show similar movements and appear to be somehow related; one famous example is that the number of people who drowned by falling into a pool correlates with the number of films Nicolas Cage appeared in (see the website: www.tylervigen.com/spurious-correlations; accessed 23 May 2020). However, argument (iv) does not apply to our contention. The cases we study involve the actions of the same subject and business; moreover, they have many things in common, such as decision-making, input factors and outcome implications, which are considered to be related. In fact, this can be seen from the findings in Section 3, with respect to the verification in Section 4.3, which confirms that whether there is one or multiple project areas, the efficiency of bidding increases in the sense that the more project areas there are, the lower the bid price will be.

Next, we examine (iii) above, the possibility that another factor affects both factors, making them appear to be correlated. This is the so-called lurking variable; for example, although people who carry lighters may seem to be prone to cancer, cigarettes (the lurking variable) are the real culprit. Usually, it is difficult to quash all confounding factors. On the other hand, our contention is that neither (iii) nor (iv) is the case with respect to the verification in Section 4.4. In comparing the average bidding rate for each operator, it is possible that a larger operator bids in more than one region and the bidding is more efficient, but the size of the predetermined price is not positively related to the efficiency of bidding (negative significant relationship), resulting in no finding of a significant relationship between the size of the predetermined price and the winning rate. In other words, it has been shown that larger firms are not necessarily more efficient bidders. Although other confounding factors are possible, we use the results of this natural experiment to verify the direct relationship between A and B because it can directly verify the relationship between A and B rather than eliminating all other possibilities.

It was possible to compare spontaneous A → B (cross-border → efficient) and involuntary A → B (involuntary cross-border → efficient) events as a result of non-spontaneous events that occurred in A → B. As a result, efficiencies were achieved in the former, but not in the latter. In other words, efficiency is not causing crossing. This is because if B → A, A should be achieved if B occurs, regardless of whether A is voluntary or involuntary. However, this is not consistent with our findings. The fact that only spontaneous A gave rise to B means that A has been shown to cause B, which we discuss in Section 4.5.

In other words, this natural experiment study shows a causal relationship between voluntary expansion of business areas in the construction industry and bid efficiency by examining involuntary crossing events.

4.3 Relationship between number of business market areas and pricing

Our result is contrary to the general view that companies that conduct business over a wide area tend to offer bid prices that are lower than those of firms operating in narrow business areas. We test the robustness of this result in two ways.

Firstly, we check the relationship between a firm's number of business areas and its pricing rate. If a wide-ranging firm has an economy-of-scale advantage with respect to pricing, then the number of business areas should be negatively correlated with the bids and winning prices (i.e. the higher the number of areas, the lower the bids). Therefore, we estimate the following equation to check for this negative correlation:

$$\text{Rate}_i or\ WinRate_i = \alpha_3 + \beta_{3,1}\text{Tikusu}_i + \sum_{j\in J}\beta_{3,j}L_j(+\beta_{3,2}\text{log}bidlast_i\ + \beta_{3,3}noofparticipants_i) + \sum_{j\in J}\beta_{3,j}Department\ Dummy_j + \sum_{y\in Y}\beta_{3,y}Year\ Dummy_y + \varepsilon_3, \quad (3)$$

where the variables have the same meaning as in equation (2). *TIKUSU* is the number of areas, and ε is an error term. The coefficients to be estimated are α_3 and $\beta_{3,1}$, $\beta_{3,2}, \ldots, \beta_{3,3}$.

The estimation results are shown in Table 4.

Table 4 shows that the coefficients for *TIKUSU* (number of areas) are positive and statistically significant for both the bid and winning price. Wide-ranging business firms thus have pricing advantages based on economies of scale. As the number of market areas increases, the firm's bidding price over the predetermined price decreases. This result has one caveat: the year dummies include only the period after the department integration occurred because the number of areas is directly linked to the integration. In addition, the adjusted R-squared is not sufficiently large. Therefore, this finding presents supportive but not strong evidence for our results. Omitted variable bias may be present.

4.4 Relationship between firm behaviour and pricing

Secondly, from the perspective of a firm's bid decision-making, we consider the firm's average bid price as the firm's behaviour and verify the relationship between the cross-border dummy (and number of market areas) and the firm's average bid price. Our estimation equation is uses either the firm's average bid or winning price as the dependent variable, a constant, estimated coefficients for multiple cross-border dummy variables (number of market areas), size and competition as the independent variables. Table 5 shows the estimation results.

Dependent variable	*RATE*				*WINRATE*			
Method: least squares	n = 45,806				n = 7,031			
	Coefficient (Std error)		Coefficient (Std error)		Coefficient (Std error)		Coefficient (Std error)	
C	0.943	***	1.165	***	0.938	***	0.961	***
	(0.0014)		(0.0075)		(0.0024)		(0.0144)	
TIKUSU	0.000	*	0.000	***	0.000		0.000	
	(0.0001)		(0.0001)		(0.0002)		(0.0002)	
LOG(BIDLAST)			−0.011	***			−0.001	
			(0.0004)				(0.0008)	
NOOFPARTICIPANTS			−0.002	***			−0.003	***
			(0.0001)				(0.0001)	
Department dummy	Yes		Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes		Yes	
R-squared	0.287		0.331		0.235		0.295	
Adjusted R-squared	0.287		0.331		0.233		0.293	
S.E. of regression	0.064		0.062		0.051		0.049	
Akaike info criterion	−2.660		−2.724		−3.110		−3.191	

Note: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$

Table 4. Estimation results for cross-border number effect

Table 5.
Estimation results of firm behaviour

Dependent variable	Firm's average *RATE*		Firm's average *WINRATE*	
Method: least squares	n = 45,806		n = 7,031	
	Coefficient (Std error)	Coefficient (Std error)	Coefficient (Std error)	Coefficient (Std error)
C	0.964 ***	1.240 ***	0.969 ***	1.187 ***
	(0.0007)	(0.0035)	(0.0016)	(0.0093)
CROSSBORDER	−0.004 ***	0.001 ***	−0.003 ***	0.001
	(0.0004)	(0.0004)	(0.0009)	(0.0009)
LOG(BIDLAST)		−0.015 ***		−0.012 ***
		(0.0002)		(0.0005)
NOOFPARTICIPANTS		0.000 ***		−0.001 ***
		(0.0000)		(0.0001)
Department dummy	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
R-squared	0.355	0.476	0.279	0.378
Adjusted R-squared	0.354	0.476	0.277	0.377
S.E. of regression	0.034	0.030	0.034	0.031
Akaike info criterion	−3.934	−4.143	−3.930	−4.078

Note: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$

Table 5 shows that the coefficient of the cross-border dummy is negative except when other variables [log(*bidlast*) and *noofparticipants*] are included. Even with the firm-level estimation, we observe that geographically wide-ranging businesses bid low; thus, they are efficiently promoting projects.

Both these robustness checks firmly support our results. Our study's main results are supported from both the construction industry and public procurement standpoints.

4.5 Integration of Ishikari office

The causal relationship between participation by large-scale construction companies in many areas and a low bid/winning public procurement price is unknown. Thus, we do not identify causality in the following two cases: firstly, whether a company operating in a large geographic area offers low bidding/winning prices through some type of efficiency; and secondly, whether a company that can offer a low bid/winning price operates in a large geographic area.

The causal connection between a firm's behaviour or ability to offer low (or high) bid prices and the size of its geographic area of operations is not a one-way relationship but, rather, a bi-directional relationship. To determine which direction is dominant, we use a natural experiment based on the integration of the procurement offices. We have already shown that a firm that does business in a large geographic area can offer low bid pricing. Next, we look at the exogenous event that affected these firms' business areas.

The Ishikari Department of the MLIT was integrated into the neighbouring Sapporo Department on 1 April 2010. This integration – effectively an exogenous factor for construction companies – was the result of a political decision related to administrative reform aimed at reducing government. Through this integration, a firm placing bids under the purview of the Ishikari Department was considered as also bidding under the purview of the Sapporo Department, which meant that the firm was (or seemed to be) doing business in two public procurement areas.

To estimate the firm's behaviour, for each department, we set a dummy variable equal to 1 if a project was in that department and 0 otherwise (see Table 6 for the descriptive statistics of each department).

If an exogenous event forces a firm to expand from one to two or more market areas, a crucial question related to the causal connection is whether the firm can continue to offer low bid pricing even after the enforced area expansion. If low bid pricing is associated with the enforced expansion, it follows that the larger the business area, the lower the bid price. If the low bid pricing is not associated with the enforced expansion, then a larger market area does not lead to low bid pricing, but a low-bid firm is likely to expand to a larger market area.

We construct cross-terms between the Ishikari Department and the other department variables. The Ishikari Department firms with cross-border variables include firms that integrated either voluntarily or involuntarily. In comparing cross-terms between the Ishikari Department and the other departments (the control group), if the cross-border effect in the Ishikari Department is smaller than that in the control area, cross-border behaviour does not lead to public procurement efficiency in the construction business. However, if both groups provide similar low-level bid/winning prices, the cross-border business itself leads to efficiency.

We use a difference-in-differences method to analyse this effect. Difference-in-differences is a statistical technique used in quantitative research that attempts to mimic an experimental research design using observational study data to examine the differential effect of a treatment on a treatment group vs a control group in a natural experiment. The effect of a treatment on an outcome is calculated by comparing the average change over time in the outcome variable for the treatment group to the average change over time for the control group.

We compare three areas. The control areas that are compared with the Ishikari Department are selected on the basis of similar numbers of projects and participants, in addition to the common area characteristic of a shared river; the rivers are the Ishikari River for the Ishikari Department, the Teshio River for the L01 area (Asahikawa) and the Tokachi River for the L04 area. The similarity among L01, L04 and L09 depends on geographic conditions.

We construct the following regression equation to analyse the cross-border effect using the location variables and cross-border dummy variable:

Department name	Variable name	No. of projects	Gross no. of participants
Asahikawa Department	L01	751	4,644
Hakodate Department	L02	516	2,430
Otaru Department	L03	387	2,146
Obihiro Department	L04	859	6,666
Abashiri Department	L05	753	3,867
Kushiro Department	L06	662	4,657
Rumoi Department	L07	372	1,679
Muroran Department	L08	586	3,633
Ishikari Department	L09	495	4,178
Sapporo Department	L10	1,324	10,287
Wakkanai Department	L11	326	1,619

Table 6. Descriptive statistics of each department

$$Rate_i = \alpha_4 + \beta_{4,1}\text{crossborder}_i + \beta_{4,2}\text{L09} \times \text{crossborder}_i + \beta_{4,3}\text{L10} \times \text{crossborder}_i + \sum_{j \in J} \beta_{4,j} L_j \left(+\beta_{4,5}\text{log}\textit{bidlast}_i + \beta_{4,6}\textit{noofparticipants}_i\right) + \sum_{j \in J} \beta_{4,j} \textit{Department Dummy}_j + \sum_{y \in Y} \beta_{4,y} \textit{Year Dummy}_y + \varepsilon_4. \quad (4)$$

In $WinRate_i$, subscript 4 is replaced by subscript 5.

Where the variables have the same meaning as in equation (1). j indicates the department number, from 1 to J (J = 11), the variables L09 and L10 are the dummy variables shown in Table 4 and ε is an error term. The coefficients to be estimated are α_2 and $\beta_{3,1}$, $\beta_{3,2}$, . . ., $\beta_{3,6}$. The dummy variables include the department dummy for each department and the year dummy for each year. y indicates the year from 2006 to 2011; the base year is 2012.

The estimation results are shown in Table 7.

The integration merged the Ishikari Department (L09) into the Sapporo Department (L10). As a result, those who had previously bid only for the Ishikari Department were bidding for the Sapporo Department projects as well if they wished to continue bidding for projects, making it appear that they were bidding cross-border. However, this is an involuntary cross-border bid. Therefore, the bidding rates of projects that were cross-bordered in the Ishikari Department (voluntary cross-borders) were compared to those cross-bordered in the Sapporo Department (including involuntary cross-borders). If the bidding rate is lower in Ishikari, this indicates voluntary cross-border bidders achieve efficient bidding rates. In other words, the proof of causality is shown by the natural experiment described in Section 4.2.

Dependent variable	*RATEi*		*WINRATEi*	
Method: least squares	n = 45,806		n = 7,031	
	Coefficient (Std error)	Coefficient (Std error)	Coefficient (Std error)	Coefficient (Std error)
C	0.944 ***	1.165 ***	0.940 ***	0.962 ***
	(0.0014)	(0.0076)	(0.0025)	(0.0147)
CROSSBORDER	−0.004 ***	0.001	−0.005 ***	−0.005 ***
	(0.0007)	(0.0007)	(0.0014)	(0.0014)
L09 × CROSSBORDER	−0.015 ***	−0.020 ***	−0.025 ***	−0.021 ***
	(0.0037)	(0.0036)	(0.0081)	(0.0077)
L10 × CROSSBORDER	0.012 ***	0.000	−0.010 **	−0.006
	(0.0020)	(0.0020)	(0.0043)	(0.0041)
LOG(BIDLAST)		−0.002 ***		−0.003
		(0.0001)		(0.0001)
NOOFPARTICIPANTS		−0.011 ***		0.000 ***
		(0.0004)		(0.0008)
Department dummy	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
R-squared	0.288	0.332	0.239	0.298
Adjusted R-squared	0.288	0.331	0.237	0.296
S.E. of regression	0.064	0.062	0.051	0.049
Akaike info criterion	−2.662	−2.725	−3.115	−3.195

Table 7. Estimation results for cross-border effect

Table 7 shows that the coefficients of L09 × *CROSSBORDER* are negative and strongly significant for both the bid rate and winning bid rate. L10 × *CROSSBORDER* is positive and significant or insignificant except for the estimate of the winning bid rate, excluding the estimation that includes the predetermined price and number of participants variables. In other words, as we assumed, bidding in voluntary cross-borders is more efficient than in involuntary cross-borders, as confirmed by our reasoning. Thus, as Section 4.2 explains, a causal relationship has been established that voluntary expansion of business areas in the construction industry achieves bid efficiency. In the third column, the coefficients of both L09 × *CROSSBORDER* and L10 × *CROSSBORDER* are negative and significant; however, the null hypothesis is rejected at the 1% significance level (0.0090) when the Wald test is used to find the probability that the value of L09 × *CROSSBORDER* is smaller.

These findings indicate that firms that do business in multiple areas tend to offer lower (more competitive) prices. Clarifying the mechanism through which doing business in multiple areas causes lower pricing is this study's unique contribution. We can infer how businesses in the broad area can enhance efficiency via two factors. Firstly, firms that do business in multiple areas can establish the same job levels across various areas. This has an important effect in the industry. Secondly, firms in multiple areas are likely to be challengers in new markets, so they might animate a stagnant atmosphere as mavericks in price competition for public procurement.

5. Conclusions

This study uses low bids to explore the relationship between geographic business areas and the cost-efficiency of construction companies. Using public procurement data from 2006 to 2012, we compare the bid behaviours of companies that are active across both department market areas, either voluntarily or involuntarily, to companies that are limited to a single market area. We find that the coefficient of the treatment group variable (the cross-term between the Ishikari Department and cross-border) is significantly negative (efficient) in terms of pricing. This indicates that firms that do business in multiple areas tend to offer lower (more competitive) pricing levels, which supports the conventional thinking about economies of scale. This study's unique contribution is in its explanation of the mechanism through which doing business in multiple areas causes lower pricing.

The results are verified in terms of causal inference by considering two aspects: the relationship between a firm's number of market areas and pricing rate and the relationship between the firm's behaviour and pricing rate. Both tests support our findings. As this research is guided by causal inferences obtained through a natural experiment, the results are fully generalizable beyond the Hokkaido region investigated here. However, future studies should confirm that our results are generally applicable by investigating the behaviour of local, regional, national and international contractors.

The results of this study make an empirically significant contribution to the literature by clarifying the causal relationship between bid efficiency and the geographic business scope of construction companies, which has not been clarified in previous studies of firm behaviour. The results of this study provide guidelines for realising productivity improvements in the construction industry.

The three main implications of this study for construction economics and management are as follows. Firstly, the results of the empirical analysis based on the natural experiment conducted in this study indicate that firms that do business in multiple areas have lower (more efficient) pricing levels, while those with lower cost levels do business in multiple areas. Consistent with this result, policy measures to enhance total industrial productivity should include a plan to support firms doing business in multiple areas. Some levels of government offer preferential treatment programs in procurement auctions for SMEs. For example, California's Small Business Preference Program provides small firms with a 5% bid discount. The effects of bid preferences on auction outcomes have been analysed by Krasnokutskaya and Seim (2011). Nakabayashi (2013) examines the extent to which small business allocations increase government procurement costs (e.g. the lack-of-competition cost exceeds the production inefficiency cost). However, it might be necessary to promote operations in multiple markets rather than offer preferential treatment. Indeed, it is not easy for a local authority to take this step. Therefore, authorities need to cooperate with others in neighbouring areas to implement a preference program that fosters business operations in multiple areas.

Secondly, this study applies an empirical method and a natural experiment (similar to a randomized controlled trial) to construction-related economics research and construction management research, which typically use qualitative procedures or case studies. We expect this study to become a primer for using empirical methods in this research area.

Thirdly, our findings show that the factors of economies of scale in terms of market area (e.g. managerial issues, climate conditions and geographical situations) need to be investigated in further detail. Extending this examination to other areas, to the country as a whole and across other global regions is another challenge. For example, a broader perspective, wider range of competition and more globalized vision may increase efficiency. Creating equivalent resources across multiple large business areas may also increase efficiency. Our next challenge is examining why doing business in a broad area leads to cost efficiency.

This study has several limitations. As this study deals with public procurement, it is necessary to consider the possibility of bid rigging. Although its results and methods can be generalised in studies of construction management, they are applied to a specific geographic area at this study. The study's purpose was to better understand the characteristics of companies in the construction industry in a geographic market and to suggest measures for improving productivity based on an accurate understanding of company characteristics. The study's results show that encouraging companies to conduct business in multiple geographic areas is effective in improving productivity.

There are also some policy and management implications. According to this study, the key to success in the construction industry is to go beyond concentrating on one area that is good for firm knowledge and experience and requires accepting the challenges of multiple areas that present new opportunities. Increasing competition and efficiency may be the reason doing business in a broader area leads to reduced prices. This implication is the main contribution of this study.

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