

The effect of increasing the scale of demand on the emergence of innovative firms in public procurement

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Abstract

Purpose – This study aims to examine the association of demand scale expansion on the emergence of innovative firms in public procurement. It investigates how the size of overall demand and number of procurement opportunities influence the generation of innovative construction companies in Japan.

Design/methodology/approach – Using public procurement data from Japan's construction industry (2006–2020), this study uses a move-to-front model to explain innovation emergence and applies fixed-effects panel analysis to examine how demand scale impacts innovative firm creation across different regional markets over time.

Findings – This study identifies a significant positive relationship between the emergence of innovative firms and both the total procurement volume and the number of procurement opportunities. Specifically, increasing both the total procurement budget and the number of procurement opportunities is more effective for stimulating innovation than simply increasing average project size. The elasticity of innovation with respect to total budget exceeds one, suggesting that increases in the budget are associated with proportionally greater effects on innovation than increases in procurement opportunities alone.

Practical implications – The findings indicate that both business expansion orientation and price sensitivity orientation are necessary conditions for innovation. Public procurement can be strategically structured to stimulate innovation by increasing both the total budget and the number of procurement opportunities, rather than concentrating solely on large-scale projects.

Social implications – Strategic management of public procurement can significantly influence innovation in the construction industry, with potential benefits for economic growth, infrastructure development and public service delivery.

Originality/value – This study offers a novel theoretical and empirical contribution by applying a move-to-front model – previously unexplored in the context of public procurement – to explain how demand scale influences the emergence of innovative firms. Using rich panel data from Japan's construction sector (2006–2020), it demonstrates that total procurement volume and opportunity frequency significantly affect innovation outcomes. By linking competitive bidding structures to innovation dynamics, the study provides actionable insights for policymakers seeking to stimulate innovation through strategic demand-side instruments, particularly in sectors where public procurement constitutes a major share of market activity.

Keywords Competitive bidding, Innovative firms, Japan, Public Procurement

Paper type Research paper



1. Introduction

This study examines the key elements of innovation, specifically focusing on the effect of demand scale on the emergence of innovative firms in public procurement. We construct a novel model in which a company's ability to win bids changes depending on innovation occurrence and use this model to examine how demand scale affects both individual company bidding behavior and the broader emergence of innovative firms.

In this study, innovative companies are defined as those whose total successful bids (product sales) have grown significantly over multiple years. Using a move-to-front model to explain innovation emergence, we demonstrate that innovative companies are more likely to win individual tenders, and that demand size is significantly related to this outcome. We simultaneously examine the emergence of innovative firms over time using a fixed-effects model based on changes in demand scale.

Innovation promotion typically includes measures such as R&D tax support, research subsidies, human capital supply policies, intellectual property protections and competition promotion. In industries where public procurement constitutes significant demand, procurement policies may also be crucial for innovation promotion. This study quantitatively examines this relationship using Japanese public procurement data from 2006 to 2020.

The remainder of this paper is organized as follows. Section 2 discusses previous studies on innovation and extracts relevant elements. Section 3 presents our empirical hypotheses. Section 4 provides an overview of the data. Section 5 discusses our model, results and robustness checks. Section 6 concludes with implications and future research directions.

2. Previous research on innovation

2.1 How can innovation be understood?

Schumpeter (1942) regards innovation as a driving force of economic development and classifies it into five types. The Oslo Manual of the Organisation for Economic Co-operation and Development (OECD) (2018) defines business innovation as “a new or improved product or business process (or a combination thereof) that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm” (p. 20).

2.2 Analysis of innovation in economics and management

In economics, particularly industrial organization theory, a central question is how firms and markets should be organized to produce optimal economic benefits. Schumpeter (1942) distinguishes between market structures suited for static resource allocation versus technological progress, arguing that large firms in concentrated markets drive long-term production expansion. This led to two key hypotheses:

H1. Innovation increases with firm size.

H2. Innovation increases with market concentration.

However, more fundamental determinants of technological progress have received increasing attention, categorized into three groups: demand structure, technological opportunities and appropriability conditions (Cohen and Levin, 1989). The empirical literature on these relationships shows that demand scale is particularly important – as demonstrated by Schmookler (1962), who found that capital expenditure cycles in downstream industries “lead” the cycle of related patents in capital goods industries.

In management literature, innovation is viewed through diffusion processes (Rogers, 1962; Moore, 1991) and transition impacts on industries and markets (Utterback and

[Abernathy, 1975](#)). More recent work examines challenges firms face when creating innovation ([Christensen, 1997](#)), including the increasing prominence of startups as innovation generators. Management literature also emphasizes three factors in successful innovation: aggressiveness in pursuing new opportunities, cost advantages and certainty in innovation outcomes.

2.3 Policies to promote innovation

Market economies may under-provide innovation due to knowledge spillovers. Various policy instruments address this, with R&D tax credits and direct funding effective in the short term, and human capital development more effective long term ([Bloom et al., 2019](#)). Public procurement has gained importance as a demand-oriented innovation policy ([Cozzi and Impullitti, 2010](#); [Slavtchev and Wiederhold, 2016](#)), offering benefits like learning and technological improvements that spill over into the broader marketplace.

Recent studies on public procurement have increasingly recognized its role as a strategic instrument for fostering innovation in various sectors. [Andersson et al. \(2025\)](#) highlight how emerging technologies like artificial intelligence can enhance operational capabilities and create value in governmental procurement processes. In the construction industry, [Matos et al. \(2024\)](#) demonstrate how digital innovations such as building information modeling (BIM) can optimize procurement procedures when integrated into legal frameworks. [Liljeroos-Cork and Laitinen \(2024\)](#) emphasize the importance of boundary spanners in facilitating knowledge transfer across ecosystem boundaries to create value in infrastructure procurement. Furthermore, [Kodym \(2024\)](#) proposes a value-centered approach to procurement that enables innovative and socially responsible practices. These studies collectively suggest that public procurement can serve as a driver for innovation when strategic considerations are embedded in procurement practices and when boundaries between stakeholders are effectively managed. However, as [Fridner \(2025\)](#) notes, becoming an attractive customer to strategic suppliers remains a challenge for public organizations, highlighting the need for a deeper understanding of how demand characteristics influence supplier innovation behaviors.

The theoretical foundations of public procurement as an innovation policy instrument have been significantly developed through several seminal contributions that inform this study. [Edler and Georghiou \(2007\)](#) proposed a conceptual framework distinguishing between general and strategic procurement, demonstrating that public demand – accounting for 16.3% of EU GDP – can function as a major driver of innovation in sectors such as construction, health care and transportation. Building on this foundation, [Edquist and Zabala-Iturriagagoitia \(2012\)](#) advanced the field by conceptualizing public procurement for innovation (PPI) as a mission-oriented policy instrument designed to address grand societal challenges, and proposed a three-dimensional taxonomy based on user characteristics, procurement processes and cooperative arrangements. From the supplier perspective, [Uyarra et al. \(2014\)](#) identified critical barriers to innovation through public procurement, such as limited interaction with procuring entities, excessive specification in tenders and insufficient risk management, with these challenges being particularly acute for R&D-intensive organizations and smaller firms. [Grimbert, Zabala-Iturriagagoitia and Valovirta \(2024\)](#) further extended the theoretical discourse by conceptualizing transformative PPI, identifying 45 capabilities that contracting authorities must possess to implement PPI effectively as a transformative policy instrument. These capabilities are categorized into ordinary, dynamic and functional types.

Recent empirical investigations provide robust evidence on PPI effectiveness. [Czarnitzki et al. \(2020\)](#) demonstrated that securing innovative procurement contracts significantly

improves innovation performance among German firms, while [Krieger and Zipperer \(2022\)](#) showed that green public procurement specifically enhances environmental innovation, particularly for small firms. These contributions provide the theoretical basis for this study, which investigates the relationship between demand scale and the emergence of innovative firms in the Japanese construction industry. This study extends the existing literature by offering novel insights into how the structure of procurement demand – especially the balance between total budget and opportunity frequency – influences innovation dynamics through a move-to-front theoretical framework. [Uyarra et al. \(2020\)](#) further synthesize the theoretical foundations by examining how public procurement functions as an industrial policy instrument, demonstrating that procurement's innovation-inducing capacity depends critically on the alignment between procurement design, market characteristics and innovation objectives.

2.4 Synthesizing economics and management perspectives

From the literature review, we identify six key factors related to innovation, which can be classified as demand side or supply side. Demand-side factors include demand size, appropriability and certainty, all of which increase innovation returns. Supply-side factors include technological opportunity, aggressiveness and cost advantage, which make innovation easier, more frequent or less expensive to achieve.

Importantly, the relationship between these factors and innovation is not necessarily linear. For example, the relationship between competition and innovation is often inverted U-shaped ([Aghion et al., 2005](#); [Correa, 2012](#)), suggesting complex interactions among innovation determinants. Our study aims to empirically investigate these relationships, focusing particularly on demand scale's effect on innovative firm emergence.

Recent comprehensive surveys of the PPI literature highlight that, although prior studies demonstrate positive effects of procurement demand shocks on firm-level innovation, substantial gaps persist in understanding the dynamics of buyer–innovator relationships and the mechanisms through which procurement generates innovative outcomes ([Chiappinelli et al., 2025](#)). In particular, the literature calls for further empirical investigation into how demand characteristics – such as the balance between total budget scale and opportunity frequency – influence the emergence of innovation, and how procurement design features affect both the type and durability of the resulting innovations. The move-to-front model proposed in this study addresses these critical gaps by offering a novel theoretical framework for understanding how demand-side factors enable firms to gain competitive advantages in procurement markets. Additionally, our empirical analysis of Japanese construction procurement provides new insights into how procurement portfolios can be optimally structured to foster the emergence of innovative firms. These findings contribute to the growing body of evidence indicating that PPI fosters innovation, particularly through incremental rather than radical innovations. Furthermore, this study extends the literature by demonstrating how specific demand scale characteristics can be strategically configured to enhance innovation outcomes.

3. Empirical hypotheses

Our empirical strategy examines both necessary and sufficient conditions for innovation emergence. We first test the correlation between innovation and the six factors identified from literature. We then examine which elements are associated with innovative firms across regional markets and over time.

Prediction 1: Innovation is positively correlated with demand scale. Other factors such as technological opportunity and appropriability also have significant relationships with innovation.

While these factors interact in complex ways, with some being interrelated and others representing trade-offs, our focus remains on demand scale's role in innovation. We use panel data with fixed effects to isolate the impact of individual factors.

Prediction 2: Increasing public procurement can give rise to innovative firms.

To examine this prediction, we analyze time-separated subsets of mutually exclusive regions, testing the relationship between demand scale and innovative firm creation over time. The institutional structure of Japanese public procurement provides a quasi-experimental setting for this analysis.

3.1 Addressing potential endogeneity

While this study examines the relationship between the scale of demand and the emergence of innovation, it recognizes important limitations in establishing a definitive causal direction. Although government spending decisions are largely driven by factors external to the innovation status of individual firms, the relationship between procurement demand and innovation outcomes should be interpreted with caution. Our analysis identifies patterns of association rather than providing evidence that procurement demand directly influences innovation outcomes. The institutional separation between government procurement decisions and firm-level innovation activities offers a plausible basis for examining this relationship; however, we refrain from making strong causal claims due to the methodological limitations discussed below.

Our fixed-effects panel model addresses potential omitted variable bias by controlling for time-invariant unobserved heterogeneity across regions and years. While some time-varying unobserved factors might remain, the consistency of our results across different specifications suggests that our findings regarding demand scale's positive relationship with innovative firm emergence are robust.

The institutional separation between government procurement decisions and firm-level innovation activities further strengthens our causal interpretation, creating a setting where procurement budget changes represent exogenous shocks to demand scale faced by construction firms.

Our analysis period (2006–2020) coincides with a period of demographic stability across Japan's regional development bureau jurisdictions. During this timeframe, all eight regional bureaus experienced population stagnation or modest decline, with annual population changes typically ranging between -0.5% and $+0.2\%$. This demographic stability mitigates concerns about differential regional population dynamics driving both procurement allocation and innovation outcomes. Similarly, while regional economic conditions do vary, the institutional structure of Japan's public procurement system – where major infrastructure spending decisions are predominantly driven by national-level policies such as disaster recovery programs (post-2011 earthquake reconstruction) and stimulus measures rather than local economic performance – provides additional confidence in treating procurement scale as largely exogenous to regional innovation capacity. Nevertheless, we acknowledge that some time-varying regional factors cannot be fully controlled, including variations in local construction industry concentration, changes in regional university research capacity and differential implementation of prefectural innovation support programs. These limitations necessitate cautious interpretation of our results as strong associational patterns rather than definitive causal relationships.

While we treat changes in public procurement demand as exogenous, it is conceivable that innovative firms might influence demand allocation indirectly through political lobbying, regional embeddedness or long-term strategic relationships with public agencies. Although Japan's public procurement budgets are largely driven by centralized policies such as disaster recovery plans and macroeconomic stimulus programs, local discretion and historical contractor relationships could introduce endogeneity risks. To mitigate such concerns, we use a fixed-effects panel model that accounts for time-invariant regional characteristics and year-specific shocks. However, future studies could further reinforce causal identification using quasi-experimental designs such as difference-in-differences or instrumental variable approaches to address potential bidirectional causality.

4. Overview and data on public procurement

The public procurement data in this study comes from construction works ordered by Japan's Regional Development Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (MLITT) from 2006 to 2020. Japan's public procurement system operates primarily through competitive bidding with first-price sealed bids, where contracts are typically awarded to the lowest bidder within a secret planned price ceiling. The MLITT also uses a comprehensive evaluation method for some projects, where factors beyond price – such as experience, construction schedule and design – are considered (Arai and Morimoto, 2017, 2019).

Firms are classified into Ranks A through D based on project size eligibility (from ¥720m and above for Rank A to below ¥60m for Rank D). Almost all projects (99.94% of the 131,905 reviewed) were awarded through general competitive bidding rather than negotiation contracts or designated bidding. While bid rigging is strictly regulated with penalties including surcharges and nomination suspensions, our study does not specifically address this issue.

Figure 1 shows construction volume trends, which increased after 2011 due to reconstruction following the Great East Japan Earthquake and recovery in private investment. Regional composition shifted from metropolitan dominance pre-2010 to increased activity in Tohoku (for disaster recovery) and Kanto (for Tokyo Olympics facilities) in later years.

4.1 Innovative company definition

In construction, especially public procurement, we measure innovation through market success rather than patents alone. While technologies and patents are important, true innovation manifests as significant economic success. We therefore define innovative companies as those consistently increasing their share of successful bids over time. This approach aligns with other innovation studies (Reichstein, Salter and Gann, 2005; Lim and Ofori, 2007) and is similar to the UK Innovation Survey's methodology that identifies the top 20% of firms deriving sales from new products.

Specifically, we classify a company as innovative if its total annual bid amount exceeds 120% of the previous year's total for three consecutive years (calculated using the Paasche formula). This is analogous to identifying firms that consistently increase their market share over multiple years; if a firm secures 20% more business annually for three consecutive years, it indicates the presence of a systematic competitive advantage. This approach captures the cumulative impact of various innovation types – whether process innovations (new construction methods), product innovations (new materials) or organizational innovations – that ultimately manifest as market success. This broader conceptualization aligns with Article 2(22) of EU Directive 2014/24/EU, which defines innovation as “the

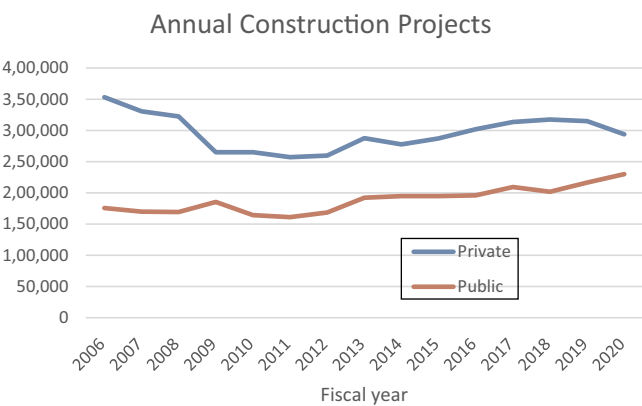


Figure 1. Annual construction volumes
Source: Author's own creation

implementation of a new or significantly improved product, service or process,” encompassing the various types of incremental improvements that characterize construction industry innovation. Many construction innovations are incremental and not formally patented, yet they significantly contribute to competitive advantage and performance.

This definition avoids simultaneity problems in regression analysis since the decision to participate in tenders and the characteristics of those tenders precede the innovative firm designation, which is determined afterward by aggregating bid outcomes.

Although we define innovative firms based on their sustained increases in total successful bid amounts, it is necessary to acknowledge that such a definition may capture not only technological or organizational innovation, but also improvements in pricing strategy, marketing or bidding tactics. These elements may contribute to increased market share without reflecting fundamental innovation in products or processes. Nevertheless, given the nature of the construction industry – where patents are rare and many innovations are incremental and non-codified – market performance serves as a practical proxy for capturing innovation outcomes. Moreover, this approach aligns with international practices such as the UK Innovation Survey, which uses output-based criteria to identify innovative firms. Future research could enhance this measurement by incorporating additional indicators such as technological specifications in evaluation criteria or qualitative data from comprehensive evaluations.

A central methodological limitation of this study arises from the use of a single procurement data set to construct both the innovation indicator and the demand-related variables. Specifically, firm innovativeness – defined as achieving a growth rate of 120% or more in total successful bids over three consecutive years – and demand scale indicators – such as expected prices and total procurement values – are both constructed from procurement outcomes. This introduces the possibility of a mechanical correlation that cannot be fully ruled out: higher procurement demand naturally raises the likelihood of procurement success, and when innovation is defined in terms of such success, the resulting empirical association may be partially tautological.

This limitation has important implications for the interpretation of results: the observed relationships may reflect competitive dynamics within procurement environments rather

than substantive causal effects of procurement on innovation. Ideally, innovation should be assessed using independent, output-based indicators – such as innovative turnover or new product introductions, as used in the UK Innovation Survey – that are not contingent upon procurement performance. The findings should be understood as patterns of innovation expression within procurement systems, rather than as evidence that procurement policies exert a direct causal influence on innovation. Although we adopt this market performance-based approach in light of the characteristics of innovation in the construction industry – where patents are uncommon and incremental improvements are prevalent – we recognize that this measurement strategy limits the strength of any causal inferences that may be drawn from the findings.

4.2 Data description

Our data set covers eight regional development bureaus (Tohoku, Kanto, Hokuriku, Chubu, Kinki, Chugoku, Shikoku and Kyushu) and includes information on each bureau, office, tender date, contract date, project name, construction type, bidding method, evaluation criteria, company names, estimated prices and bid results. Table 1 presents the descriptive statistics.

The Kanto region shows the highest number of cases (approximately twice that of Shikoku). Over time, procurement volume generally decreased, with FY2006 showing the highest count and FY2018 the lowest. No outliers exceeding twice the standard deviation were observed in these trends.

4.2.1 Dependent variables. Innovative firm dummy (firm-level analysis): Binary indicator equal to 1 if a firm achieves $\geq 120\%$ growth in total successful bid amounts for three consecutive years.

Count of innovative firms (panel analysis): Number of newly emergent innovative firms in each region-year combination.

4.2.2 Key independent variables. Demand scale variables:

Demand1 (total procurement value): Sum of all contract amounts in each region-year, measured in Japanese yen (millions) and log-transformed. Range: ¥15.2bn to ¥284.7bn across region-years.

Demand2 (average procurement size): Total procurement value divided by number of contracts. Range: ¥18.3m to ¥156.8m per contract.

Expected bid price (firm level): Government's pre-tender budget estimates, averaged across all tenders in which a firm participated.

4.2.3 Control variables (previously listed as “other factors”). Construction and contract characteristics:

Construction type dummies: Civil engineering (45% of contracts), building construction (31%), equipment installation (12%), maintenance (8%), other (4%).

Contract rank dummies: Rank A ($\geq$ ¥720m, 8% of contracts), Rank B (¥240m–720m, 15%), Rank C (¥60m–240m, 35%), Rank D ($<$ ¥60m, 42%).

– Bidding method dummies: General competitive bidding (99.94%), comprehensive evaluation method (0.06%).

Geographic and temporal controls:

Regional bureau dummies: Kanto (largest, 18% of contracts), Tohoku (15%), Kinki (14%), Chubu (13%), Kyushu (12%), Chugoku (11%), Hokuriku (9%), Shikoku (8%).

Year fixed effects: 2006–2020 (15 annual dummies)

Regional economic controls:

Regional GDP growth rates (annual, source: Cabinet Office)

Public investment trends by region (source: Ministry of Finance)

Table 1. Descriptive statistics

Region											
FY		Kanto	Kinki	Kyushu	Shikoku	Chugoku	Chubu	Tohoku	Hokuriku	Total	
Panel A: number of procurements by region per year											
2006		1,948	1,423	2,100	635	1,185	1,221	1,604	1,097	11,213	
2007		1,754	1,176	1,857	688	1,190	1,283	1,611	1,016	10,575	
2008		1,859	1,322	1,764	648	1,307	1,307	1,483	938	10,358	
2009		1,675	1,159	1,858	630	1,075	1,431	1,590	1,043	10,461	
2010		1,336	1,023	1,438	558	944	1,125	1,306	822	8,552	
2011		1,471	1,089	1,370	550	913	1,240	1,440	849	8,922	
2012		1,316	1,105	1,481	533	878	1,257	1,344	752	8,666	
2013		1,553	1,365	1,651	661	980	1,476	1,486	1,086	10,258	
2014		1,242	1,049	1,125	515	1,029	1,110	1,126	764	7,960	
2015		1,100	802	1,124	463	737	992	966	638	6,822	
2016		1,175	919	1,463	545	761	1,106	1,256	764	7,989	
2017		1,063	835	1,136	525	741	988	1,088	682	7,058	
2018		945	852	1,105	492	861	1,016	1,007	648	6,926	
2019		1,223	967	1,279	563	768	1,194	1,150	882	8,026	
2020		1,248	993	1,455	576	717	1,188	1,113	829	8,119	
Total		20,908	16,079	22,206	8,582	13,816	17,934	19,570	12,810	131,905	
Panel B: status of individual variables											
Innovative	Demand	TechOpportunity1		TechOpportunity2		Appropriability1		Appropriability2		CostAdvantage	
Number	Yen	Number	Number	Number	Number	Number	Percentage	Percentage	Number	Percentage	Ratio
Mean	0.020	4.1E+09	1.257	1.764	11,250	0.060	0.982	0.964	40,292	0.057	0.289
Median	0	1.9E+08	1,000	1,000	10,474	0.036	0.964	4,000	4,000	0.000	0.193
Maximum	1	9.1E+11	8,000	11,000	140,000	6,870	4,000	3802,000	1,000	1,000	10.326
Minimum	0	149	1,000	1,000	1,000	-1,000	0.099	1,000	0.000	0.000	0.000
Std. Dev.	0.139	2.9E+10	0.981	1.225	6,763	0.118	0.142	135,657	0.203	0.337	0.337
Observations	20913	17907	20913	20913	20913	17567	17907	20913	20913	20913	20821
Source(s): Author's own creation											

Construction industry employment levels by region (source: Ministry of Internal Affairs and Communications)

4.2.4 Sample size and exclusions. The inclusion of these control variables reduces our sample from approximately 8,500 unique firms to 7,200 firms (15% reduction) due to:

Missing data in regional economic indicators (3% reduction)

Firms lacking three consecutive years of bidding data required for innovation classification (8% reduction)

Exclusion of extreme outliers (contracts > 2 standard deviations from mean, 4% reduction)

The final data set contains 112,450 firm-year observations for the cross-sectional analysis and 120 region-year combinations (8 regions × 15 years) for the panel analysis.

5. Model and results

5.1 Theoretical model of firm innovation and winning bids

We propose a model where innovation occurs through a Poisson process, affecting firms' competitive ranking in procurement bidding. In simplified terms, this implies that innovation events occur randomly and unpredictably at the firm level, similar to how breakthrough ideas or process improvements emerge irregularly, depending on organizational capabilities and effort. Based on "move-to-front rules" (Tsetlin, 1963), we posit that innovation enables a company to bid at the lowest price and win contracts. The Japanese first-price sealed bidding system provides an ideal setting for testing this model, as firms that innovate can "jump to the front" by offering more competitive bids. Although our move-to-front model assumes a bidding environment where innovation enhances the probability of winning contracts – primarily through price competitiveness – it is important to recognize that non-price factors such as technical scores, experience and project management are increasingly influential under Japan's comprehensive evaluation methods. While our data set indicates that over 99% of the contracts analyzed were awarded via general competitive bidding based on price, the evolving institutional context suggests that future models should accommodate multi-attribute evaluation systems. Extending the move-to-front framework to include multidimensional rankings or composite scoring criteria could provide a more accurate representation of how innovation translates into bid success under contemporary procurement practices.

In Japan's public procurement system, contracts are mainly awarded through general competitive bidding under the Accounting Law, which stipulates that the lowest qualified bidder is typically awarded the contract based on the lowest-price principle. Although the comprehensive evaluation method has been introduced in recent years, price continues to be the primary determinant of contract awards, as evidenced by our data indicating that 99.94% of contracts were awarded through general competitive bidding rather than negotiated procedures. The move-to-front model developed in this study builds upon the innovation framework proposed by Reichstein *et al.* (2005), who defined innovation in the construction sector as including not only formal patents but also process, organizational and market-oriented improvements that enhance competitiveness. In this context, innovation refers to any improvement – technological, organizational or process-oriented – that allows firms to submit more competitive bids while maintaining profitability. This inclusive view is particularly relevant to the construction industry, where formal patents are uncommon, yet incremental improvements in project management, construction methods, cost efficiency and organizational processes can provide measurable competitive benefits. The move-to-front mechanism operates on the premise that innovative firms can use these improvements to submit lower bids without reducing profit margins, thereby advancing in the competitive

ranking. Although [Krieger et al. \(2024\)](#) raise concerns that price-based procurement may impede innovation, our model indicates that within Japan's transparent institutional setting, genuine innovation leads to cost reductions that allow firms to submit competitive bids while maintaining profitability, creating a virtuous cycle in which innovation contributes to market success. This relationship is supported by Japan's institutional environment, where the transparency and standardization of the bidding process ensure that sustained success in securing contracts reflects inherent competitive strengths rather than relational advantages.

In our model, innovation encompasses not only technological advances but also process improvements, market innovations and organizational changes that provide competitive advantages. When innovation occurs, the firm jumps to first place in the ranking, while previously higher-ranked firms drop one position.

Formally, let i index companies, t represent time and $X_i(t)$ be company i 's ranking at time t among N total firms. The probability of jumping to the top differs by company but remains constant over time. The time t_i when firm i first jumps to the top follows an exponential distribution $P[t_i > t] = \exp(-wt)$, where w is the firm-specific innovation rate.

The rank of company i at time t is expressed by:

$$X_i(t) = x_i + \sum_{k=1}^N \int_0^t 1_{X_k(s-0) > X_i(s-0)} \nu_k(ds) + \int_0^t (1 - X_i(s-0)) \nu_i(ds) \quad (1)$$

This model is particularly well-suited for analyzing innovation in Japanese public procurement because:

1. The first-price sealed-bid method inherently selects the most qualified bidder at discrete points in time.
2. The lowest-bidder-wins system creates a direct correlation between innovation capability and bid success.
3. While innovation accumulates gradually, competitive bidding creates distinct moments where innovations are tested against competitors.

Through this process, firms that innovate consistently win more bids over time, increasing their market share. We therefore identify innovative firms by their sustained growth in total winning bid amounts rather than just win frequency.

The move-to-front model conceptualizes business competition as a dynamic ranking system, in which firms are positioned according to their competitive strength in securing government contracts. When a firm introduces an innovation – encompassing not only technological breakthroughs but also improvements in sales strategies, organizational efficiency, cost management and general business practices – it is immediately repositioned at the top of the ranking, while all previously higher-ranked firms are shifted downward by one position. [Equation \(1\)](#) models the temporal evolution of Firm i 's ranking through three components: its initial position, the number of downward shifts resulting from other firms' innovations and the upward repositioning it undergoes upon introducing its own innovation. This model effectively reflects the dynamics of the construction industry, in which comprehensive business improvements – such as enhanced project management, more efficient bidding strategies, stronger client relationships and innovative construction techniques – provide immediate competitive advantages that increase the likelihood of securing contracts and expanding market share through discrete bidding processes.

Furthermore, while the move-to-front model is well suited to first-price sealed-bid systems, such as those widely used in Japanese public procurement, it could be extended to capture multi-attribute evaluation environments. In particular, future research could adapt the model to account for composite scoring mechanisms where price is only one component

among several, such as technical quality, environmental performance or risk management. Such generalizations would enhance the model's applicability to value-based procurement frameworks increasingly adopted in both domestic and international settings.

5.2 Empirical approach

Our empirical strategy has two stages. First, we identify innovative companies as those consistently increasing their winning bid totals over multiple years. Second, we use a logit model to examine which factors predict innovative firm status:

$$\text{logit}(p_i) = \alpha + \beta X_i + \varepsilon$$

where p_i is the probability that firm i is innovative, and X_i is a vector of variables related to innovation determinants. The logit model identifies firm-level characteristics that are associated with a higher likelihood of innovation, analogous to distinguishing the attributes of more successful firms from those of less successful ones. The full model specification is:

$$\begin{aligned} \text{logit } P_i = & \alpha_1 + \beta_{1,1} \text{Demand}_i + \beta_{2,1} \text{TechOppotunity1}_i + \beta_{3,1} \text{TechOppotunity2}_i \\ & + \beta_{4,1} \text{Appropriability1}_i + \beta_{4,1} \text{Appropriability2}_i + \beta_{5,1} \text{CostAdvantage}_i \\ & + \beta_{6,1} \text{Agressiveness1}_i + \beta_{5,1} \text{Agressiveness2}_i + \beta_{6,1} \text{Certainty1}_i \\ & + \beta_{6,1} \text{Certainty2}_i + \sum \beta_{j,1} \text{Otherfactor}_{j,i} + \varepsilon_i, \end{aligned} \quad (2)$$

where:

- Demand = Average expected price of bids in which the company participated.
- TechOppotunity1 = Number of regional development bureaus where the firm participates (network breadth).
- TechOppotunity2 = Number of construction types the firm undertakes (scope breadth).
- Appropriability1 = Average number of participants in bids (competition intensity).
- Appropriability2 = Average bid rate in participated projects (price competition).
- CostAdvantage = Firm's average bid rate across all participated tenders.
- Aggressiveness = Number of bids the firm participates in.
- Certainty1 = Ratio of successful bids to total participation.
- Certainty2 = Range of bid prices in tenders (indicating clarity of specifications).

We estimate this model using both logit and OLS methods to examine how these factors relate to innovative firm status.

6. Estimation results

Table 2 presents our estimation results using both logit and OLS methods. The relationship between demand scale (measured by expected price) and innovative firm status is positive and strongly significant across all specifications, with and without covariates. This supports our primary hypothesis that demand scale is associated with increased innovation. These findings can be interpreted through the lens of the move-to-front model: larger procurement budgets create substantial incentive structures that justify the high upfront costs of innovation, while frequent procurement opportunities offer repeated occasions for innovative firms to advance in competitive rankings and demonstrate their advantages. The pronounced effect of demand scale is consistent with Schmookler's (1962) seminal finding that downstream demand fluctuations drive innovation in capital goods industries, and it

Table 2. Estimation results

Method	Dependent variable: InnovativeFirmDummy					
	OLS Coefficient (std error)	OLS Coefficient (std error)	OLS Coefficient (std error)	Binary logit Coefficient (std error)	Binary logit Coefficient (std error)	Binary logit Coefficient (std error)
Demand	7.05E-12*** (1.89.E-12)	2.92E-11*** (3.38.E-12)	1.70E-11*** (3.42.E-12)	6.36E-11*** (1.84.E-11)	2.44E-10*** (3.19.E-11)	1.40E-10*** (3.47.E-11)
TechOpportunity1	-0.001** (0.0005)	0.003*** (0.0008)	0.008*** (0.0008)	-0.008 (0.0073)	0.054*** (0.0094)	0.104*** (0.0107)
TechOpportunity2	0.005*** (0.0008)	0.002* (0.0011)	-0.002*** (0.0012)	0.075*** (0.0104)	0.040*** (0.0144)	-0.008 (0.0156)
Appropriability1	0.000 (0.0002)	0.000 (0.0003)	-0.001*** (0.0003)	0.003 (0.0029)	0.002 (0.0042)	-0.013*** (0.0044)
Appropriability2	-0.015 (0.0132)	0.031 (0.0204)	0.008 (0.0207)	-0.180 (0.1848)	0.407 (0.2583)	0.086 (0.2698)
CostAdvantage	-0.210*** (0.0238)	-0.494*** (0.0465)	-0.476*** (0.0486)	-3.088*** (0.3290)	-6.614*** (0.6048)	-6.686*** (0.6523)
Aggressiveness	0.000*** (0.0000)	0.000*** (0.0000)	0.000*** (0.0000)	-0.006*** (0.0004)	-0.007*** (0.0005)	-0.006*** (0.0006)
Certainty1	-0.048*** (0.0043)	-0.044*** (0.0084)	-0.006 (0.0087)	-0.735*** (0.0616)	-0.690*** (0.1123)	-0.163 (0.1184)
Certainty2	-0.024*** (0.0047)	-0.005 (0.0079)	0.028 (0.0082)	-0.446*** (0.0768)	-0.117 (0.1042)	0.296*** (0.0948)
Constant	0.314*** (0.0226)	0.643*** (0.0472)	0.662*** (0.0495)	0.960*** (0.3043)	4.868*** (0.5974)	5.369*** (0.6451)
Other Factors	No	Yes	Yes	No	Yes	Yes
Other Dummies	No	No	Yes	No	No	Yes
Observations	98,960	44,014	44,014	98,960	44,014	44,014
R-squared	0.005	0.014	0.031	¥0.010	¥0.023	¥0.056
Adjusted R-squared	0.005	0.014	0.030			
				¥: McFadden R ²		

Note(s): The symbols ***, ** and * indicate significance at the 1, 5 and 10% levels, respectively
Source(s): Author's own creation

further extends [Edler and Georghiou's \(2007\)](#) theoretical proposition that sufficient procurement scale is a prerequisite for stimulating innovation.

For technological opportunity indicators, both regional network expansion and construction-type diversity show positive and significant relationships with innovation. This suggests that exposure to diverse practices and techniques significantly facilitates innovation capabilities in construction firms.

Appropriability results diverge somewhat from expectations. The positive relationship between competition intensity and innovation suggests that demanding competitive environments may stimulate rather than discourage innovation, possibly because large-scale demand attracts more competitors.

Regarding managerial factors, aggressiveness (bidding frequency) shows a negative relationship with innovation, suggesting that strategic selectivity in bidding may be more important than volume. Certainty shows mixed results: lower win probabilities are associated with innovative firms, possibly because innovative firms tackle more challenging, competitive projects.

In summary, demand scale's relationship with innovative firm emergence is strongly significant across all specifications, confirming Prediction 1. The other factors show more complex patterns, but generally support our theoretical framework. The inconclusive effects of technological opportunity indicators warrant more detailed investigation. Although regional network expansion is positively associated with innovation, its weaker effect relative to demand scale suggests that access to diverse practices alone may be insufficient in the absence of adequate market incentives. This finding aligns with [Cohen and Levin's \(1989\)](#) observation that demand-side factors frequently outweigh supply-side technological opportunities in shaping innovation outcomes, particularly in traditional industries such as construction, where incremental innovations prevail over radical breakthroughs.

6.1 Panel fixed-effects analysis

To further test the relationship between demand scale and innovative firms, we use panel data analysis, dividing our data into 120 separate market segments (15 fiscal years $\times$ 8 regional bureaus). This approach uses a within-region over-time comparison, allowing us to examine the relationship between demand variation and innovation patterns while controlling for time-invariant regional characteristics while controlling for time-invariant regional characteristics such as local business culture and geographic advantages. We estimate:

$$\log(\text{SumInnovativeFirmDummy}_{i,j}) = \beta_1 \log(\text{Demand1}_{i,j}) + \beta_2 \log(\text{Demand2}_{i,j}) + \sum_{i \in \text{region}} \sum_{j \in \text{financialyear}} \beta_{i,j} X_{i,j} + \alpha + \varepsilon_{i,j}, \quad (3)$$

where *SumInnovativeFirmDummy* represents the number of innovative firms in region *i* and year *j*, Demand1 is the total procurement value, and Demand2 is the average procurement size. We include regional and year fixed effects to control for unobserved heterogeneity.

[Table 3](#) shows that Demand1 (total value) is significantly positive while Demand2 (average size) is significantly negative. This suggests that increasing the total procurement budget while simultaneously increasing the number of procurement opportunities is most effective for stimulating innovation. The elasticity of innovation with respect to total budget exceeds one, indicating that budget increases have proportionally larger effects on innovation than increases in procurement opportunities alone. This finding indicates that a 10% increase in total government spending is associated with a more than proportional

Table 3. Panel analysis

Dependent variable: SumInnovativeFirmDummy		
Method: panel least squares		
	Coefficient (std error)	Coefficient (std error)
Demand1	1.176*** (0.1757)	1.261*** (0.1920)
Demand2	−1.135*** (0.1948)	−1.240*** (0.2207)
Tech1		0.168 (0.1373)
Tech2		0.402** (0.1610)
Appr1		0.051 (0.0367)
Appr2		2.758** (2.6765)
Cost		−2.925 (7.2485)
Aggr		−0.007 (0.0066)
Cert1		−0.892* (1.0427)
Cert2		−0.374 (0.9957)
Constant	−4.489** (2.1337)	−5.598 (7.6866)
Cross-section fixed (dummy variables)	Yes	Yes
Period fixed (dummy variables)	Yes	Yes
Observations	120	120
R-squared	0.927	0.938
Adjusted R-squared	0.910	0.916

Note(s): The symbols ***, ** and * indicate significance at the 1, 5 and 10% levels, respectively

Source(s): Author’s own creation

increase in the number of innovative firms, suggesting the presence of a multiplier effect whereby larger budgets amplify innovation beyond initial expectations. The results from our panel analysis provide robust empirical support for theoretical predictions derived from both economics and management literature. Importantly, these findings offer quantitative validation of [Uyarra et al.’s \(2014\)](#) supplier-side insights concerning the critical role of procurement opportunity frequency in fostering innovation emergence.

These findings are robust to inclusion of covariates controlling for technological opportunities, appropriability, cost advantage, aggressiveness and certainty. The institutional context of Japanese public procurement, where decisions are largely exogenous to firm innovation status, provides support for the robustness of these associational patterns, though causal interpretation remains limited by the methodological constraints discussed earlier.

6.2 Robustness check

We verify our results’ robustness in two ways. First, we test alternative thresholds for defining innovative firms, changing our criterion from 20% to 10% and 25% annual growth over three consecutive years. [Table 4](#) shows that the results remain consistent across these definitions, with all coefficients maintaining the same signs and similar magnitudes. This confirms that our findings are not artifacts of an arbitrary threshold choice.

Second, we examine potential multicollinearity among explanatory variables. [Table 5](#) shows that most correlation coefficients are below 0.4, with only one reaching 0.683, well below conventional thresholds for problematic multicollinearity (typically 0.8).

Our proxy variable selection is theoretically and empirically justified. Regional development bureaus and construction type diversity effectively capture technological opportunities in public procurement, as they represent situations where firms encounter diverse practices and techniques in competitive environments. While our appropriability measures are indirect, they reasonably approximate competitive intensity, which directly

Table 4. Different ways to cut data

Dependent variable: Method:	Paarsche10 Binary logit Coefficient (std error)	Paarshe25 Binary logit Coefficient (std error)
Demand	1.82E-10*** (2.88.E-11)	1.73E-10*** (3.94.E-11)
TechOpportunity1	0.047*** 0.008	0.116*** 0.014
TechOpportunity2	0.035*** 0.011	0.012 0.020
Appropriatability1	0.009*** 0.003	-0.005 0.005
Appropriatability2	-0.073 0.207	-0.274 0.354
CostAdvantage	-6.663*** 0.498	-7.446*** 0.842
Agressiveness	-0.003*** 0.000	-0.008*** 0.001
Certainty1	-0.182** 0.088	-0.625*** 0.164
Certainty2	0.077 0.080	0.406*** 0.116
Constant	4.872*** 0.496	5.408*** 0.835
OtherFactors	Yes	Yes
OtherDummies	Yes	Yes
Observations	44,014	44,014
McFadden R^2	0.033	0.074

Note(s): The symbols ***, ** and * indicate significance at the 1, 5 and 10% levels, respectively

Source(s): Author's own creation

affects innovation returns in construction where traditional intellectual property protection is challenging.

Although these robustness checks enhance confidence in our main findings, several limitations persist. These include time-varying firm-level characteristics – such as size, financial capacity and management quality – that may jointly influence innovation outcomes and bidding performance, as well as unobserved region-specific factors – such as local economic conditions, infrastructure policies and industry agglomerations – that may confound the observed relationship between procurement demand and the emergence of innovative firms.

6.3 Limitations and future research directions

While this study provides robust evidence of the relationship between demand scale and innovative firm emergence, several limitations should be acknowledged. Our fixed-effects panel model controls for time-invariant regional characteristics but cannot account for all time-varying firm-level factors such as size, financial capacity and management quality that may jointly influence innovation outcomes and bidding performance. Additionally, unobserved region-specific factors such as local economic conditions, infrastructure policies and industry agglomerations may confound the observed relationship between procurement demand and innovative firm emergence.

Table 5. Correlation coefficients

Method	Demand	TechOpportunity1	TechOpportunity2	Appropriability1	Appropriability2	CostAdvantage	Aggressiveness	Certainty1	Certainty2
Demand	1								
TechOpportunity1	0.213	1.000							
TechOpportunity2	0.049	0.304	1.000						
Appropriability1	0.145	0.090	0.068	1.000					
Appropriability2	-0.105	-0.090	-0.076	-0.115	1.000				
CostAdvantage	-0.121	-0.159	-0.054	-0.134	0.291	1.000			
Aggressiveness	0.083	0.709	0.448	0.122	-0.096	-0.135	1.000		
Certainty1	-0.050	-0.209	-0.334	-0.225	0.119	0.074	-0.336	1.000	
Certainty2	-0.050	-0.015	-0.087	0.098	0.337	-0.063	-0.066	0.120	1.000
Source(s): Author's own creation									

Future research could strengthen causal identification through instrumental variable approaches, exploiting exogenous variations in government spending driven by political cycles or natural disasters. Incorporating firm-level panel data would allow for better control of heterogeneity across companies and provide more nuanced insights into the mechanisms through which demand scale influences innovation decisions.

7. Conclusion

This study makes several contributions to understanding innovation in the construction industry. Using Japanese public procurement data (2006–2020), we demonstrate that demand scale has a significant positive effect on innovative firm emergence, with both the total volume and number of procurement opportunities playing crucial roles.

Our move-to-front model provides a novel theoretical framework for understanding how innovation translates into market success in competitive bidding environments. Our empirical findings establish demand scale as a fundamental determinant of innovation in construction, extending beyond traditional Schumpeterian hypotheses. The empirical findings offer robust validation of the core predictions of the move-to-front model concerning innovation dynamics in competitive environments. The consistent positive association between demand scale and the emergence of innovative firms indicates that sufficiently large and frequent procurement incentives enhance firms' motivation to innovate and advance in the competitive ranking. This mechanism functions as predicted by the model: innovation events follow a Poisson process, with their frequency increasing when market rewards justify the associated investment risks. Specifically, our panel analysis shows that increasing both the total procurement budget and the number of opportunities generates more innovative firms than simply increasing average project size.

A key methodological limitation of this study is that both the innovation indicator and demand variables are constructed from the same procurement data set. Firm innovativeness – defined as a 120% or greater increase in total successful bids over three consecutive years – and demand indicators such as expected prices and total procurement values are all derived from procurement outcomes. This raises the possibility of mechanical correlation: higher procurement demand naturally increases success rates, and when innovation is defined in terms of such success, the empirical relationship may be partly tautological. As a result, the observed associations may reflect competitive dynamics within procurement processes rather than causal effects of procurement on innovation. Ideally, innovation should be assessed using independent, output-based indicators – such as innovative turnover or new product introductions, as used in the UK Innovation Survey – that are not contingent on procurement outcomes. Our findings should thus be understood as patterns of innovation expression within procurement systems, not as evidence that procurement policies exert direct causal influence. Although we adopt this market performance-based approach due to the characteristics of innovation in the construction industry – where patents are uncommon and incremental improvements prevail – we recognize that this measurement strategy limits the strength of causal claims that can be made.

The social and policy relevance of this study must be understood in light of its methodological limitations. While our findings suggest associations between procurement characteristics and innovation patterns, they indicate possible directions rather than definitive solutions to productivity challenges in the construction sector. While public procurement may support a broader innovation ecosystem, our analysis does not demonstrate that its design alone can generate innovation. The move-to-front model illustrates how competitive advantages may arise under certain procurement conditions; however, this should not be taken as evidence that procurement reforms will consistently produce innovation across diverse contexts. Policymakers should recognize that the effectiveness of

procurement-based innovation strategies depends on various contextual factors, including regional economic conditions, institutional capacity and complementary support mechanisms beyond procurement policy itself.

While this study provides robust evidence of the relationship between demand scale and innovative firm emergence, several limitations should be acknowledged. Our definition of innovative firms, while grounded in market performance, may not capture all dimensions of innovation. Our data is limited to the Japanese public construction procurement context, which may limit generalizability. While our fixed-effects model addresses many endogeneity concerns, we cannot completely rule out all potential confounding variables or reverse causality issues.

Building on our findings, future research could explore comparative studies across different countries and procurement systems to test external validity and identify institutional factors that moderate the relationship between demand scale and innovation. Longitudinal case studies of specific innovative firms could provide deeper insights into the mechanisms through which procurement opportunities translate into innovative capabilities. Additionally, exploring how different innovation types (process, product, organizational) respond to demand changes and examining the interaction between demand-side procurement policies and supply-side innovation support measures would contribute to a more comprehensive understanding of construction innovation ecosystems.

Future research could strengthen causal identification through several methodologically rigorous approaches. Instrumental variable strategies could exploit exogenous variations in government spending driven by political cycles or natural disasters that affect procurement allocation independently of firm innovation capacity. Difference-in-differences designs could use policy changes such as comprehensive evaluation methods implemented at different times across regions. Independent innovation measures represent a critical advancement, incorporating indicators such as patent applications or R&D expenditure that do not depend on procurement success. Firm-level panel data would enable better control of time-varying firm characteristics, while cross-national comparative studies could examine whether procurement-innovation associations reflect universal mechanisms or Japan-specific factors. These approaches would collectively move beyond the associational relationships identified in our study toward more robust causal inference regarding procurement's role in fostering innovation.

Moreover, the implications of this study are not limited to the Japanese context. Similar procurement innovation strategies have been pursued under the EU Public Procurement Directive 2014/24/EU, which emphasizes life-cycle cost, social value and environmental sustainability in awarding contracts. The EU Public Procurement Directive 2014/24/EU introduced the transformative Innovation Partnership Procedure (Article 31), which enables contracting authorities to identify unmet needs for innovative products, services or works beyond the scope of existing market solutions, thereby repositioning public procurement from a passive purchasing function to an active instrument for fostering innovation. This institutional framework offers a relevant comparative perspective for understanding how formal procurement procedures can systematically promote innovation, thereby complementing our findings regarding the role of demand scale characteristics in fostering the emergence of innovative firms in Japan's construction sector. [Cerqueira Gomes \(2021\)](#) presents a comprehensive analysis of the Innovation Partnership Procedure established under Directive 2014/24/EU, examining its core institutional features and assessing the extent to which the EU can expand innovation-oriented procurement across member states, while addressing harmonization challenges posed by divergent national administrative law traditions. Likewise, countries such as South Korea and the UK have institutionalized public procurement as a driver of innovation through dedicated programs and strategic procurement offices. Comparative studies across these jurisdictions would provide valuable insights into

how institutional design shapes the innovation-inducing capacity of public demand. Our findings are consistent with the European Commission's Guidance on Innovation Procurement [revised in 2021([European Commission, 2021](#))], which underscores that effective innovation procurement necessitates both sufficient scale and frequent opportunities to engage innovators in public procurement processes. This framework offers a robust theoretical basis for understanding how demand-side characteristics systematically shape innovation outcomes across diverse institutional contexts.

Ethics statement

This study used publicly available procurement data from the Ministry of Land, Infrastructure, Transport and Tourism (MLITT) of Japan. No personal data was collected or analyzed, and the study did not involve human participants beyond the use of anonymized bid information. All data was handled in accordance with relevant regulations and ethical guidelines for research using public administrative data.

Data availability

The data that support the findings of this study are available from Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLITT). Restrictions apply to the availability of some data, which were used under license for the current study, and so are not publicly available. Data that are not subject to these restrictions are available from the authors upon reasonable request.

References

- Aghion, P., Bloom, N., Blundell, R., Griffith, R. and Howitt, P. (2005), "Competition and innovation: an inverted-U relationship", *Quarterly Journal of Economics*, Vol. 120 No. 2, pp. 701-728, doi: [10.1162/0033555053970214](#).
- Andersson, P.E., Arbin, K. and Rosenqvist, C. (2025), "Assessing the value of artificial intelligence (AI) in governmental public procurement", *Journal of Public Procurement*, Vol. 25 No. 1, pp. 267-500, doi: [10.1108/JOPP-05-2024-0057](#).
- Arai, K. and Morimoto, E. (2017), "Construction industry and competition policy in Japan", *International Journal of the Economics of Business*, Vol. 24 No. 3, pp. 345-363, doi: [10.1080/13571516.2017.1339187](#).
- Arai, K. and Morimoto, E. (2019), "The construction industry and (dis)economies of scope: empirical research in the Hokkaido procurement auction", *Journal of Industry, Competition and Trade*, Vol. 19 No. 2, pp. 281-292, doi: [10.1007/s10842-018-0285-5](#).
- Bloom, N., Van Reenan, J. and Williams, H. (2019), "A toolkit of policies to promote innovation", *Journal of Economic Perspectives*, Vol. 33 No. 3, pp. 163-184, doi: [10.1257/jep.33.3.163](#).
- Cerqueira Gomes, P. (2021), *EU Public Procurement and Innovation: The Innovation Partnership Procedure and Harmonization Challenges*, Edward Elgar Publishing, Cheltenham.
- Chiappinelli, O., Giuffrida, L.M. and Spagnolo, G. (2025), "Public procurement as an innovation policy: where do we stand?", *International Journal of Industrial Organization*, Vol. 100, p. 103157, doi: [10.1016/j.ijindorg.2025.103157](#).
- Christensen, C.M. (1997), *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business School Press, Boston, MA.
- Cohen, W.M., and Levin, R.C. (1989), "Empirical studies of innovation and market structure", in Schmalensee, R. and Willig, R. (Eds), *Handbook of Industrial Organization*, North Holland, Amsterdam, Vol. 2, pp. 1059-1107.

- Correa, J.A. (2012), "Innovation and competition: an unstable relationship", *Journal of Applied Econometrics*, Vol. 27 No. 1, pp. 160-166, doi: [10.1002/jae.1262](https://doi.org/10.1002/jae.1262).
- Cozzi, G. and Impullitti, G. (2010), "Government spending composition, technical change and wage inequality", *Journal of the European Economic Association*, Vol. 8 No. 6, pp. 1325-1358, doi: [10.1111/j.1542-4774.2010.tb00557.x](https://doi.org/10.1111/j.1542-4774.2010.tb00557.x).
- Czarnitzki, D., Hottenrott, H. and Thorwarth, S. (2020), "Innovation subsidies and firm performance: evidence from a general equilibrium model", *Economic Policy*, Vol. 35 No. 103, pp. 425-482.
- Edler, J. and Georghiou, L. (2007), "Public procurement and innovation—resurrecting the demand side", *Research Policy*, Vol. 36 No. 7, pp. 949-963.
- Edquist, C. and Zabala-Iturriagoitia, J.M. (2012), "Public procurement for innovation as mission-oriented innovation policy", *Research Policy*, Vol. 41 No. 10, pp. 1757-1769.
- European Commission (2021), (18 June 2021), "*Commission Notice: Guidance on Innovation Procurement (Updated)*", Brussels.
- Fridner, D. (2025), "Becoming an attractive public customer to strategic suppliers", *Journal of Public Procurement*, Vol. 25 No. 2, doi: [10.1108/JOPP-05-2024-0058](https://doi.org/10.1108/JOPP-05-2024-0058).
- Grimbert, S.F., Zabala-Iturriagoitia, J.M. and Valovirta, V. (2024), "Transformative public procurement for innovation: ordinary, dynamic and functional capabilities", *Public Management Review*, pp. 1-24, doi: [10.1080/14719037.2024.2326079](https://doi.org/10.1080/14719037.2024.2326079).
- Kodym, J. (2024), "Buying what matters: towards a value model allowing to implement policy preference in public procurement", *Journal of Public Procurement*, Vol. 24 No. 4, pp. 168-231, doi: [10.1108/JOPP-07-2023-0046](https://doi.org/10.1108/JOPP-07-2023-0046).
- Krieger, B. and Zipperer, V. (2022), "Does green public procurement trigger environmental innovations?", *Research Policy*, Vol. 51 No. 6, p. 104516, doi: [10.1016/j.respol.2022.104516](https://doi.org/10.1016/j.respol.2022.104516).
- Krieger, B., Prüfer, M., and Strecke, L. (2024), "Public procurement can hinder innovation", *ZEW Discussion Paper No. 24-009*, ZEW, Leibniz Centre for European Economic Research, Mannheim.
- Liljeroos-Cork, J.M. and Laitinen, K. (2024), "Boundary spanners as a key to value creation in infrastructure procurement", *Journal of Public Procurement*, Vol. 24 No. 4, pp. 747-835, doi: [10.1108/JOPP-07-2023-0046](https://doi.org/10.1108/JOPP-07-2023-0046).
- Lim, J.N. and Ofori, G. (2007), "Classification of innovation for strategic decision making in construction businesses", *Construction Management and Economics*, Vol. 25 No. 9, pp. 963-978, doi: [10.1080/01446190701317693](https://doi.org/10.1080/01446190701317693).
- Matos, B.C., Cruz, C.O. and Branco, F.A. (2024), "Building information modeling in construction projects: the case of the Portuguese code of public contracts", *Journal of Public Procurement*, Vol. 25 No. 1, pp. 296-406, doi: [10.1108/JOPP-02-2024-0022](https://doi.org/10.1108/JOPP-02-2024-0022).
- Moore, G.A. (1991), *Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers*, Harper Business, New York, NY.
- Organisation for Economic Co-operation and Development (OECD) (2018), "Oslo manual 2018: Guidelines for collecting, reporting and using data on innovation", 4th Edition, OECD, Paris, available at: www.oecd.org/science/oslo-manual-2018-9789264304604-en.htm (accessed 31 January 2022).
- Reichstein, T., Salter, A.J. and Gann, D.M. (2005), "Last among equals: a comparison of innovation in construction, services and manufacturing in the UK", *Construction Management and Economics*, Vol. 23 No. 6, pp. 631-644, doi: [10.1080/01446190500126940](https://doi.org/10.1080/01446190500126940).
- Rogers, E.M. (1962), *Diffusion of Innovations*, Free Press, New York, NY.
- Schmookler, J. (1962), "Economic sources of inventive activity", *The Journal of Economic History*, Vol. 22 No. 1, pp. 1-10, doi: [10.1017/S0022050700102311](https://doi.org/10.1017/S0022050700102311).
- Schumpeter, J.A. (1942), *Capitalism, Socialism and Democracy*, Impact Books, Floyd, VA.

- Slavtchev, V. and Wiederhold, S. (2016), "Does the technological content of government demand matter for private R&D? Evidence from US states", *American Economic Journal: Macroeconomics*, Vol. 8 No. 2, pp. 45-84, doi: [10.1257/mac.20130189](https://doi.org/10.1257/mac.20130189).
- Tsetlin, M.L. (1963), "Finite automata and models of simple forms of behaviour", Russian mathematical surveys, Vol. 18 No. 4, pp. 1-27, doi: [10.1070/RM1963v018n04ABEH001139](https://doi.org/10.1070/RM1963v018n04ABEH001139).
- Utterback, J.M. and Abernathy, W.J. (1975), "A dynamic model of process and product innovation", *Omega*, Vol. 3 No. 6, pp. 639-656, doi: [10.1016/0305-0483\(75\)90068-7](https://doi.org/10.1016/0305-0483(75)90068-7).
- Uyarra, E., Edler, J., Garcia-Estevez, J., Georghiou, L. and Yeow, J. (2014), "Barriers to innovation through public procurement: a supplier perspective", *Technovation*, Vol. 34 No. 10, pp. 631-645.
- Uyarra, E., Flanagan, K., Magro, E. and Zabala-Iturriagagoitia, J.M. (2020), "Public procurement, innovation and industrial policy: rationales, roles, capabilities and implementation", *Research Policy*, Vol. 49 No. 1, p. 103844.

Further reading

- Arai, K. (2021), "Geographic market size and low bid competitiveness in construction companies", *Competitiveness Review: An International Business Journal*, Vol. 32 No. 1, pp. 85-102, doi: [10.1108/CR-10-2020-0124](https://doi.org/10.1108/CR-10-2020-0124).
- Arai, K. and Morimoto, E. (2021), "Productivity and innovation in the Japanese construction industry", *Construction Innovation*, Vol. 21 No. 4, pp. 636-653, doi: [10.1108/CI-11-2020-0171](https://doi.org/10.1108/CI-11-2020-0171).
- Arslan, S.H. and Sohail, M. (2021), "How does ambidextrous leadership promote innovation in project-based construction companies? Through mediating role of knowledge-sharing and moderating role of innovativeness", *European Journal of Innovation Management*, Vol. 24 No. 5, pp. 1762-1788, doi: [10.1108/EJIM-02-2021-0083](https://doi.org/10.1108/EJIM-02-2021-0083).
- Blundell, R., Griffith, R. and Van Reenen, J. (1995), "Dynamic count data models of technological innovation", *The Economic Journal*, Vol. 105 No. 429, pp. 333-344, doi: [10.2307/2235494](https://doi.org/10.2307/2235494).
- Department for Business, Innovation and Skills (2014), "UK innovation survey: highly innovative firms and growth", available at: www.gov.uk/government/uploads/system/uploads/attachment_data/file/289234/bis-14-643-uk-innovation-survey-highly-innovative-firms-and-growth.pdf (accessed 31 January 2022).
- Edquist, C. and Hommen, L. (2000), "Let the state play a bigger role in innovation", *Technology Review*, No. 6, pp. 17-21.
- European Parliament and Council (2014), "Directive 2014/24/EU of the European parliament and of the council of 26 February 2014 on public procurement and repealing directive 2004/18/EC", *Official Journal of the European Union*, Vol. L, Vol. 94, pp. 65-242.
- Hall, B.H., and Rosenberg, N. (2010), *Handbook of the Economics of Innovation*, Vol. 1 and 2, Elsevier, Amsterdam.
- Hariya, Y., Hattori, K., Hattori, T., Nagahata, Y., Takeshima, Y. and Kobayashi, T. (2011), "Stochastic ranking process with time dependent intensities", *Tohoku Mathematical Journal*, Vol. 63 No. 1, pp. 77-111, doi: [10.2748/tmj/1303219937](https://doi.org/10.2748/tmj/1303219937).
- Kissi, E., Aigbavboa, C. and Kuoribo, E. (2022), "Emerging technologies in the construction industry: challenges and strategies in Ghana", *Construction Innovation*, Vol. 23 No. 2, pp. 815-834, doi: [10.1108/CI-11-2021-0215](https://doi.org/10.1108/CI-11-2021-0215).

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