Impact of Corporate Credit Scoring on Construction Contractors in China

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Abstract: In an attempt to enhance the trustworthiness of contractors and reduce corruption, the Chinese government has launched a construction contractor credit scoring (CCCS) scheme in Beijing to evaluate the compliance and integrity of contractors registered in the construction market. The contribution of this paper to the body of knowledge is to analyze how the incorporation of CCCS may affect general contractors' present and future competitiveness through a case study in China. This paper analyzes the procurement of 158 building projects tendered in Beijing involving 2,071 local general contractors active in the market. The results show that (1) the contractors' CCCS scores are important for being awarded large and mega project contracts; (2) CCCS scores have a generally positive effect on future corporate financial income; and (3) contrary to expectations, the policy does not increase the CCCS of companies. Finally, the changing trend in contractors' CCCS scores is observed to be highly correlated with their initial values (the scores of higher CCCS scoring companies increase faster on average than that of other companies). The final remarks address ways to better implement CCCS schemes in the future and avoid the potential risks involved in their use. **DOI: 10.1061/(ASCE)CO.1943-7862.0001631.**

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Introduction

Governments worldwide consume many resources, goods, and services, and governmental expenditures account for a large portion of gross domestic product (GDP). Being ethical and transparent as well as pursuing principles such as efficiency, competition, value for money (VFM), and industrial development are keys to successful public procurement (Raymond 2008). However, corruption and collusion are serious problems in many developing countries given poverty and weak law enforcement (Nwabuzor 2005).

To help improve the situation in Beijing, a construction contractor credit scoring (CCCS) scheme that evaluates the credibility and compliance of construction contractors was first launched by the local government in 2013. However, even though the Beijing CCCS scheme has been gradually adopted by other provincial governments in China, its impact on contractor selection and project procurement has not yet been tested empirically. As is common practice in China today, phased policy initiation and closely evaluated pilot schemes are to be conducted before large-scale implementation to reduce risks and improve further implementations (Swanson and Bhadwal 2009). Therefore, comparing the policy goals with the results actually achieved is particularly important (Nakamura 1987).

Toward this end, this article aims to gauge the impact of CCCS on project procurement and construction contractors during the initial implementation stages. The development of construction project procurement in China is first reviewed, and the recently incorporated CCCS project procurement policy is introduced. With the aim to disclose the impact of applying CCCS scores in construction project procurement, the process of developing and applying this new public policy is then reviewed. The research questions to be answered are then posed: How do the CCCS scores affect contract competition? What is the relationship between the new policy and changes in corporate income? How do CCCS scores change over time? Discussions are further developed to help policy implementation on a larger scale and to benefit potential applications in other countries.

Literature Review

Public Procurement Policy

The procurement stage of public projects is most commonly affected by unethical and illicit practices. This situation has led to calls for improved procurement practices in both developed and developing countries (Tow and Loosemore 2009). As an antidote to these problems, alternative ranking and scoring rules, including the average bid method (Ioannou and Leu 1993) and below-average

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bid method (Ioannou and Awwad 2010), have been increasingly applied in some countries [see Ballesteros-Pérez et al. (2015b) for a recent and comprehensive taxonomy].

In addition to price, other issues that are frequently advocated include schedule, safety, and management ability, which should be assessed in contractor selection as and prequalification (e.g., Hatush and Skitmore 1998). Likewise, appropriate corporate credit measures reflected in corporate compliance and previous performance on projects and contract implementation are said to be critical (Drew and Skitmore 1992; Shen and Song 1998; Shen et al. 2004), which is why multiattribute tender evaluations have gained in popularity in recent years (Ye et al. 2012).

That public procurement should be concerned with issues affecting disadvantaged groups is also important. For example, Walker and Preuss (2008) examined opportunities for enhancing sustainability in supply chains by sourcing from small and medium-sized enterprises (SMEs) in health care and local governments. This examination is important because "SMEs are more innovative and come up with new products, but are often taken over by big suppliers who end up deciding what you should have" (Walker and Preuss 2008, p. 20).

In the United Kingdom, for example, the government's sustainable development strategy requires local governments to embed sustainable development considerations into decisions on government spending and foster some changes in public procurement in local governments (Preuss 2009). Therefore, the priorities of public procurement should be developed based on needs given the political, economic, social, technological, environmental, and legal background (e.g., Bekkers et al. 2011). Integrity and accountability for the use of public money need to be emphasized, as does the expectation of high levels of credibility among participating companies and governmental officials. The policy examined in this study is an attempt to incorporate such credibility into public procurement policies.

Situation in China

Since joining the World Trade Organization in 2001, the broad expectation has been that China will assume much more responsibility in the international market and maintain improved ethical norms in both Chinese society and with business collaborators worldwide (Tam 2002). In pursuance of these expectations, many administrative authorities have issued policies and regulations to assure the compliance of companies. For example, China's 2005 Company Law (Lin 2010) legislates that companies should respect laws, social morality, and trade honesty, as well as assume an exemplary level of social responsibility. Subsequently, in 2008, the State Council issued the *Guidelines on Corporate Social Responsibility Fulfilment for State-Owned Enterprises in China*, requiring all state-owned enterprises to actively guarantee social responsibility in terms of awareness, implementation, business credits, prudent use of resources, and environmental protection.

Within this context, Chinese construction contractors are becoming increasingly aware of the importance of corporate social responsibility and the nexus between corporate social performance and financial performance (Xiong et al. 2016). However, China's construction industry has been plagued by scandals and tragedies for a long time. These events have been mostly caused by low trade credit and poor quality construction work (Shaw 1997).

As with many developing nations, the construction industry consumes a large amount of resources and energy, generally involving poor working conditions, frequent conflicts, and significantly negative impacts on the environment (Fenn et al. 1997; Lu and Tam 2013; Shen and Tam 2002). More than 40 million immigrant construction workers exist in China, many of whom are not paid on time (CSB 2013); this situation, along with China's other structural problems and below-standard worker safety, have contributed to a large number of casualties in the construction industry (Liu et al. 2011). The prevalence of corruption and collusive bidding are two other well-known problems (Xiao 2014).

Competitive bidding has been used in China since the early 1980s (Lai et al. 2004). Along with China's economic transition to a market economy, the procurement of construction projects has changed from a negotiated awarding procedure in which only state-owned contractors were entitled to participate to an open competitive tendering scheme (Shen and Song 1998). As defined in the public procurement regulations by the Chinese Ministry of Finance (MOF 2004) and construction tender regulations issued by the National Development and Reform Commission (NDRC 2003), the procedures for construction project procurement generally comprise tender notice (invitation), submission, opening, evaluation, and selection.

Construction contractors are divided into three main grades: general contractors, specialist contractors, and labor contractors (MOC 2015). For general contractors, an additional grade of "Excellence" is available, in addition to Grade 1, Grade 2, and Grade 3. Such grading reflects corporate capital, size, and previous performance record (Shen et al. 2004) and is only required for tender notification and prequalification.

Competition intensity in the national construction project market is very high (Ye et al. 2008). Multicriteria tender assessment methods are available in contractor selection, with bid evaluations used to measure whether bidders' proposals meet client expectations. According to a survey by Shen and Song (1998), construction quality, schedule, and costs are the three most important factors when selecting the company to win the auction. Additional factors including market conditions, payment arrangements, number of competitors, and third-party stakeholders have also been identified (Ye et al. 2012). Therefore, many tender evaluation criteria have proliferated over the years, with both quantitative and multicriteria approaches being applied (Lai et al. 2004; Shen et al. 2004).

However, the main awarding criterion—the lowest price offered—is still widely used in China, as it is in many construction industries throughout the world (Ballesteros-Pérez et al. 2015a, 2016). As is well known, this economic awarding criterion does not guarantee that the final cost is necessarily the lowest (Wong et al. 2001). Given the highly competitive profile of China's construction market (e.g., Cheah and Chew 2005), contractor selection using the lowest price often attracts unrealistically low bids. Bidders face the temptation of relinquishing the prospect of making a reasonable profit by legitimate means to be awarded a contract. Once awarded, they seek to obtain a profit through subsequent changes and claims. Therefore, such a situation often causes future problems for both the owner and the contractor when claims arise over scope, costs, quality, and schedule disagreements (e.g., Ioannou and Leu 1993; Ye et al. 2008).

Construction Contractor Credit Scoring

Credit scoring is the process of assigning a quantitative value to represent creditworthiness and has become a popular theme in recent research and practice (Arya et al. 2013). The scores are based on a statistical analysis of a person's credit report and ability to repay potential loans (Arya et al. 2013). A variety of credit scoring models have been developed, with the most common in financial markets being the individual credit score developed by the Fair Isaac Corporation (FICO) (Mayer et al. 2009). The FICO score has been used by many commercial banks to make loan decisions and to determine whether the borrower can be given a "prime rate"

for having a satisfactory credit score. When house prices declined in the United States in 2008, for instance, mortgage defaults rose sharply and were particularly concentrated among "subprime" borrowers with low FICO scores (Mayer et al. 2009).

Credit scoring of construction contractors provides an important means of helping to avoid poor credit-related problems, such as shoddy projects, chains of defaults, and corruption. For example, the Delphi interview studies by Hatush and Skitmore (1997) found that credit status and reputation, as well as technical ability and management capability, were critical to successful contractor selection in prequalification and bidding. Similar to general credit scores at the individual and corporate levels, contractor credit in the construction industry measures the willingness and likelihood of successfully completing a construction project (Liu and Zhu 2006). However, only a few studies on contractor credit scores exist, with Liu and Zhu (2006), for example, proposing an approximate set method to assess contractors' credit, and Tserng et al. (2010) using three option-based credit models to predict construction contractor defaults.

Beijing, the capital of China, with 21.5 million residents and 2,071 registered construction contractors, generates significant demand for construction work. In recognition of the problems associated with lowest bid tendering, Beijing Municipal Commission Housing and Urban-Rural Development (BMCHURD) and Beijing Municipal Commission of Development and Reform (BMCDR) issued their pilot policy, *Quantitative Tender Assessments for Beijing Construction Projects*, effective since the start of 2013. The change brought about by this policy was the launch of the CCCS scheme for contractors registered in Beijing and its use in subsequent tender assessments to enhance the credibility and reputation of construction contractors and to reflect the strong determination of the central government to improve the overall credit rating of the construction industry.

Of particular relevance is an amendment incorporating CCCS scores into the construction project procurement process in Beijing, which clearly envisions that "a company's market performance today will determine its market access and market share tomorrow." The policy involves CCCS scores rated by the government authority and used in tenderer selection and as an essential part of the current tendering evaluation system combining economic bid (EB) and technical bid (TB) scores. The intensely competitive nature of Beijing's construction industry indicates that construction contractors naturally expect to seek a competitive advantage by improving their CCCS scores.

Similarly to the FICO formula, the calculation of CCCS scores involves a complex process with assessments of organizational-level information including contract information, technical progress, professional awards, and corporate social responsibility. Project-level information also exists, encompassing such items as general management, safety management, construction site management, quality management, contract management, HR management, and materials management, as well as another 352 penalty items covering these aspects.

The launch of a new policy in China usually comprises problem identification, policy initiation, implementation, and evaluation. Typical of the Chinese government's approach, the large-scale implementation of new policies necessarily involves evaluated pilot studies and the phased initiation of a policy to help avoid risks and inform future policies (Swanson and Bhadwal 2009). Timely evaluation of the impact of pilot studies is important to alert wrong decisions, guide future policy revisions and improvements, provide alternative approaches, and gain extra support for decision makers (Weiss 1988).

However, although the CCCS project procurement policy had the reasonable expectation that companies would perform better as a result, its actual effect on contractors—the main players in the construction market—have yet to be evaluated empirically. As commented in 2000 by Economics Nobel Laureate James Heckman, micro data including individual data and individual decision models are needed to test micro policies and provide a more credible description (Heckman 2001). Therefore, this article is aimed at providing an understanding of the effects of CCCS procurement by using quantitative analysis methods on empirical evidence from real projects and companies in Beijing.

Research Methods

Data

Detailed information on 158 high-rise residential construction projects tendered in Beijing during 2013 and the bidders' evaluation scores were collected from the Beijing Engineering Construction Trading Information Centre (BECTIC). These projects comprise 85.9% of all open bid housing projects in Beijing during 2013. To investigate the effects of CCCS procurement at the organizational level, the 2,071 registered general construction contractors in Beijing are analyzed, with a special focus on the 175 with CCCS scores among the top 10%. These 175 companies have total revenues amounting to 70% of the total construction expenditures in Beijing from 2011 to 2013. Key descriptions of the sample projects and sample companies are summarized in Table 1.

Analyses

A twofold method of analysis is applied to both the project and the organizational levels. Because CCCS policies aim to align a company's market performance with its market access and market share, the main focus of the analyses is to estimate the extent to which a company's CCCS score affects its market access and prospects of winning contract auctions (Research question 1), increases its company income (Research question 2), and changes its CCCS scores over time (Research question 3). To investigate these effects, quantitative analysis techniques including basic descriptive statistics, principal component regression, and latent variable growth modeling are applied. These techniques are described in terms of competitive measurements in project bidding and evaluating the impact at the organizational level.

Competitiveness Measurement in Bidding

The economic bid (EB) score is determined by comparing bid prices. Normally, the bid closest to the average bid receives the highest score. Technical bid (TB) scores are provided by five (or seven, if the project is large) industry experts according to an itemized questionnaire. The overall score of bidder i for project j, Q_{ij}, is calculated by multiplying the EB, TB, and CCCS scores of bidder i, that is, S_{ij}^{EB}, S_{ij}^{TB}, and S_{ij}^{CCCS} respectively, by the respective weights (W_j^{EB}, W_j^{TB}, and W_j^{CCCS}) stated in the tender documents, such as

$$Q_{ij} = W_j^{EB} \cdot S_{ij}^{EB} + W_j^{TB} \cdot S_{ij}^{TB} + W_j^{CCCS} \cdot S_{ij}^{CCCS} \quad (1)$$

where the CCCS weights have four levels: 5%, 10%, 15%, and 20%, which normally depend on the project's size (small, medium, large, and mega) (BMCHURD and BMCDR 2012) as specified in Table 1. Therefore, first, a one-way ANOVA is performed to test whether the CCCS scores differ between the groups formed by all bidders, the shortlisted bidders, and the winners.

Table 1. Data summary of the sample projects and companies

Sample	Group	Size (10^6 CNY)	Frequency	Percentage	Mean value	Standard deviation
158 projects	Small	Less than 30	2	1.3	19.24	1.79
	Medium	30–100	56	35.4	60.94	19.26
	Large	100–300	72	45.6	169.91	55.61
	Mega	Greater than 300	28	17.7	442.28	180.4
		Total	158	100	177.65	157.54
175 contractors	Grades	Excellent	63	36	—	—
		Grade 1	105	60	—	—
		Grade 2	7	4	—	—
	Average income 2011–13	Less than 100	8	4.57	74.61	31.11
		100–1,000	124	70.86	469.02	240.75
		Greater than 1,000	43	24.57	2,394.85	1,641.69
		Total	175	100	924.19	1,186.12

Note: 1 USD = 6.69 CNY on 17 July 2018.

Second, we measure the contribution of the CCCS scores to determine the winners. For this purpose, the variable CCCS competitiveness (noted as C^{CCCS}) measures the effect of *CCCS* scores between the winner and both second best and last ranked bidder, respectively, as

$$C_j^{CCCS-1} = S_{j-bestQ}^{CCCS} - S_{j-2^{nd}\,bestQ}^{CCCS} \quad (2)$$

$$C_j^{CCCS-2} = S_{j-bestQ}^{CCCS} - S_{j-lastQ}^{CCCS} \quad (3)$$

Similar statistics, including C_j^{EB-1}, C_j^{EB-2}, C_j^{TB-1}, and C_j^{TB-2}, are calculated to measure the competitiveness for EB and TB.

Finally, considering the impact of project size, the Kruskal-Wallis test is also applied to determine whether statistics including C_j^{CCCS-1}, C_j^{CCCS-2}, C_j^{EB-1}, C_j^{EB-2}, C_j^{TB-1}, and C_j^{TB-2} differ by project size. The Kruskal-Wallis test is a nonparametric test that compares the medians of two samples. The test is also called the "one-way ANOVA on ranks" that, unlike the latter, does not assume that the residuals follow a normal distribution.

Additionally, Wilcoxon signed rank tests are used to demonstrate whether the null hypothesis (i.e., the medians of the paired differences equal zero) must be accepted or rejected for each project size (small, medium, large, and mega). Again, the Wilcoxon signed-rank nonparametric test is an alternative to the paired Student's t-test when the population cannot be assumed to be normally distributed. All of the results are subsequently presented in the *Analysis and Results* section.

Evaluating Impact at the Organizational Level

Organizational level analyses are needed to link the CCCS scores and corporate income, as well as changes in the CCCS scores over time. The former answers the second research question, that is, whether the current CCCS scores determine the contractor's market access. The latter answers the third research question, that is, to borrow Beijing's contracting authority words, whether "a company's market performance today determines its market access and market share tomorrow."

Correlation analysis is first conducted to test the change in corporate income with the emergence of CCCS scores from 2012 to 2013, that is, just before and after the implementation of the new policy. If, as proposed in the second research question, the CCCS increases corporate income, a positive correlation should result. The regression expression is subsequently presented but contains the following variables: values of construction contracts awarded in Beijing during 2013 (Y), values of construction contracts awarded in Beijing during 2012 (as X_2), and the contractor's CCCS score (X_1).

Additionally, a latent growth (curve) model (LGM)—a longitudinal design of structural equation modeling (SEM)—is used to answer the third research question, that is, examining the changes in CCCS scores over time. SEM is a common quasi-routine data mining approach used in social science studies (Xiong et al. 2015), and LGM in particular is used to measure the changing trend of some variables over time to reveal both intraindividual and interindividual variability (MacCallum and Austin 2000). The advantages of LGM also include the ability (1) to provide conclusions at the aggregate level; (2) to model growth over time in linear or nonlinear trajectories; and (3) to use estimated parameters for subsequent predictions (Walker et al. 1996). The application of LGM, which aims to understand the average change and individual variation in changes, to longitudinal data assumes that each company has a specific intercept and changing slope (Peterson et al. 2011).

Repeated measures of individual contractors' CCCS scores across five periods are used in model development. Various statistics, including Chi-square (χ^2), root mean square error of approximation (RMSEA), comparative fit index (CFI), and the Tucker-Lewis index (TLI) are also used to assess the model's goodness of fit, as subsequently detailed.

Analyses and Results

Competitiveness Measurement in Bidding

The typical Beijing project procurement practice, even in open tendering, is to shortlist no more than seven bidders. This practice is verified in the sample in which this occurred in 145 out of the 158 auctions involved. In addition, 2,071 registered general contractors exist in the Beijing construction market, and 175 have CCCS scores higher than 67.71 (out of 100). As shown in Table 2, companies with higher CCCS scores account for a larger proportion of selected bidders and winners.

With median CCCS scores of 80.91 and 83.55, the shortlisted bidders and winners are clearly higher than the 50.5 of the 2,071 companies as a whole. This situation is confirmed by a Kruskal-Wallis test with $p < 0.001$ ($\chi^2_{df=2} = 1{,}364.51$). Therefore, the null hypothesis is rejected; that is, the medians of all of the groups' (i.e., general contractors, shortlisted bidders, and winners) CCCS scores are not equal. Therefore, the CCCS score has proven its effectiveness in narrowing market access to insufficiently scored construction companies.

Table 2. CCCS scores related to market access and market share at the project level

CCCS scores	2071 companies	782 shortlisted bidders in 158 contracts	Winners of 158 contracts
Range	33.00–96.71	44.50–96.71	46.50–96.71
Mean (95% CI)	54.75 (54.37, 55.15)	78.40 (77.48, 79.28)	80.50 (78.43, 82.47)
SD (95% CI)	9.14 (8.634, 9.655)	12.66 (12.064, 13.20)	13.09 (11.64, 14.31)
Mode	50	50.50	73.17
Median	50.5	80.91	83.55
> 67.71	175 (8.45%)	625 (79.95%)	134 (84.81%)
≤ 67.71	1,896 (91.55%)	157 (20.05%)	24 (15.19%)

Note: 782 shortlisted bidders and 158 winners are calculated by direct count; that is, the same company may have been shortlisted or a winner several times.

Next, the top of Table 3 provides the descriptions of the EB, TB, and CCCS weights for the 158 sample auctions and related competitiveness measurement statistics.

Kruskal-Wallis tests are first applied to determine whether the statistics C_j^{EB-1}, C_j^{EB-2}, C_j^{TB-1}, C_j^{TB-2}, C_j^{CCCS-1}, and C_j^{CCCS-2} differ by project size. Only C_j^{EB-1} (with $p = 0.028$), C_j^{EB-2} (with $p = 0.0012$), and C_j^{CCCS-2} (with $p = 0.039$) are found to barely reject the null hypothesis (for $\alpha = 0.001$, despite still less than 0.05). Therefore, the latter three statistics need to be analyzed by project size (as in Table 3).

Wilcoxon signed rank tests are then used to test C_j^{EB-1}, C_j^{EB-2}, and C_j^{CCCS-2} by different project size groups, as well as the overall C_j^{CCCS-1}, C_j^{TB-1}, and C_j^{TB-2} statistics. With only two cases $N = 2$, the data subset of small projects is not used for the Wilcoxon test.

The results from Table 3 suggest that (1) the median of C_j^{CCCS-1} is not significantly different from zero $p = 0.393$; (2) the median of C_j^{CCCS-2} between the medium-size projects is not significantly different from zero $p = 0.470$, but the medians of C_j^{CCCS-2} between the large and mega projects are significantly larger than zero; and (3) despite differences across project size groups, the medians of C_j^{EB-1}, C_j^{EB-2}, C_j^{TB-1}, and C_j^{TB-2} are significantly larger than zero. This finding indicates that few bidders win a contract solely because of their higher CCCS scores. However, bidders with low CCCS scores are unlikely to win large and mega projects, meeting the expectations of the policy (that CCCS scores are important in tender assessments). In contrast, and as probably expected, EB and TB—being always significant—have a more significant impact on the final contract award.

Evaluating Impact at the Organizational Level

Based on the results of the correlation analyses, a reasonable attempt is to predict the corporate income of company i in 2013 (Y) from the previous records of the company in 2012 (X_2) and its CCCS scores (X_1) using the equation $Y = a + b_1 * X_1 + b_2 * X_2$.

Applying multiple linear regression produces a condition index (CI) > 30 and a variance proportion larger than 0.5, indicating that collinearity is likely to have a distorting effect. To avoid this bias, principal component regression is used to obtain the corrected coefficients [see Liu et al. (2003) for further details], which produces

$$Y = -8{,}988{,}692{,}233.544 + 120{,}325{,}609.947X_1 + 0.539X_2 \quad (4)$$

with $R^2 = 0.65$. This value indicates that good corporate behavior may be tacit knowledge when clients were selecting contractors before the enforcement of the new policy.

Table 3. Descriptive statistics and competitiveness measurement statistics of project weights

Type	N	Minimum	Maximum	Mean	Standard deviation	Significance of Wilcoxon signed rank tests
EB weight	158	0.48	0.90	0.537	0.056	/
TB weight	158	0.00	0.90	0.330	0.053	/
CCCS weight	158	0.05	0.20	0.132	0.029	/
C_j^{EB-1}	158	−1.490	9.000	3.919	2.164	/
Small	2	6.000	6.330	6.167	0.235	—
Medium	56	−1.490	9.000	4.218	2.100	[a]
Large	73	−6.550	5.950	1.114	2.220	[a]
Mega	27	0.000	7.650	3.241	2.086	[a]
C_j^{EB-2}	158	−2.040	20.400	6.559	4.288	/
Small	2	6.000	6.330	6.167	0.235	—
Medium	56	−1.490	9.000	4.218	2.100	[a]
Large	73	−2.040	20.400	5.904	3.919	[a]
Mega	27	0.000	7.650	3.241	2.086	[a]
C_j^{TB-1}	158	−4.330	14.400	4.358	2.400	[a]
C_j^{TB-2}	158	−3.170	14.000	5.455	2.610	[a]
C_j^{CCCS-1}	158	−5.610	4.900	0.115	1.788	0.393
C_j^{CCCS-2}	158	−6.550	8.830	0.925	2.376	/
Small	2	−2.700	−0.390	−1.543	1.630	/
Medium	56	−4.130	5.990	0.138	1.817	0.470
Large	73	−6.550	5.950	1.114	2.220	[a]
Mega	27	−5.190	8.830	2.230	3.113	[a]

Note: "/" indicates that the statistic was not submitted to the Wilcoxon signed rank test. "—" indicates that the statistic was not submitted to the Wilcoxon signed rank test because of insufficient sample size.

[a]Significant at $p < 0.001$.

Table 4. Descriptive statistics and correlations for corporate credit scores during 2013–2015

Variables	Mean	Standard deviation	Skewness	Kurtosis	Correlation 1	2	3	4
1. CCCS13Mid	79.981	7.685	0.353	−0.786				
2. CCCS13End	79.840	8.631	−0.189	0.151	0.919			
3. CCCS14Mid	79.016	9.692	−0.215	−0.591	0.859	0.862		
4. CCCS14End	78.636	9.709	−0.362	−0.67	0.789	0.818	0.882	
5. CCCS15Mid	77.505	10.803	−0.502	−0.361	0.740	0.773	0.828	0.934

Note: $N = 169$, all correlations are significant at $p < 0.001$.

Considering that the overall corporate income increase for contractors with the highest CCCS scores from 2012 to 2013 is approximately the difference between $\sum_{i=1}^{175} Y = \text{CNY } 251.53$ billion and $\sum_{i=1}^{175} X_2 = \text{CNY } 198.91$ billion (i.e., CNY 52.62 billion), the effects of the CCCS scores seem clearly influential. This influence is confirmed by the significant positive correlation of X_1 with the CCCS scores $p < 0.001$. However, the X_2 slope is not significant $p = 0.224$. These results indicate that the CCCS scores are likely to become an independent factor that contributes to corporate income, different from the factors that describe previous corporate incomes.

Finally, repeated measures of individual contractors' CCCS scores are used across five periods: the middle of 2013, the end of 2013, the middle of 2014, the end of 2014, and the middle of 2015. These measures are called *CCCS13Mid*, *CCCS13End*, *CCCS14Mid*, *CCCS14End*, and *CCCS15Mid*, respectively. Table 4 summarizes descriptions of the CCCS scores at these points and the correlations of 169 of the 175 (96.6%) contractors after deleting cases with missing data. Also worth highlighting is that the normality of the data is an important assumption when applying the default maximum likelihood estimation method in LGM. For this purpose, for the sample skewness and excess kurtosis range to be within $[-1, 1]$ is generally sufficient (Xiong et al. 2015). As presented in Table 4, this case is for the five variables.

Next, the LGM as shown in Fig. 1 was developed using AMOS version 21.0 software. The LGM goodness of fit, as previously described, requires the following conditions to be checked (King and McInerney 2014): Chi-square (χ^2 preferably with $p < 0.05$, but at least with $p < 0.10$), the root mean square error of approximation ($RMSEA < 0.08$), the comparative fit index ($CFI > 0.9$), and the Tucker-Lewis index ($TLI > 0.9$). All conditions are met, with $\chi^2_{(df=4)} = 7.868$ ($p = 0.097$), $CFI = 0.997$, $TLI = 0.992$, and $RMSEA = 0.076$, suggesting a sufficient model fit. Given this verification, using the proposed LGM to describe the changes in companies' CCCS scores over time is acceptable. Coefficients of determination (R^2) ranging from 0.740 to 0.934 of the five variables also indicate that a satisfactory amount of variance is explained.

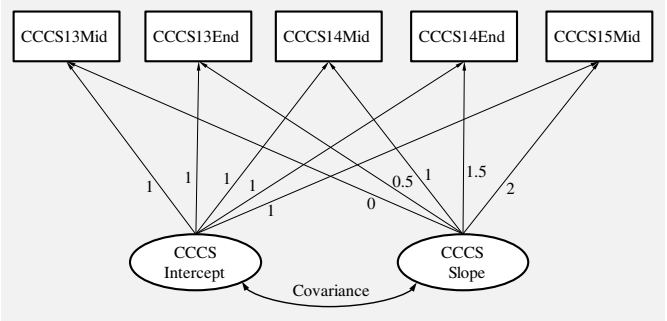

Fig. 1. Latent growth model measuring CCCS score variations over time. Numbers on the arrows are proposed loadings, for example $CCCS2013End = 1 * CCCSintercept + 0.5 * CCCSslope + error$.

Finally, according to the results shown in Table 5, the average initial CCCS score of the companies in the middle of 2013 was 80.124 (46.748 variance), with an average slope of −1.079 (5.987 variance). After conducting a standard transformation, the distribution of the slope values indicates that 32.96% of the companies have a positive slope (increasing CCCS trend), whereas 67.04% of companies have a negative slope (i.e., decreasing CCCS trend) over the five periods. The significant covariance ($p = 0.05 \approx \alpha$) between the intercept and slope indicates that companies with higher intercepts have larger average slopes.

Findings and Discussion

The theoretical and practical implications concerning the impact of Beijing's new policy are discussed in the following subsections.

Are CCCS Scores Important for Winning a Contract?

The *CCCS* scheme was launched by the government to monitor and enhance contractor performance. The practice of incorporating the CCCS scores into the bid evaluation process, as required by Beijing's new procurement policy, is intended to push companies to increase their corporate credit ratings to avoid being disadvantaged against their competitors. As presented in the analysis section, the two aspects linking policy and projects are particularly explored in terms of tender access and bidding competitiveness. For access, companies with higher CCCS scores are most likely to be shortlisted as bidders. This finding is supported by previous studies on prequalification criteria, in which corporate credit and reputation are held to be a major concern (Hatush and Skitmore 1997; Shen and Song 1998; Shen et al. 2004).

The tender assessment of Beijing projects is further evaluated to gauge the impact of CCCS scores on bidder competitiveness, indicating that contractors with the lowest CCCS scores are unlikely to be awarded contracts for large and mega projects, whereas the competition between the winner and the second best candidate is mainly determined by price and technical soundness. Therefore, this new policy should eliminate unreliable candidates and focus the competition among reliable candidates on preparing for

Table 5. LGM parameter estimates

Variables	Estimate (E)	Standard error (SE)	Critical ratio (CR = E/SE)	p-value
CCCS intercept	80.124	0.582	137.613	[a]
CCCS slope	−1.079	0.271	−3.976	[a]
Intercept-slope covariance	7.917	4.035	1.962	0.05

[a]Significant at $p < 0.001$.

projects, indicating that the weights allocated to CCCS scores by BMCHURD and BMCDR (2012) for large and mega projects are appropriate. However, the insignificant competitiveness difference in CCCS scores has also been found in medium-size projects, which could be a consequence of too small weights being allocated to the CCCS scores for this type of project.

In this regard, the manipulation of credit scores is also a major concern in previous research (Mayer et al. 2009), and the appropriate sizing of these weights should avoid this such manipulation. The CCCS for large and mega projects were important but not overemphasized, whereas the CCCS for medium-size projects should probably have to be revised if the CCCS component wants to be minimally emphasized.

What is the Impact of CCCS Scores on Corporate Income?

In addition to the examination of CCCS scores at the project level, an exploration at the organizational level is also conducted. By acknowledging the importance of corporate credit in the contractor selection, the scheme makes quantitatively explicit what was originally a tacit rule: "a company's market performance today will determine its market access and market share tomorrow." Correlation and regression analyses indicate that the newly emerged CCCS scores contributed to changes in corporate income between 2012 and 2013. The large coefficient of the CCCS in Eq. (4) indicates that corporate credit significantly affects corporate income because only bidders with high CCCS scores are being shortlisted and are eventually awarded contracts.

Additionally, knowing whether Beijing's CCCS scheme affects subsequent project performance (delays, quality, safety or cost issues, for instance) would be interesting. The data required to answer this question are not generally published by the Chinese government nor are they easily shared by contractors. However, items describing satisfactory past execution performance are assessed when updating contractors' CCCS scores. Therefore, to remain competitive and being shortlisted for future tenders, a contractor needs to perform consistently according to expectations. This safeguard is another point in favor of the credit scoring policy.

Therefore, although well known for its poor quality and low-trust interorganizational relationships, the construction industry is becoming strongly demanding of trust-based collaboration and higher ethical standards (Wood et al. 2002). The analysis results show that appropriate ethical standards emphasizing corporate credit have been achieved over time, despite the widespread lack of trust and credit in China after its sudden economic transformation. This finding is also consistent with the longitudinal study by Xiong et al. (2016) that found a virtuous nexus between construction enterprises' financial performance and their corporate social responsibility in China. Additionally, this nexus is already rooted in China's ubiquitous Confucius-based culture of "using proper ways to riches and honor" and "seeing profits as well as rightness," as in the *Analects*.

How do CCCS Scores Change over Time?

In many cases, the instruments of public policy are not neutral and unexpected effects but are common in their implementation. A public policy may incentivize some and penalize others (Lascoumes and Le Gales 2007). Therefore, the different effects of the new project procurement policy need to be carefully considered. The policy takes for granted that it can improve corporate credit because, as reported in the mass media, it is instrumental in determining corporate income (Wang and Yu 2012). However, the results of the latent growth model do not support this assumption. This lack of support might be attributed to the short observation period and inconsistency of the selected contractors. In the latter case, contractors with higher initial CCCS scores are found to always enjoy more rapid increases in their CCCS scores, whereas contractors with lower initial CCCS scores may face a slower increase or a more rapid decrease in their CCCS scores.

In the long run, these companies may face a polarized situation. One the one hand, contractors with high corporate credit face the virtuous nexus between corporate social performance and financial performance. Companies with better financial performance can allocate more resources (defined as "slack resources") to socially responsible activities, which ultimately increases financial performance to gain an even stronger competitive advantage (Waddock and Graves 1997; Xiong et al. 2016). On the other hand, companies with lower corporate credit can fall into the "vicious circle" between business and society of Porter and Kramer (2011). Therefore, a major concern is how to inspire companies with lower corporate credit to change and improve their future performance.

Conclusions

Trustworthiness and corruption have long been major causes of concern in the Chinese construction industry, and the Chinese government's CCCS scheme in Beijing is intended to address these problems. The scheme aims to evaluate the compliance and integrity of firms registered as contractors in the construction market. However, whether and how well this scheme is working, and its side effects on local contractors, is unclear.

Through the procurement of 158 building projects in Beijing involving 2,071 local general contractors, this paper analyzes the scheme's effects on contractors' competitiveness after its implementation in 2013. In particular, the findings show that (1) contractors' CCCS scores are important to their selection for bidding and being awarded contracts for large and mega projects; (2) the CCCS scores have a generally positive effect on corporate financial income; and (3) unexpectedly, the policy does not increase the CCCS of companies. The changing trend in CCCS scores is also associated with their initial values because the scores of higher CCCS scoring companies increase more rapidly on average than that of other companies.

The important implications for project management and project procurement are that the incorporation of explicit CCCS scores is useful in selecting more reliable contractors. The implementation of this new policy is expected to help create shared value by maximizing the economic and social benefits for both contractors and the government. However, construction companies need time to recognize the role of the CCCS scores in awarding contracts and take action to seek a competitive advantage by improving their CCCS scores over time. Considering the significant competition in the Chinese construction industry, expecting that many companies with initially low CCCS scores attempt to secure more contracts by increasing their corporate credit is reasonable.

The main limitation of this study is that the empirical evidence covered only 175 large general contractors between 2013 and 2015. Future data collection may require a different approach depending on the questions to be answered. For example, further research is needed to investigate the visibility of contractor credit scores and risks, such as credit score manipulation. The visibility of contractor credit scores could lower the information asymmetry between clients and contractors, improve public supervision, and improve the ethical behavior of contractors in the face of social pressure and competitive forces.

Furthermore, the risks associated with the implementation of this new policy should also not be ignored. For example, the CCCS weight must be appropriate. If the weight is too low, corporate credit does not affect the contract award, as was the case for medium-size projects. In contrast, if the weight is too high, corporate credit may be overemphasized such that a contractor could earn a project by its reputation rather than by sound preparation for the project. Finally, the overemphasis of corporate credit may lead to the manipulation of credit scoring. For the implementation phase, contractors must have sufficient time and resources to make changes to improve their performance, and further research is needed to ensure that these changes are fully considered. The outcomes of this study also have particular implications for many other developing countries struggling with corruption and pursuing higher standards in public procurement and in providing a head start to contractors whose ethical behavior and past performance have been satisfactory.

Data Availability Statement

Data generated or analyzed during the study are available from the corresponding author by request. Information about the *Journal*'s data-sharing policy can be found here: http://ascelibrary.org/doi/10.1061/(ASCE)CO.1943-7862.0001263.

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