Results Through Transparency: Does Publicity Lead to Better Procurement?

Charles Kenny and Ben Crisman

Abstract

Governments buy about $9 trillion worth of goods and services a year, and their procurement policies are increasingly subject to international standards and institutional regulation including the WTO Plurilateral Agreement on Government Procurement, Open Government Partnership commitments and International Financial Institution procurement rules. These standards focus on transparency and open competition as key tools to improve outcomes. While there is some evidence on the impact of competition on prices in government procurement, there is less on the impact of specific procurement rules including transparency on competition or procurement outcomes. Using a database of World Bank financed contracts, we explore the impact of a relatively minor procurement rule governing advertising on competition using regression discontinuity design and matching methods. The rule does appear to have a small, positive impact on bidding levels, suggesting the potential for more significant and strongly enforced transparency initiatives to have a sizeable effect on procurement outcomes..

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Charles Kenny
Center for Global Development

Ben Crisman
Center for Global Development

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Center for Global Development
2055 L Street NW
Washington, DC 20036

202.416.4000
(f) 202.416.4050

www.cgdev.org

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Introduction

Current estimates place the size of government contracting at $9,000,000,000,000 per year globally (Kenny and Karver, 2012). This procurement is governed by rules on tender preparation, advertising, bidding procedures and selection methods that vary between countries, institutions, and tender types. The stated aim of most rules is to ensure value for money delivering a high quality product at the lowest price. An intermediate aim for many tenders is to maximize competition as a tool to deliver that result. The presence of numerous bidders is at least one indication of active competition for contracts. It may reflect a strong and clear set of bid documents, a clear and simple bid process, the perception of a level playing field for bidders, and a client with the capacity and incentives to treat winning contractors fairly.[1]

Procurement rules are frequently designed to maximize competition through creating a (perceived) level playing field, standardizing processes and advertising bid opportunities. A number of transparency initiatives including the Open Contracting Partnership seek to foster the level playing field and awareness in the procurement process through publication and data release.[2] While we will see there is some nascent evidence that these approaches work, the empirical case for the impact of transparency on procurement is still partial at best. This paper seeks to add to the evidence base, using World Bank financed contracts as the subject of analysis.

The World Bank finances approximately 20 billion USD in government contracting each year.[3] Bank-financed goods, works, and services are usually procured following a set of guidelines published by the institution. The guidelines outline a number of different procurement approaches applicable to different goods and services –including commodified low-cost goods, consultancies, and more complex construction, or services projects. Amongst competitively bid works procurements, one variation of rules is between National Competitive Bid (NCB) and International Competitive Bid (ICB). The difference between the two are comparatively minor, involving the language of documents and the advertising of the tender opportunity. According to the procurement guidelines, NCB:

> *May be the most appropriate way of procuring goods or works which, by their nature or scope, are unlikely to attract foreign competition... Advertising may*

[1] At the same time we should note there is a significant difference between the number of bidders and the level of 'actual' competition in practice, especially in cases where a number of the bidders are colluding or submit frivolous or very weak bids. This has been found to be a common problem in the case of a sample of World-Bank financed infrastructure bids in Africa, for example (Africon, 2008).

[2] See http://www.open-contracting.org/

[3] http://go.worldbank.org/GM7GBOVGS0

> *be limited to the national press or official gazette, or a free and open access website. Bidding documents may be only in a national language of the borrower's country... If foreign firms wish to participate under these circumstances, they shall be allowed to do so.*[4]

According to the procurement guidelines for ICB:

> *The Bank will arrange for... publication in UN Development Business online (UNDB online) Prequalification and bidding documents and the bids shall be prepared in one of ... English, French, or Spanish.... Bidding documents shall be so worded as to permit and encourage international competition.*

ICB is designed to increase competition and attract leading international firms to work on large, complex contracts. As such, it is linked to some of the oldest justifications for donor involvement in investment lending –that client countries lack the hard currency and the technical capacity to deliver complex development projects and require foreign exchange and foreign expertise to compensate for these shortcomings. At the same time, the practical difference between the approaches is limited –NCB is open to international bidders, for example, and ICB is open to nationals. (Indeed, as a practical matter, nationals usually win ICBs; looking at our dataset of World Bank financed goods and works contracts awarded between 1995 and 2007, local firms have accounted for 70.38 percent of the value of ICB contracts.)

Given the practical difference between NCB and ICB procurements is limited to advertising and language, any difference in outcomes between ICB and NCB might be taken as a measure of the impact of advertising and language. We will see the picture is not that simple, however: ICB and NCB approaches are selected in part based on the nature of the goods and works being contracted –including if they are likely to appeal to international bidders.

In an attempt to overcome this problem and measure the 'true' impact of transparency we use a fuzzy regression discontinuity design that exploits the fact that the World Bank sets thresholds on the size of contracts that mandates the use of ICB. Contracts just smaller than the threshold are unlikely to be markedly different than contracts just larger than the threshold, and so any difference in observed competition outcomes can more fairly be said to reflect the impact of moving from NCB to ICB rules. While our regression discontinuity design does present some evidence for a positive impact on bidding outcomes from ICB, our

[4] http://siteresources.worldbank.org/INTPROCUREMENT/Resources/ProcGuid-10-06-RevMay10-ev2.pdf

estimates suffer from what can be described as a weak instrument problem –for this reason we also employ two matching techniques which similarly describe a positive impact of ICB on bidding outcomes, though of lessened magnitude.

The outcomes we consider include the total number of bidders a contract receives, the nationality of bidders, the number of addenda, and days to contract finalization. Both our regression discontinuity design and matching techniques identify an increase in the number of bidders *and* in ex-post renegotiation as a result of increased publicity. We find mixed evidence on the effects of ICB on the nationality of bidders, however, the weight of the evidence suggests that listing a contract through International Competitive Bidding results in an increase in foreign bidders overall and an increase in bidders from OECD countries. Unfortunately, we have no way of directly estimating price effects, though we offer some suggestive evidence that prices were largely unaffected by ICB status.

Literature Review

It is a common argument that competition improves outcomes (Smith, 1776). There is evidence that this applies to government procurement. Iimi (2006) finds that the winning bid on Japanese aid projects falls as a proportion of the ex-ante cost estimate as the number of bidders climbs to eight. Estache and Iimi (2008) suggest that improved competition on developing country infrastructure projects would reduce prices by an average of 8 percent with the effect reaching its maximum between 4 and 14 bids. Onur et al. (2012) finds that competition reduces price of Turkish public procurements as does allowing foreign bidders. Galletta et al. (2015) suggest DRC roads contract prices are lower where there are more bidders.

There is also evidence that the form of procurement process as well as the environment in which the procurement takes place can impact levels of competition and pricing. Ohashi (2009) suggests that removing discretion on bidder qualification reduces prices by 3 percent in Japanese local contracting. Soraya (2009) finds transparency in a World Bank Urban Infrastructure Project in Bali may have generated prices that were lower by 21 percent while Kenny (2010) finds World Bank Financed road construction costs are lower where measures of Voice and Accountability are high.

Specifically regarding tender advertising and transparency, Pavel et al. (2013) look at contracting in the Slovak Republic and find that e-procurement and advertising leads to more bids and lower prices. And in perhaps the closest analysis to the one we will perform in

this paper, Coviello and Mariniello (2014) use regression discontinuity to suggest advertising Italian local government tenders at the regional level increases bidders and reduces prices.

This paper uses a database of over 65,000 World Bank works contracts to look at specific procurement rule around advertising/language, employing a regression discontinuity approach in an attempt to find a causal link. We also look at the impact of procurement rules on the participation of foreign bidders in particular as one of the primary reasons for employing ICB is to attract such bidders. The discontinuity we exploit is that the World Bank mandates the use of ICB on contracts over a threshold estimated contract size set at the country level. Many ICBs involve contracts that are significantly below that threshold, but the threshold still appears to act as a forcing mechanism for enough contracts that we can use that discontinuity to evaluate the impact of moving from NCB to ICB.

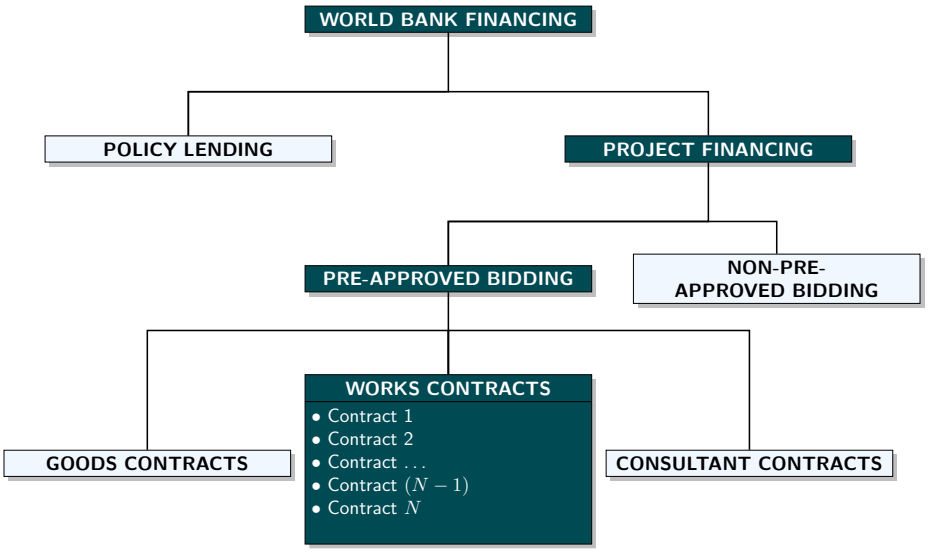
As well as measuring the impact of transparency, this paper will provide some evidence about the widespread assumption that 'strong procurements' –well designed, well managed bid documents that attract high bidder interest– are associated with 'strong agencies' or 'strong institutional environments' for procurement. This is linked to an assumption that country-level characteristics are responsible for a substantial part of the variability in procurement indicators. Not least, country-level procurement assessments based on this assumption feed into World Bank Country Policy and Institutional Analysis rankings that in turn help to determine allocations from the Bank's soft lending arm, IDA. Similarly, at the agency level, the focus on agency capacity in procurement risk assessments as part of World Bank project appraisal, for example. This stands in contrast to Estache and Iimi (2008), who specify a bid model in terms of particular technical details of a contract, suggesting it is such details that predominate in determining procurement outcomes. The analysis should provide some indication of whether 'strong procurements' as measured by competition as well as negotiation time and number of amendments are largely the result of 'strong agencies,' 'strong countries' or contract idiosyncrasies.

Data Overview

The data used in the current study originate from the World Bank's business warehouse database, and consists of Bank-financed contracts awarded in fiscal years 1995-2007 (civil works only).[5] The contracts are those that are 'prior review' –cleared by World Bank technical and procurement experts before they are signed, based on contract size thresholds. Most

[5]The dataset was obtained from the Data Warehouse in 2015. Corrections to the database are being constantly made by information specialists; so the number of observations in the database for a given year can change over time.

FIG. 1: Which Data Enter the Database



of the analysis is limited to such procurements which use international competitive bidding (ICB) or national competitive bidding (NCB).

Our database contains approximately 70,000 contracts which cover 132 countries, and range from hospital construction, to road maintenance and replacing drinking fountains in schools. Of these contracts 47,282 are listed via the National Competitive Bidding System and 18,152 via International Competitive Bidding. 5,234 fall into other categories (shopping, etc. . .). Figure 1 lays out exactly which contracts can be found in our dataset and table 1 gives summary statistics for the variables used in our analysis.

Our dataset includes for each contract the contract amount, the total number of bids, contract addenda and days between award and signature of the contract. Long contract finalization times (here measured as the gap between World Bank non-objection of contract award and contract signature) delay project implementation. In addition they may signal a number of potential underlying problems: weak bid documents absent sufficient technical detail; low capacity in the client agency and/or the potential negotiation of side payments.[6] Contract amendments usually raise prices and may reflect poorly designed original bid and contract documents.[7]

[6] A caveat here regards overly expeditious completion of negotiation, which may lead to an unclear contract which is hard to enforce or suggest a 'precooked' outcome.

[7] Again, however, there are alternate explanations –unanticipated input price change or other factors beyond agency and contractor control.

TABLE 1: Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
ICB	0.281	0.45	0	1	65,794
No. Bids Received	5.99	22.99	0	824	71,028
Foreign Bids	0.28	0.70	0	4	71,028
OECD Bids	0.19	0.70	0	4	71,028
Chinese Bids	0.21	0.79	0	4	71,028
No. of Addenda	0.27	0.77	0	22	71,028
Days to Finalization	44.42	79.70	0	2074	65,845
Value of Contract (in millions)	1.03	4.90	0	446.62	71,028
School Contract	0.08	0.26	0	1	71,028
Road Contract	0.16	0.37	0	1	71,028
Construction Contract	0.31	0.461	0	1	71,028
Hospital Contract	0.02	0.13	0	1	71,028
Agency Experience	492.30	699.40	1	2885	71,028

In addition, we have data on the country of origin of bidders, as well as country and agency issuing the contract. We use the agency data to construct a proxy for procurement experience, simply using the number of times a particular agency is listed as the implementor throughout the database. We also identify particular kinds of projects by their title, identifying contracts whose title includes "constru,[8]" "road," "hospital," or "school." Contracts are further categorized by type (Maintenance, Infrastructure, Civil Works, Buildings) and sector (Transportation, Sanitation, Agriculture, etc.). Taking data available from World Bank documentation we construct a set of thresholds that mandate the use of ICB for contracts over a given size in particular countries. A full tabulation of these variables can be found in the appendix.

There are a number of caveats about data quality. First, the number of bidders is not validated by World Bank staff, and practices on what is entered may vary (bid documents purchased versus bids received versus bids evaluated, for example). There are a number of extreme (and repeated) outliers in the number of bidders which received 800+ bids which we take to be suggestive of coding error rather than overwhelming competition. For this reason we censor our bids received variable at 100 bids. Similarly we only have the country of origin for up to four bidders. Consequently our number of foreign bidders variable is heavily censored at 4. Data on bidder country origin is based on country of registration –so that local subsidiaries of international firms will be reported as national firms. Agency names

[8]For construction we require the string to include 'constru' rather than construction to avoid a number of spelling errors and abbreviations.

are not standardized, suggesting that contracts issued by one agency may be listed under two different agencies. This will add noise to the agency experience variable. Regarding the thresholds data, there is a concern that given the approval dates for the contracts in this dataset range from 1995 to 2007, the thresholds or procurement methods almost certainly have changed over time.[9] Certain projects will set their own ICB threshold levels which might be lower than a country's national threshold. However, use of these thresholds would introduce substantial endogeneity issues. This and other data entry errors will at the least add noise and may add unobserved bias. Given the (still) comparatively large sample size of well-documented contracts, it is still to be hoped that these errors are comparatively unimportant in terms of biasing results.

Additionally, the contract value data we have are for realized contract value, or the actual value of the contract that was financed. The decision to mandate listing as ICB is made based on the engineer's estimate of what the (package of) contract(s) should cost, ex-ante. Thus, if ICB "works" and reduces the price of an project, it could reduce it to below the value of a similar NCB contract.[10] We will discuss these and our econometric solutions to these problems in more detail in section .

The data allows us to illustrate a number of interesting trends and country statistics regarding World Bank financed works contracts. Looking at out three procurement measures we find that:

1. On average ICB contracts are more likely to have a high number of bidders compared to NCB and other procurement methodologies. As can be seen in Table 2, 77.3 percent of

[9] We have requested these historical thresholds data from the World Bank Feb. 29 2016 and are awaiting a response.

[10] An additional issue is that under World Bank procurement guidelines, similar, but discrete contracts can be listed together to allow large companies to bid for all of them at once. Paragraph 2.4 of Guidelines: Procurement under IBRD Loans and IDA Credits (2004) states the following: "*For a project requiring similar but separate items of equipment or works, bids may be invited under alternative contract options that would attract the interest of both small and large firms, which could be allowed, at their option, to bid for individual contracts (slices) or for a group of similar contracts (package). All bids and combinations of bids shall be received by the same deadline and opened and evaluated simultaneously so as to determine the bid or combination of bids offering the lowest evaluated cost to the Borrower.*" This means that the ex-post contract values that we have may represent a fractional component of the engineer's estimate. For example, a school building contract in Afghanistan listed under X-project requests a number of schools with the same specifications in different areas. The actual value of each of these ICB listed works contracts is around 500,000USD, well under the 5,000,000USD threshold for ICB procurement. Combined, they equal approximately 12,000,000USD over the threshold. While there is no way to tell with certainty whether each of these contracts was listed via this alternative contracts method, it would be less likely that X local school construction contracts would be listed through the ICB system were it not that the combined contract value surpassed the country threshold.

TABLE 2: Bids Received by Procurement Type

			Procurement Method			
			ICB	NCB	Other	Total
Bids Received	Zero	Count	108	240	39	387
		%	0.58%	0.51%	0.75%	0.54%
	One	Count	2,553	7,453	2,989	12,995
		%	13.79%	15.76%	57.11%	18.30%
	Two	Count	1,544	5,361	313	7,218
		%	8.34%	11.34%	5.98%	10.16%
	Three +	Count	14,307	34,228	1,893	50,428
		%	77.29%	72.39%	36.17%	71.00%
	Total		18,512	47,282	5,234	71,028

ICB contracts had more than three bidders compared to 72.4 percent of NCB contracts and only 36.17 percent for other contracts.

2. The average number of bidders on ICB contracts fell from peak value of 9.17 bids in 2004 to 4.68 in 2011. Over the same period, the same figures for NCBs are 4.45 in 2004 and 3.50 in 2011.

3. ICB contracts tend to take longer to finalize. Average finalization time for ICB contracts was 53.40 days compared to only 41.87 for NCB contracts. In the long run, finalization times do not appear to be trending in any direction, but spiked for both ICB and NCB in 2013.

4. The average number of amendments for ICB contracts was 0.53. NCB contracts over the same period had an average of only 0.17 addenda. These figures appear to be increasing over time, particularly for ICB (see the appendix).

Visualization of these data and other exploratory statistics and figures can be found in the supplementary appendix. These include the average and standard deviation of total bids by year, a truncated histogram of total bids received by project, share of total contract value between procurement methods, the share of total contract value by the origin of bidder, and average contract finalization time and number of amendments.

With the limitations presented by the data above, we turn to the methodologies we employ to identify the causal impact of increased transparency in procurement on competition.

Econometric Strategy

Our primary aim is to estimate the effect of an increase in publicity mandated for World Bank financed ICB contracts (as compared to NCB contracts) on measures of competition as proxied by the number of bids a contract receives. To do this we estimate the following equation:

$$Y_i = \alpha + \beta ICB + \gamma X_i + \theta_c + \lambda_t + \psi_s + \varepsilon_i \tag{1}$$

Where Y_i is the procurement outcome of interest, here number of bids received, type of bids received, the number of addenda and time to contract finalization, for contract i; X_i is a vector of contract characteristics including the log value of the contract, implementing agency experience, the number of contracts in a project, and other contract characteristics; $\theta_c, \lambda_t, \psi_s$ are, respectively, country, type (Maintenance, Infrastructure, Civil Works, Buildings) and sector (Transportation, Sanitation, Agriculture, etc.) fixed effects for country c, type t, and sector s; and ICB is an indicator variable for whether or not the contract was listed using the ICB or NCB.

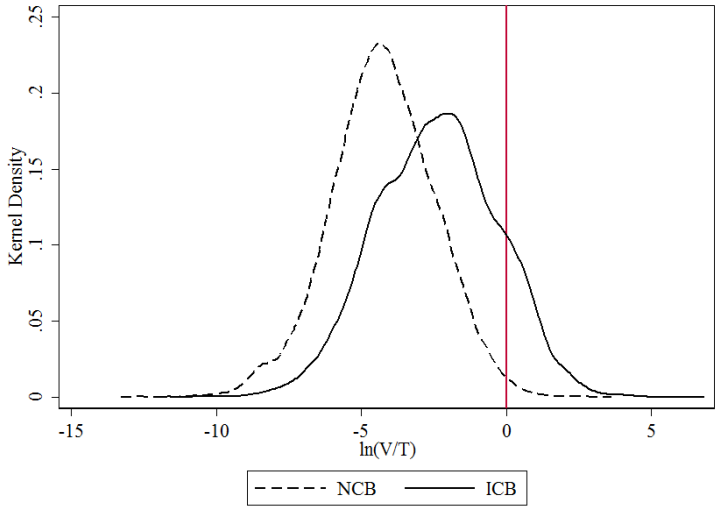
We begin by estimating a simple Ordinary Least Squares (OLS) regression. We estimate the effects of being listed via the International Competitive Bidding system on procurement outcomes (namely, number and qualities of bids) controlling for country and contract-level characteristics. Due to characteristics of our dependent variables we also employ a negative-binomial regression for total number of bids received (which displays negative binomial distribution, see figure 7) and Tobit regressions for foreign, OECD, and China bidders as they are heavily censored at four bids.[11] For each of these regressions we calculate robust standard errors.

Regression Discontinuity Design

We are concerned that some unobservable characteristic(s) of contracts might cause certain low-value contracts to be listed via ICB. For this reason, contracts with similar (low) dollar values and similar control characteristics that only differ in method of listing and thus seem comparable may be receiving different number of bids due to these unobservable characteristics. The likely effect of this is indeterminate; it might induce a downward bias in the estimated coefficient (because those contracts most likely to have fewest domestic bids would be those listed through the international system), or it may bias estimates upward as it may be that contracts most likely to attract foreign bids might be listed through ICB.

[11] Where Y_i^* is a latent variable for foreign/OECD/Chinese bids taking the form: $Y_i = \begin{cases} 4 & \text{if } Y_i^* \geqslant 4 \\ Y_i^* & \text{if } Y_i^* \leq 4 \end{cases}$

FIG. 2: Enforcement of Procurement Rules



Note: While World Bank procurement rules do allow for contracts lower than the threshold to be listed as ICB, we note that these distributions suggest that few observations are *forced* into being listed as ICB instead of NCB. Rather, we observe many procurement officers are self-selecting contracts into ICB.

For this reason, we attempt to employ a Regression Discontinuity Design (RDD) exploiting the existence of a threshold value at which a contract is required to be listed via ICB. The basic logic for the RDD is as follows; if procurement procedures are implemented and followed as intended (with no manipulation), there should be no reason to believe that the average contract with a value of one dollar less than the treatment (listing) determining threshold (T-1) should be statistically different from the average contract immediately above the threshold (T+1) except for the impact caused by the treatment (Lee and Lemieux, 2010). Thus, by measuring the magnitude of the discontinuity immediately around the threshold, we should be able to estimate the local average treatment effect (LATE) of increased advertising on bid competition. We first estimate a sharp regression discontinuity design. We estimate local linear regressions on either side of the cutoff, allowing the slope of the line to change either side, as in equation 2:

$$Y_i = \beta_0 + \beta_1 \check{V}_{ic} + \tau E_i + \beta_2 E_i \cdot \check{V}_{ic} + \varepsilon_i \tag{2}$$

This sharp RD estimates the Intention to Treat effect. As mentioned above, however, a valid sharp RD would require that no contracts with a value above the threshold would be listed via NCB (untreated) and no contracts with a value below the threshold would be listed via ICB (treated) (Hahn et al., 2001). As can be seen in figure 2, this is not the case around our

threshold. We do see fairly consistent application of treatment to contracts which are above the threshold –i.e. most of those who should be treated are treated. But there are many contracts listed under the ICB system who have values far below the threshold. This likely reflects a preference by the World Bank for financed contracts that could plausibly attract international competition to be listed as ICB. However, given that there is still an observable increase in the likelihood of being listed as ICB at the threshold (suggesting the cutoff still has some independent influence to list as NCB or ICB), we are able to overcome this characteristic by employing a Fuzzy Regression Discontinuity Design (FRDD) as presented in Lee and Lemieux (2010).

We implement this approach using the 2SLS estimator as discussed in Hahn et al. (2001). We first regress realized ICB (whether or not a contract was actually listed as ICB) against an eligibility dummy, E. In the second stage, we estimate the impact of ICB on the outcome variables using the value of ICB predicted in the first. In both stages, we include an interaction terms between $\widehat{ICB}/E$ and the logged value of the contract relative to country threshold (denoted $\check{V}$). This technique will estimate the effect of treatment on the treated (ToT).

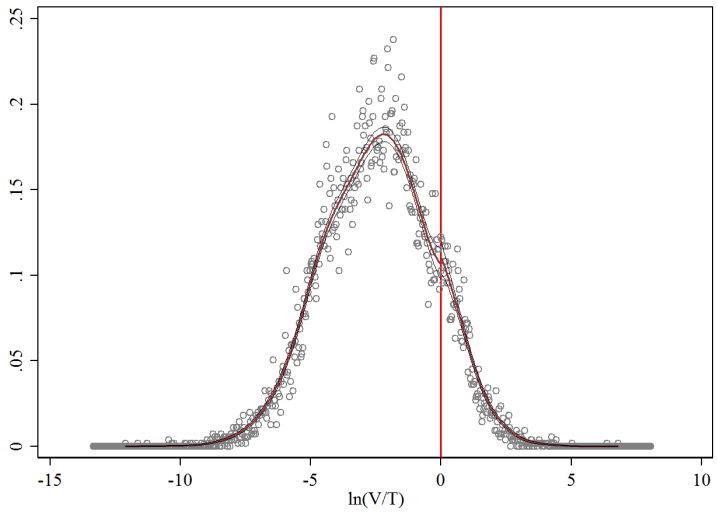
$$ICB_i = \alpha_0 + \alpha_1 \check{V}_{ic} + \pi E_i + \alpha_2 E_i \cdot \check{V}_{ic} + \mu_i \tag{3}$$

$$Y_i = \beta_0 + \beta_1 \check{V}_{ic} + \tau \widehat{ICB_i} + \beta_2 \widehat{ICB_i} \cdot \check{V}_{ic} + \varepsilon_i \tag{4}$$

Hahn et al. (2001) identify the key assumptions for the (F)RDD to be valid. First among these is continuity in the running variable. If estimated contract values are being artificially adjusted around the threshold so that the contract can be listed via NCB (or must be via ICB), the regression discontinuity design would not be valid. Note we are using actual contract values rather than estimates, which would blunt the impact of such manipulation. Nonetheless, we can test for this assumption using the McCrary (2008) test. This test determines if the density of the running variable experiences a discontinuous change at the threshold, which, if it does, would suggest that individuals are purposefully altering estimated contract values so that they will fall into either the treated or non-treated category.

We test the continuity in density of the running variables when transformed logarithmically. We take the natural log of the value less the natural log of the country threshold, essentially taking the natural log of the value of the contract relative to its country threshold. This allows us to more consistently compare across countries while preserving a stable threshold of zero when the contract value is equal to the threshold. When we run the McCrary test with this transformation we observe a normal distribution of relative contract values with no

FIG. 3: Visualization of the McCrary Test



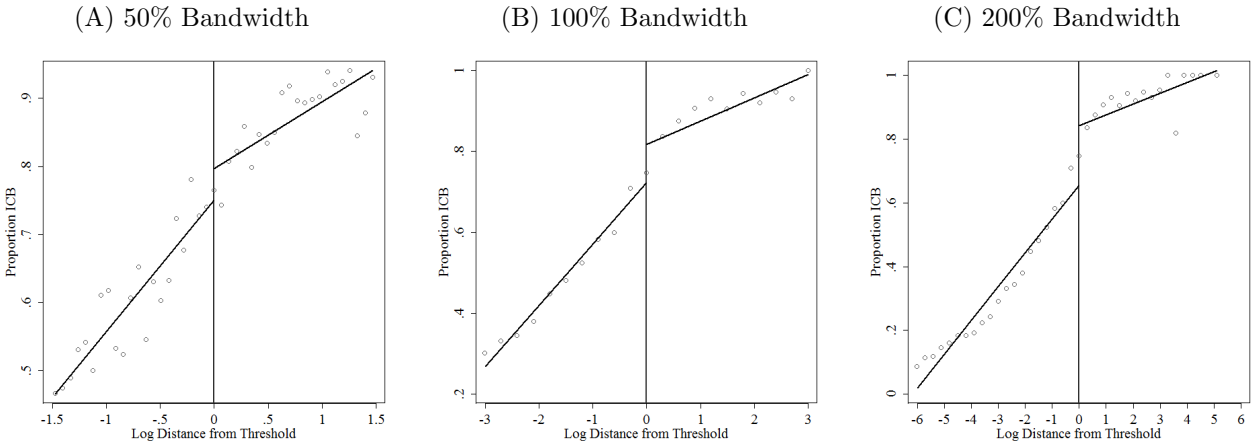
Note: Y-Axis is the density of observations. X-Axis is the running variable (log-centered value of the contract). Graphic constructed using the -DCdensity- command in Stata.

observable or statistically significant change in density immediately around the threshold, see figure 3. While we are unable to directly test price effects, this test also gives some indication that there is no price effect.[12]

A final assumption in the validity of the Fuzzy Regression Discontinuity Design is that there exists at the threshold a discontinuous jump in the likelihood of treatment. Figure 4 delineates the findings of the first stage of our FRDD estimator. At the bandwidth derived using the Imbens and Kalyanaraman (2011) optimal bandwidth algorithm (bw = 2.94) we do observe a small but significant jump in the likelihood of treatment. We observe the same at twice this bandwidth, however, this jump loses significance at 50 percent of this optimal bandwidth. The reason for this is likely stems from two data-related issues. First, while contracts whose estimated value is above the threshold limit are required to be listed via ICB the reverse is not true of those contracts with values below the threshold. As figure 4 makes clear, many contracts use ICB even below the required threshold value. Second, as mentioned above, the data we have for the running variable and not the estimated value on which the listing decision was made. There will be both positive and negative variation in

[12]For example, if the true value of the contract is equal to y^*, under NCB rules the price is simply y^*. However, if y^* is greater than the threshold value c the probability of being listed as ICB should increase. Thus, assuming a smooth distribution of y^*, in the presence of a negative price effect (where the observed price $y < y^*$) we should observe a decrease in the density of y immediately around the cut off. Therefore, we find no evidence for a price effect, but neither should this be taken as rigorous evidence of a null effect.

FIG. 4: Discontinuity in the Probability of Being Listed as ICB



Note: Local Linear Regressions over scatterplots of binned (rounded) values.

the difference between the actual and estimated costs. This uncertainty will likely reduce the observed discontinuity in receiving treatment though the magnitude of this will depend on the extent and average direction of this variation. We anticipate that if ICB works to reduce the awarded price of a contract through increased competition, we should expect some ICB contracts whose values were estimated immediately above the contract to appear in our data just below the threshold. This reduction in size of the discontinuity will likely bias upwards the final estimated LATE in that we underestimate the difference in the denominator of the wald estimator. As this estimate approaches zero, the estimated LATE will increase dramatically.

Matching Methods

As we show in the preceding section, the discontinuous increase in the probability of being listed as ICB is small and suffers from what can be considered a weak instrument problem. For this reason, we also present the results of two matching techniques; traditional Nearest Neighbor Propensity Score Matching (PSM), and Coarsened Exact Matching (CEM). In the absence of randomization or the 'as-if' randomization induced via the regression discontinuity design the researcher makes several assumptions to identify the treatment effect, τ_{ATT}. The true effect of treatment on the treated is characterized in equation 5; in essence, the difference between an observation which has been treated and what that same observation would be in the absence of treatment (Caliendo and Kopeinig, 2008).

$$\tau_{ATT} = E(\tau|T = 1) = E[Y(1)|D = 1]E[Y(0)|D = 1] \tag{5}$$

However, given that it is impossible for us to observe an individual contract's outcome both with and in the absence of treatment, matching techniques allow us to pair similar observations from both treated and non-treated groups. As Rosenbaum and Rubin (1983) demonstrate, it is possible to construct balancing scores from the propensity score, $P(T = 1|X) = P(X)$. A variety of algorithms allow us to match observations which hold a similar probability of being selected into treatment based on relevant characteristics. From there we can estimate the average treatment effect on the treated by comparing mean outcomes for both groups. The estimator employed via the Propensity Score matching techniques can be generalized to the following:

$$\underset{ATT}{\tau_{PSM}} = E(\tau|T = 1) = E[Y(1)|D = 1] - E[Y(0)|D = 1] \tag{6}$$

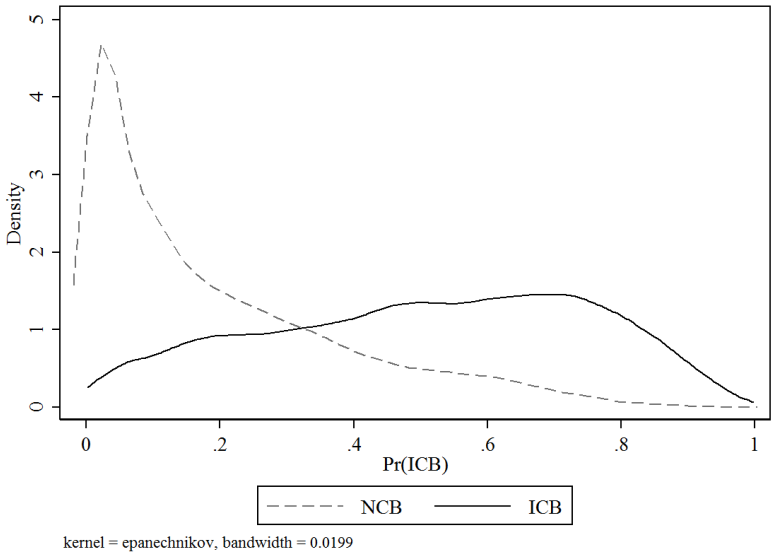
This methodology makes several assumptions to invoke a causal claim. First among this is that there is no selection based on unobservables and that all values which do determine selection can be observed $(Y(0), Y(1) \coprod D|P(X), \forall X)$. We concede that there are a number of reasons why one might suspect that in this case selection on idiosyncratic contract unobservables might play a role. However, we argue that as our regression discontinuity estimates, which will not be responsive to this potential bias, similarly find a positive effect of ICB on bidding this is of secondary concern. We match contracts on every contract characteristic that is unaffected by treatment, including the natural log of the contracted amount, sector, type, year, country, implementing agency experience, the number of contracts in a project (complexity), and whether or not the contract name includes "constru,[13]" "road," "hospital," or "school." The second assumption is that of sufficient overlap in propensity scores between the treated and non-treated groups. As can be seen in figure 5, there is substantial overlap in the propensity score.

The third assumption[14] demands an appropriate specification of the logit/probit model used to estimate the propensity score. We estimate the propensity score with a number of specifications, alternately excluding variables, and obtain qualitatively similar scores in each. However, despite these efforts we are unable to completely reduce bias using these techniques. This is likely due to the high-dimensionality of the data and overlapping contract level characteristics which can be inversely correlated. For this reason we also employ Coarsened Exact Matching (CEM) as presented in Iacus et al. (2011). CEM breaks variables into appropriately sized categories on which it then performs an exact matching algorithm. This

[13]Several construction observations are abbreviated to "constru." or include misspellings in the final few characters.

[14]A fourth assumption requires stable unit treatment values, or that the outcome of one unit is not changed by the treatment status of others. We do not expect this dynamic here.

FIG. 5: Overlap in the Propensity Score



Note: Kernel Densities of estimated propensity score for both ICB (treatment) and NCB (control) groups.

eliminates the above problems associated with the high dimensionality and can improve causal inference.

PSM matches substantially more observations, though it does a poor job of eliminating imbalance. This can be seen in table 3 where even within narrow calipers PSM has difficulty balancing across all the covariates. In contrast, Coarsened Exact Matching which matches on each covariate rather than simply on the propensity score is much better able to balance observations, but matches fewer observations. The disparity in matching success between the two methods can be better observed across covariates in figures 13 and 14 in the appendix.

CEM does a better job of reducing the bias from observable differences in treatment and control groups. However, we still observe a marked decrease in bias in both subsamples as compared to the unmatched sample. Further, we estimate model based treatment effects to ameliorate remaining biases from these differences.[15]

[15]Model based estimates simply control for the matching covariates in a weighted least squares regression as opposed to the Welch's t-test.

TABLE 3: Covariate Balance

Treatment	lnamount	agency_exp	contracts	hospital	school	construction	year
Panel A: Unmatched Sample (N = 65,785)							
Mean (ICB)	13.03	266.02	110.22	0.01	0.04	0.28	1999.80
Mean (NCB)	11.28	560.66	326.62	0.02	0.09	0.33	1999.86
Difference	1.74	-294.64	-216.40	-0.01	-0.05	-0.05	-0.06
P > |z|	0.0	0.00	0.0	0.000	0.00	0.00	0.05
Panel B: Propensity Score Matching with Calipers (N = 28,756)							
Mean (ICB)	12.94	271.48	112.58	0.01	0.04	0.28	1999.81
Mean (NCB)	12.78	266.77	109.73	0.01	0.04	0.30	1999.72
Difference	0.15	4.75	2.85	0.00	0.00	-0.018	0.09
P > |z|	0.000	0.447	0.05	0.07	0.89	0.000	0.02
Panel C: Coarsened Exact Matching (N = 12,526)							
Mean (ICB)	12.59	196.52	127.19	0.00	0.03	0.21	1999.93
Mean (NCB)	12.55	195.82	126.94	0.00	0.03	0.21	1999.93
Difference	0.04	0.70	0.25	-0.00	0.00	-0.00	0.00
P > |z|	0.16	0.90	0.92	0.99	1.00	0.99	1.00

Note: Significance in differences calculated using two-sample weighted t-tests.

Empirical Results

We first present the OLS, Negative Binomial, and Tobit regression estimates as a bench-mark. Table 4 describes the average observed change in number of bids, number of contract addenda, and time to finalization of contract. In each case we find positive and significant correlation between listing via ICB and the outcome of interest. Increasing number of bids would be considered a positive outcome, while number of addenda and time to finalization can be seen as a negative procurement outcome. The simple OLS regression finds that being listed via ICB is associated with an increase of 1.23 bidders on average. The negative binomial regression finds an increase of .10 bidders, the result is much smaller in magnitude but still highly significant. Among our foreign bidder regressions, there is minimal difference between the OLS and Tobit models, each finding an increase of .43 foreign bidders. Contract value generally increases the number of bids received. Foreign bidders are slightly more likely to have bid for road contracts and appear to shy away from construction contracts.

TABLE 4: OLS, Negative Binomial, and Tobit Specifications

	Bids		Foreign Bids		OECD Bids		China Bids		Addenda	Time
	OLS	NB	OLS	Tobit	OLS	Tobit	OLS	Tobit	OLS	OLS
ICB	1.2255**	0.1021**	0.4275**	0.4305**	0.2439**	0.2463**	0.0333**	0.0330**	0.2048***	7.0016***
	(0.169)	(0.010)	(0.008)	(0.008)	(0.006)	(0.007)	(0.005)	(0.005)	(0.009)	(0.847)
No. Contracts	0.0017***	0.0001***	-0.0001***	-0.0001***	-0.0001***	-0.0001***	0.0000	0.0000	0.0001***	0.0040**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
Agency Experience	-0.0004***	-0.0001***	0.0000*	0.0000*	0.0000	0.0000	0.0000	0.0000	-0.0000***	-0.0029***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
ln(Contract Value)	0.3060***	0.0297***	0.0431***	0.0436***	0.0241***	0.0243***	0.0092***	0.0092***	0.0511***	0.8440***
	(0.042)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.179)
School Contract	0.5879***	0.1660***	-0.0162**	-0.0158*	0.0099*	0.0098	-0.0105***	-0.0106***	0.0304***	-0.5959
	(0.194)	(0.015)	(0.008)	(0.008)	(0.006)	(0.006)	(0.004)	(0.004)	(0.008)	(0.990)
Road Contract	-1.0856***	-0.0715***	0.0400***	0.0405***	0.0342***	0.0351***	-0.0260***	-0.0277***	-0.0196**	2.6400***
	(0.124)	(0.011)	(0.007)	(0.008)	(0.006)	(0.006)	(0.004)	(0.004)	(0.010)	(0.902)
Construction Contract	0.9104***	-0.0172**	-0.0548***	-0.0554***	-0.0405***	-0.0406***	-0.0082***	-0.0086***	-0.0111*	1.8953***
	(0.175)	(0.009)	(0.005)	(0.006)	(0.004)	(0.004)	(0.003)	(0.003)	(0.007)	(0.685)
Hospital Contract	0.2263	0.1576***	-0.0033	-0.0039	-0.0414***	-0.0435***	0.0146**	0.0145**	0.2348***	4.5045**
	(0.219)	(0.024)	(0.012)	(0.013)	(0.008)	(0.009)	(0.006)	(0.006)	(0.024)	(1.955)
R^2	0.105		0.303		0.575		0.844		0.170	0.119
Sector FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	65785	65785	65785	65785	65785	65785	65785	65785	65785	60853

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses.

Further, country and sector fixed effects are jointly very significant. And with an overall R^2 of 0.1, it is worth noting that the OLS results support an interpretation of contract competition which emphasizes contract idiosyncrasies rather than features of agency, country or sector. Other notable observations in the OLS results include a positive association between having a foreign winner and time to finalization, and number of addenda. Interestingly, we also observe a decrease in the total number of bids as foreign competition increases. For every one foreign bidder, the total number of bidders would appear to decrease by two to two and a half. This is consistent with foreign firms only choosing to bid in environments of limited competition where the returns to bidding are higher. There are also legitimate concerns of reverse causality here; for example, contracts might be listed as ICB particularly because they are complex and competition is likely to be limited. These differences are unlikely to be resolved in a simple OLS regression model. To account for this bias, we turn to the results of our RDD and Matching methods.

Regression Discontinuity Estimates

Figure 6 illustrates the linear pattern in observed total number of bids received immediately around the threshold, an approximation of our RD estimation. Even without accounting for the 'fuzziness' in our estimation there appears to be a jump in the number of bids a contract receives as it crosses over the threshold nominally mandating ICB. Table 5 outlays the results of these Intention to Treat (ITT) estimations. In each case, the increase falls between an additional one-half to one bid. However, as we recall from figure 4 there is only a small jump in the observed probability of being list as ICB at the same threshold. However, given that these estimates do not account for the imperfect enforcement, they likely underestimate the size of the effect.

The results of our 2SLS regressions allow us to estimate the discontinuity in outcomes with this while accounting for this feature. We also test the robustness of the first stage As can be seen in table 6 we do observe a small but highly significant jump in the probability of being listed as ICB of around 10 percent using at the bandwidth derived employing the Imbens and Kalyanaraman (2011) optimal bandwidth selection algorithm. Instrumenting ICB by the eligibility threshold estimates an increase of approximately 9 bids as a result of being listed as ICB. At 200 percent of the optimal bandwidth, we observe broadly similar results: a 20 percent increase in probability of ICB and an increase of 5.72 bids. For both of these bandwidths, we reject a null hypothesis of weak instruments

However, at one-half the selected bandwidth, our results lose significance. We find highly inflated and insignificant increase in the number of bidders (25.48) and only a 4 percent

TABLE 5: Sharp Regression Discontinuity Estimates

Panel A: 100% Imbens-Kalyanaraman Bandwidth						
	Bids Received	Foreign Bids	China Bids	OECD Bids	Addenda	Final time
E	0.7514***	-0.0913*	0.0202	-0.2231***	0.3797***	7.7283*
	(0.222)	(0.041)	(0.036)	(0.036)	(0.052)	(3.417)
$\check{V}$	0.0811	0.1521***	0.0736***	0.1257***	0.1027***	3.5940***
	(0.055)	(0.008)	(0.009)	(0.008)	(0.009)	(0.909)
$E \cdot \check{V}$	-0.7372***	0.4159***	-0.1828***	0.2045***	0.0159	-4.8372*
	(0.154)	(0.041)	(0.028)	(0.037)	(0.049)	(2.431)
N	22575	22575	22575	22575	22575	21736
Panel B: 50% Imbens-Kalyanaraman Bandwidth						
	Bids Received	Foreign Bids	China Bids	OECD Bids	Addenda	Final time
E	1.1280***	-0.1230*	0.0242	-0.1339**	0.1677*	6.4467
	(0.315)	(0.054)	(0.051)	(0.047)	(0.069)	(4.422)
$\check{V}$	-0.4420*	0.2015***	0.1868***	0.0941**	0.2014***	2.9597
	(0.215)	(0.030)	(0.030)	(0.030)	(0.031)	(3.004)
$E \cdot \check{V}$	0.0397	0.3151***	-0.4866***	0.1254*	0.1456	0.2338
	(0.380)	(0.076)	(0.057)	(0.063)	(0.100)	(5.222)
N	8660	8660	8660	8660	8660	8402
Panel C: 200% Imbens-Kalyanaraman Bandwidth						
	Bids Received	Foreign Bids	China Bids	OECD Bids	Addenda	Final time
E	0.7330***	0.0916*	0.0366	-0.0548	0.4801***	9.1806**
	(0.193)	(0.037)	(0.033)	(0.031)	(0.047)	(3.041)
$\check{V}$	0.0947***	0.0881***	0.0404***	0.0702***	0.0739***	3.2637***
	(0.018)	(0.002)	(0.002)	(0.002)	(0.002)	(0.244)
$E \cdot \check{V}$	-0.7587***	0.3816***	-0.0865**	0.1755***	-0.0220	-4.1679
	(0.116)	(0.035)	(0.028)	(0.030)	(0.039)	(2.194)
N	59217	59217	59217	59217	59217	55243

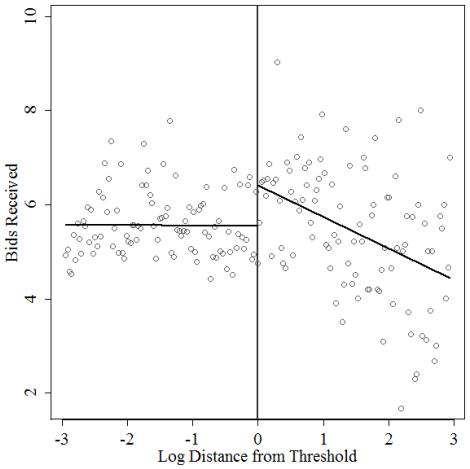
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses.

increase in the probability of being listed at ICB. In this instance, we fail to reject the null hypothesis of weak instruments.

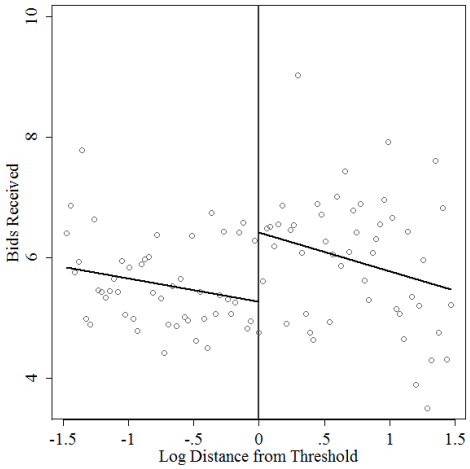
We stress that this does not imply no causal relationship between ICB and the level of competition, rather the result at this bandwidth would suggest that listing thresholds are either weakly enforced or that there may be considerable discrepancy in the estimated cost of a project (on which the listing decision is made) and the realized cost (for which we have data).

FIG. 6: Discontinuity in the Number of Bids Received

(A) 100% Bandwidth



(B) 50% Bandwidth



Note: Local Linear Regressions over scatterplots of binned (rounded) values.

We observe a similar pattern for our other dependent variables. Interestingly, and despite an overall increase in bids, we observe a decrease in number of bids from foreign sources (cumulatively) with that result being driven in part by a decrease in the number of bids coming from OECD countries. In contrast, we find a weakly significant increase in the number of bids from Chinese firms.

In addition, these magnitudes are small relative to the total number of bids received, but recall that each of these foreign bid variables are heavily censored at a value of 4. Turning to our measure of ex-post outcomes, we find that ICB contracts yield a higher number of addenda and an increase in the time to finalization of contracts. The observed increase in finalization time is only weakly significant.

The reason for this an estimated treatment effect of this magnitude compared to the OLS is partially due to the very small observed discontinuity in the likelihood: this near zero denominator artificially inflates the estimated treatment effect and likely underestimates the true discontinuity.

Given this data feature, and that we have many ICB observations listed below the threshold, we also estimate the effect of ICB using two propensity score matching techniques. This analyses serve as an additional robustness check on our regression discontinuity design.

TABLE 6: Fuzzy Regression Discontinuity Estimates

Panel A: 100% Imbens-Kalyanaraman Bandwidth						
	Bids Received	Foreign Bids	China Bids	OECD Bids	Addenda	Final time
ICB	8.99***	-1.92***	0.72*	-2.41***	3.20***	66.80*
	(2.44)	(0.55)	(0.37)	(0.53)	(0.67)	(29.09)
First Stage	0.09***	0.09***	0.09***	0.09***	0.09***	0.10***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
RK F-stat	31.26	31.26	31.26	31.26	31.26	33.82
SY 25	3.63	3.63	3.63	3.63	3.63	3.63
SY 10	7.03	7.03	7.03	7.03	7.03	7.03
N	21,474	21,474	21,474	21,474	21,474	20,678
Panel B: 50% Imbens-Kalyanaraman Bandwidth						
	Bids Received	Foreign Bids	China Bids	OECD Bids	Addenda	Final time
ICB	25.48	-3.61	1.80	-3.55	3.41	121.11
	(13.44)	(2.35)	(1.34)	(2.11)	(2.25)	(100.40)
First Stage	0.04	0.04	0.04	0.04	0.04	0.04*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
RK F-stat	2.48	2.48	2.48	2.48	2.48	2.83
SY 25	3.63	3.63	3.63	3.63	3.63	3.63
SY 10	7.03	7.03	7.03	7.03	7.03	7.03
N	8,285	8,285	8,285	8,285	8,285	8,042
Panel C: 200% Imbens-Kalyanaraman Bandwidth						
	Bids Received	Foreign Bids	China Bids	OECD Bids	Addenda	Final time
ICB	5.72***	-0.81**	0.43	-0.81***	2.18***	42.68*
	(1.22)	(0.27)	(0.23)	(0.23)	(0.34)	(16.92)
First Stage	0.20***	0.20***	0.20***	0.20***	0.20***	0.21***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
RK F-stat	132.42	132.42	132.42	132.42	132.42	140.76
SY 25	3.63	3.63	3.63	3.63	3.63	3.63
SY 10	7.03	7.03	7.03	7.03	7.03	7.03
N	55,300	55,300.00	55,300	55,300	55,300	51,482

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses.

Note: RK F-stat denotes the Kleibergen-Paap RK Wald Statistic (to test weak-identification). SY 25 SY 10 are the Stock-Yogo critical values at a maximum bias of the 2SLS estimator equal to 25 percent and 10 percent of the OLS estimator respectively. Thus at we strongly reject the null hypothesis of weak instruments at 100 percent and 200 percent of the Imbens and Kalynaraman optimal bandwidth.

Matching Estimates

Table 7 presents the estimated treatment effects from our matching techniques. For both Nearest Neighbor (PSM), and Coarsened Exact Matching (CEM), we find that being listed via ICB is associated with a positive increase in the number of bids a contract receives. We find similar, though smaller magnitude effects on Foreign bidders and this is significant across the majority of specifications. These results suggest a picture similar to that proposed by our initial OLS estimations.

TABLE 7: Matching Estimates

	Total Bids		Foreign Bids		OECD Bids		China Bids	
	PSM	CEM	PSM	CEM	PSM	CEM	PSM	CEM
Welch T-test	2.3837**,	0.3981**,	0.4886**	0.3804**,	0.2484**	0.1492**,	0.0084	-0.0219
	(0.3353)	(0.1068)	(0.0096)	(0.0154)	(0.0111)	(0.0141)	(0.0113)	(0.018)
Model Based TE	2.074***	0.388***	0.494***	0.379***	0.247***	0.148***	0.004	-0.025*
	(0.421)	(0.104	(0.011)	(0.013)	(0.011)	(0.013)	(0.008)	(0.013)
Contract Controls	✓	✓	✓	✓	✓	✓	✓	✓
Sector Dummies	✓	✓	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓	✓	✓
Region Dummies	✓	✓	✓	✓	✓	✓	✓	✓
Observations	28,784	12,526	28,784	12,526	28,784	12,526	28,784	12,526

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses.

Propensity Score Matching with a caliper of 0.025, ties, and replacement successfully matches 17,948 treated with 10,833 control observations. The weighted average difference in bids received between ICB and NCB matched pairs (calculated using Welch's weighted t-test) is 2.464, with a standard error of 0.337 and we strongly reject the null of no difference between the two groups. We find similar results for CEM which matches fewer observations, but does a better job of balancing across covariates. CEM matches 5,395 treatment to 7,131 control observations and finds an average difference of .40 bids. This result is substantially lower in magnitude, but still highly significant. Coarsened Exact Matching was better able to balance covariates across treatment and control groups and therefore better reduces bias. Because of this, we place slightly more weight on this second set of results. However, our model based (OLS) estimates appear to reduce some of the bias that we might expect from the imbalance in covariates following matching for PSM. Overall, we see very little difference between these estimates and those derived from the Welch T-test for the CEM sample even for foreign bids.

Looking at figure 12 –a visualization of the sharp RD with binned averages disaggregated by listing status– we also note that in the case of Foreign Bids and OECD bids, the RD estimates obscure some of the underlying trends in the data. For both of these outcome variables we observe that the number of bidders is almost uniformly higher for ICB observations within value categories. The high volume of ICB observations below this cutoff (coupled with a non-linear trend) leads to the effect being averaged out.

Additionally, we reconcile the differences between our regression discontinuity estimates and our matching estimates with the differences between average treatment on the treated and local average treatment effects (ATT and LATE). Given the preponderance of ICB observations that are below the threshold, the matching methodologies we employ here will incorporate the differences between the dependent variables of ICB and NCB contracts whose values are similarly far from the threshold in addition to those proximal to the cut-off. These estimate the average treatment effect on the treated across the range of contracts. ICB contracts below the threshold however are likely listed for reasons other than the size of the contract. So while our matching estimators are non-localized and better able to distinguish between treated and not-treated, they may be subject to bias due to selection on unobservables. However, both of these methodologies identify a positive and significant increase in the level of competition for contracts listed via more open procurement methods.

Conclusion

While the results presented above are fragile and based on imperfect data, they are suggestive of an economically meaningful impact of a reasonably limited increase in advertising and transparency on procurement outcomes. In each of ordinary least squares regression, regression discontinuity design, and several matching estimators, we find a significant increase in the level of competition (bids) with an increase in advertising despite several data quality issues and a number of potential biases. Our matching estimators suggest an increase in the number of foreign bidders, driven mostly by OECD countries. These results suggest a potential payoff to greater procurement transparency as advocated by groups including the Open Contracting Partnership. Policy recommendations are fairly simple; increasing advertising can improve competition and therefore procurement outcomes such as project quality and price, though we are unable to directly test for these outcomes here.

Thus, there is substantial scope for further inquiry. A potential next stage of research would be to investigate the effect of transparency on more closely monitored contracts. Namely, does better and more open contract lead to improvements in outcomes and reductions in

costs. The Road Cost Knowledge System database from the World Bank collects detailed information on the costs of road construction based on observable characteristics of the style, size, material, and terrain across which the road will be built. Comparing across only road projects would allow researchers to overcome many of the issues of comparability and selection based on unobservable characteristics that we find in this paper.

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Appendix

FIG. 7: Distribution in the Number of Bids

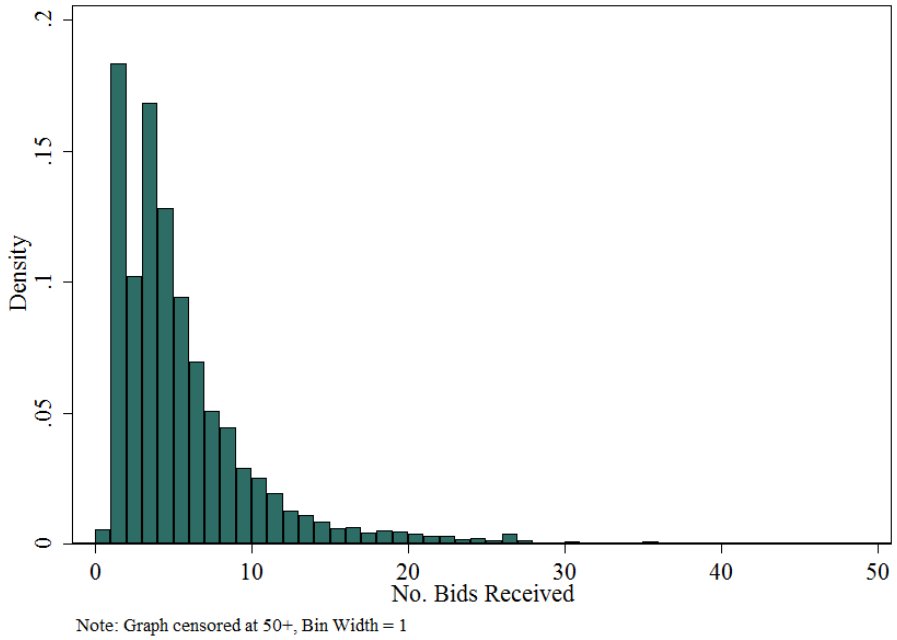


FIG. 8: Average Bids over Time

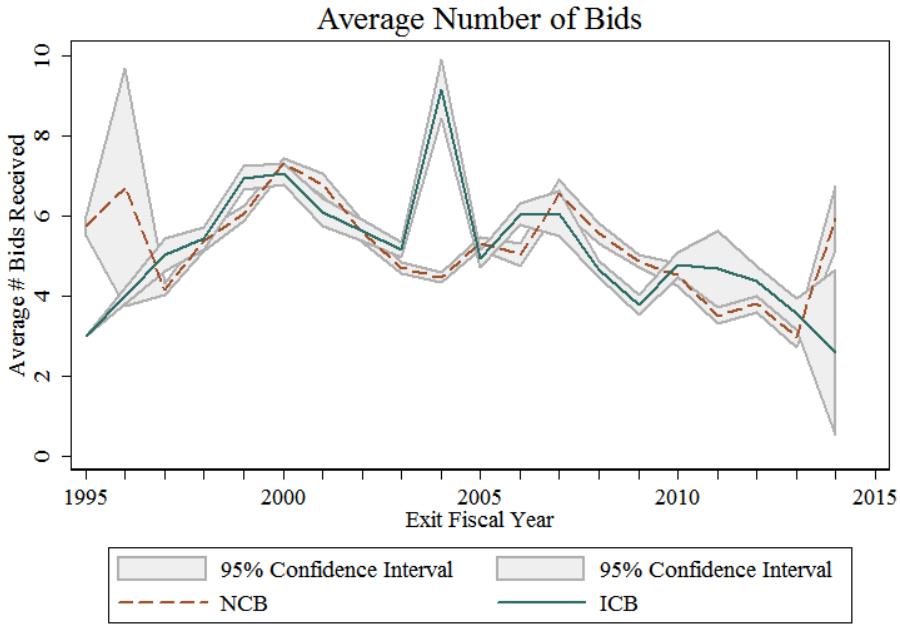


FIG. 9: Average Addenda over Time

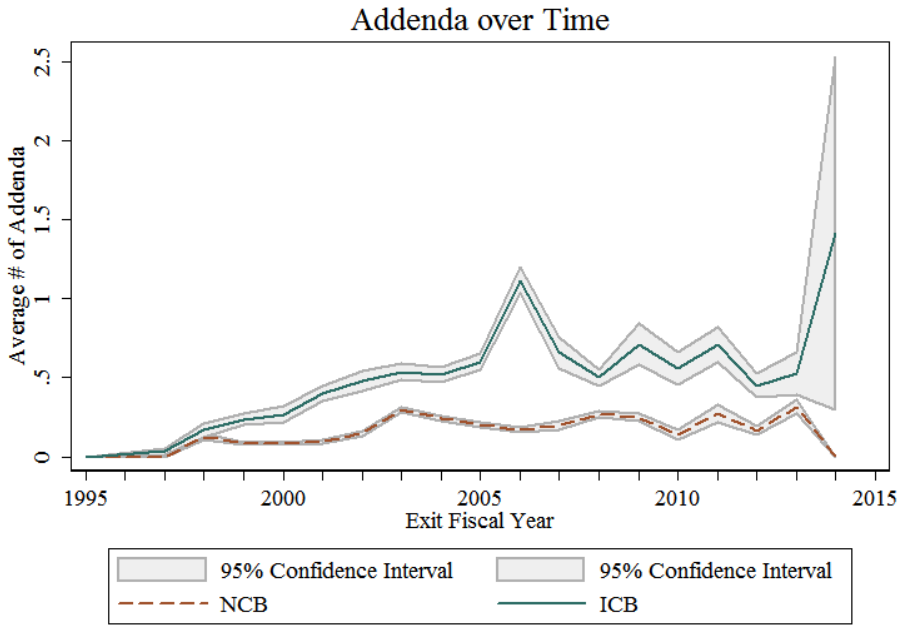


FIG. 10: Average Time to Finalization

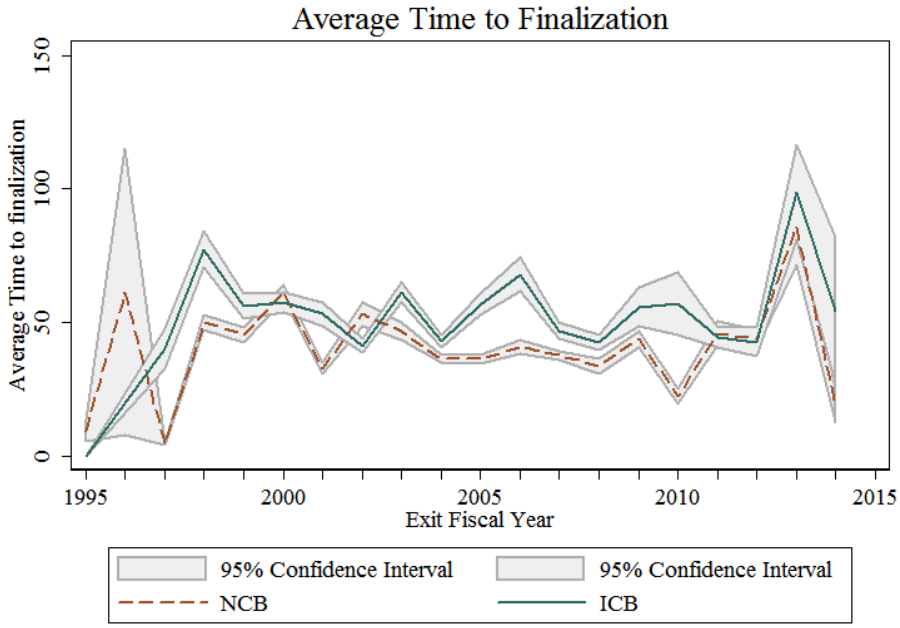


FIG. 11: Share of Total Contract Value by Procurement Method

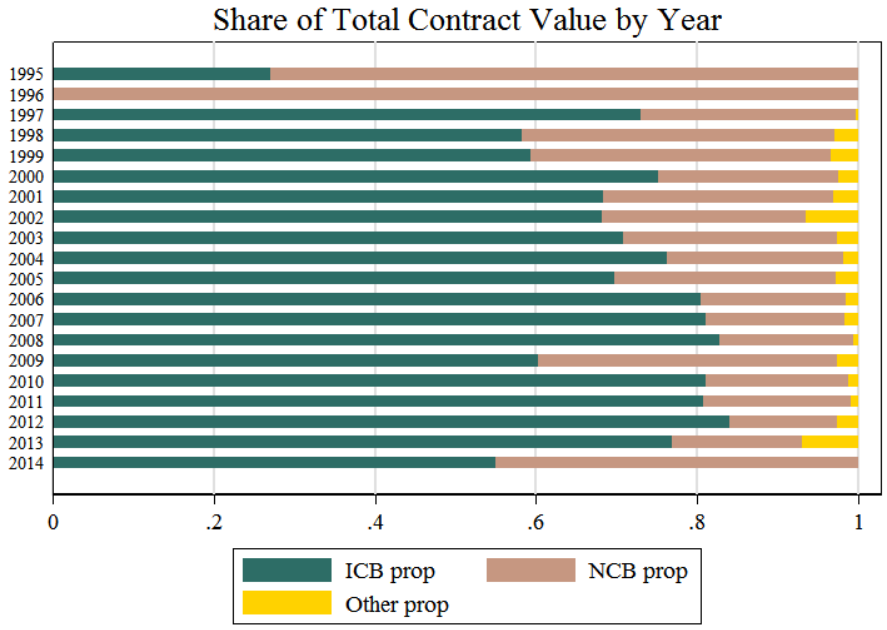
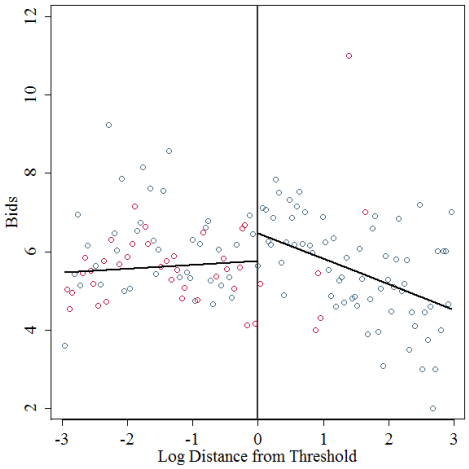
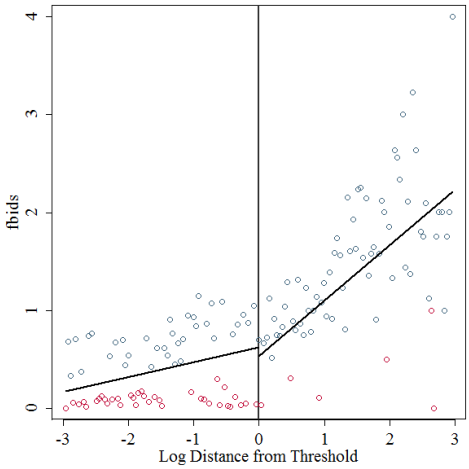


FIG. 12: ITT 100% IK Bandwidth

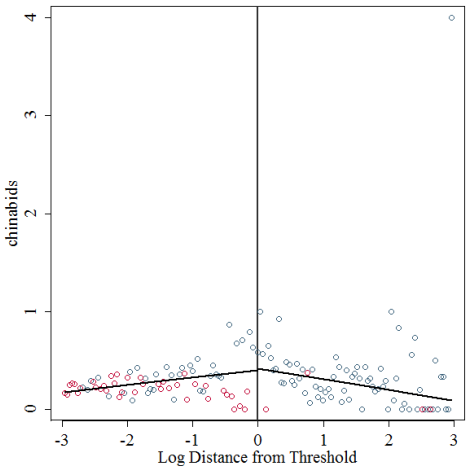
(A) Bids Received



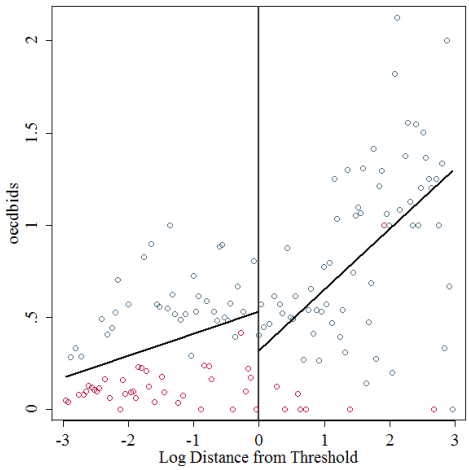
(B) Foreign Bids



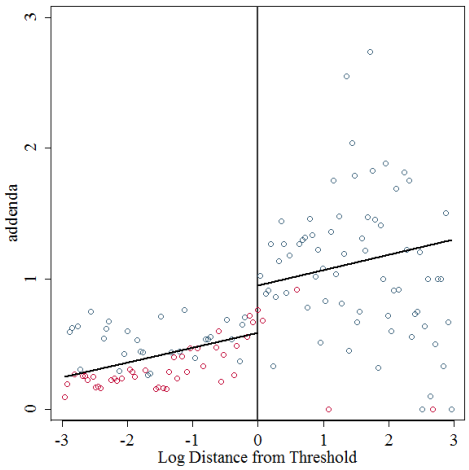
(C) China Bids



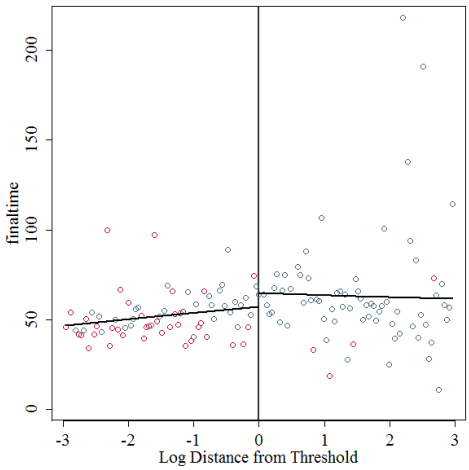
(D) OECD Bids



(E) Addenda

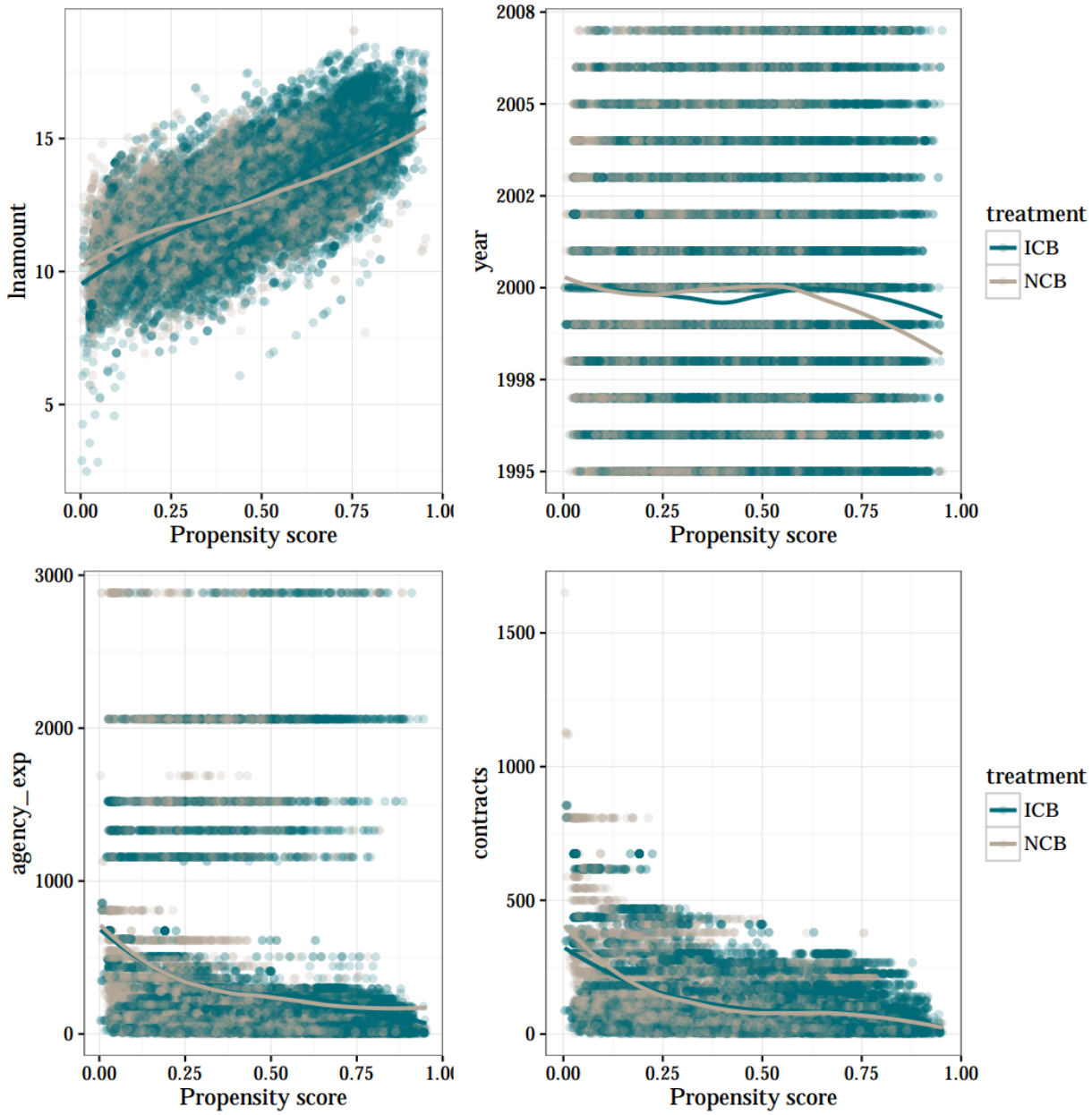


(F) Finalization Time



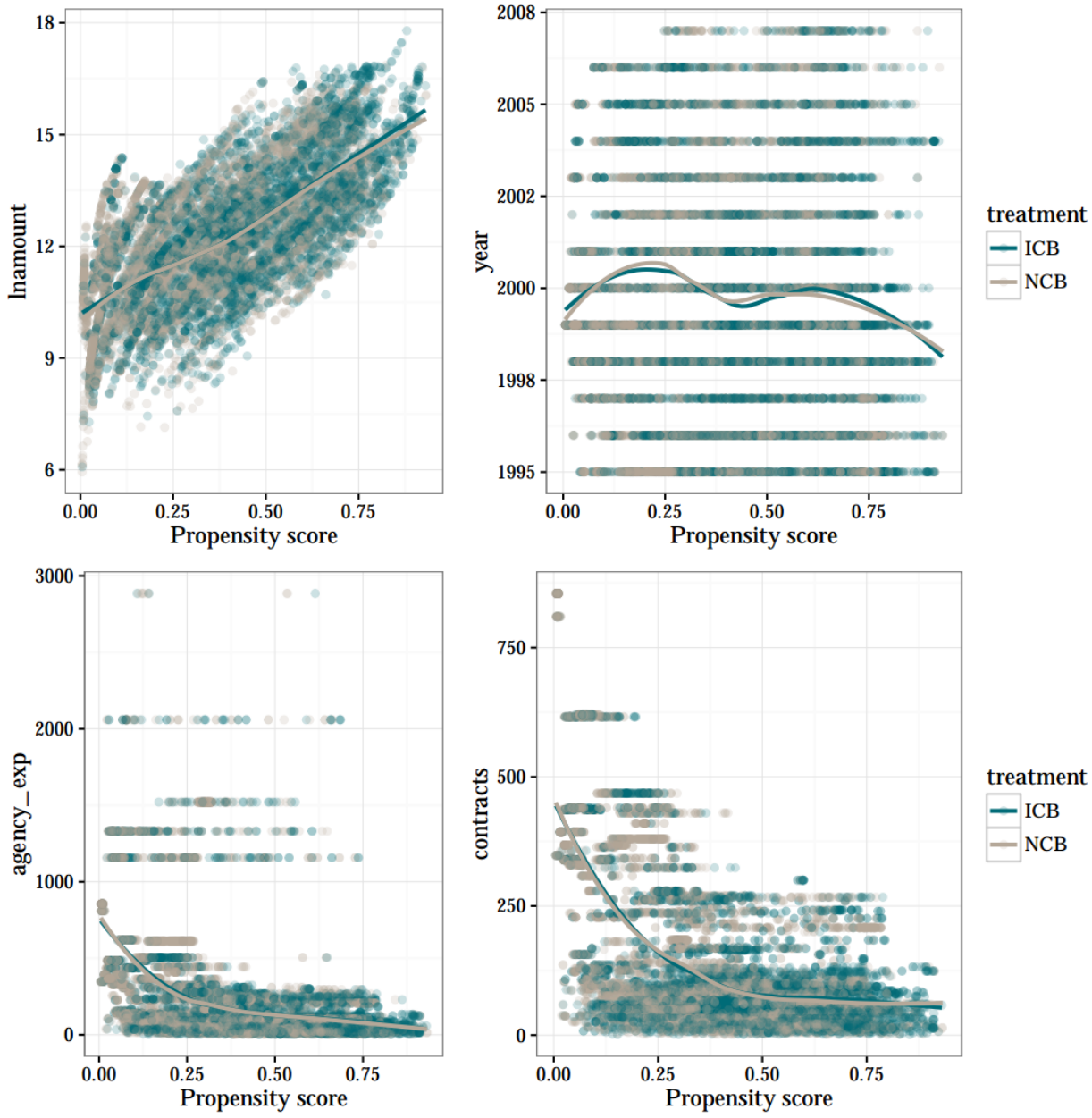
Note: Local Linear Regressions over scatterplots of binned (rounded) values by ICB status. ICB and NCB observations are blue and red respectively.

FIG. 13: Covariate Balance PSM



Note: Kernel Densities of estimated propensity score for both ICB (treatment) and NCB (control) groups.

FIG. 14: Covariate Balance CEM



Note: Kernel Densities of estimated propensity score for both ICB (treatment) and NCB (control) groups.