China's Land Market Auctions: Evidence of Corruption?

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Abstract

In China, urban land is owned and allocated by leasehold sales conducted by city land bureaus. These sales are viewed as a major venue for corruption. In an effort to cleanup, it is now required that leasehold sales be conducted at public auctions, but we argue corruption persists. The paper models corruption in a new way which is relevant in developing countries, as the choice of auction format, where there is a pre-auction side deal between a favored developer bidder and the land bureau official(s). There are two main types of auctions: regular English auction and a type we call "two-stage auction". Modeling suggests two-stage auctions are more corruptible, enabling a favored developer to signal in the first stage that the auction is "taken" which deters entry of other potential bidders and raises the chance the favored developer wins the auction. The empirics suggest that, overall, sales prices are significantly lower for two-stage auctions than English auctions. Moreover selection on unobserved property characteristics into two-stage auctions is positive: officials divert hotter properties to the more corruptible auction form. A variety of other evidence is assembled to corroborate the analysis of the form and existence of corruption.

Keywords: Land prices, auctions, corruption, China, Henry George Theorem

JEL codes: D44, D73, H82, H83, P35, P37

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This paper studies public auctions of leaseholds in the urban land market in China in 2003-2007. Urban land is owned "by the people" and its allocation done by the state, generally by each city's land bureau.[1] Starting in 1988, use rights for vacant land in the city were allocated through leaseholds, where, for a fixed sum, users obtained a lease of 30-70 years for a specified type of use (Ding and Knapp 2005, Valetta 2005). Vacant land could be rural land obtained by the city for urban use or land within the city slated for redevelopment. In the 1990's, most of these allocations were done by "negotiation" in a hidden process, where reportedly leaseholds were often sold for a tiny fraction of market value, with certain city officials enriched. This procedure deprived cities of major revenues and in many cases surely leaseholds did not go to the best user. As a current revenue source, for the 15 cities we study in China, leasehold sales were about 21% of all locally funded public expenditures in 2007.

Discontent with corruption in urban land markets prompted a series of reforms in the early 2000's. Most critically for this paper, a 2002 law banned negotiated sales by land bureaus, with the last date for any negotiated sales being August 31, 2004. For the last 4 years at least, all urban leasehold sales for private development are to be done through public auctions, with details of all transactions posted to the public on the internet. Another reform in 2002 banned the secondary market for "land development rights," which had allowed large traditional holders (e.g., state owned enterprises) to, in effect, privately sell off their own land use rights (Zhu, 2004, 2005). From 2002 on, these allocations reverted to city land bureaus. As part of showing the anti-corruption campaign was serious, there were visible indictments and convictions of high level officials connected with the land market, most visibly in Shanghai.

For the key reform, the hope was that public auctions with details posted on the internet would offer a transparency that would eliminate corruption. Indeed in terms of potential buyers' ability to enter and bid in auctions and of the bidding process once auctions are underway, auctions seem above board. However the rules allow more than one auction type and there are two main types in most cities: regular English auction and an unusual type which we call a "two-stage auction." The procedures governing these auctions are detailed later, but we believe the ability to choose two-stage auctions instead of English auctions provides the wiggle room for significant corruption to persist. The second stage of a two-stage auction is an English auction which occurs if more than

[1] Rural land is owned by the village and allocations done by the village leadership. The central government (national asset committee) and the military may control portions of city land in particular cases, as for example the national capital Beijing.

one bidder is still competing at the end of the first stage. The first stage is a time interval when bids are delivered to the land bureau and publically posted in the order received. Why might the existence of this first stage facilitate corruption?

The paper argues that corruption in land markets in China primarily takes the form of a side deal between a bidder and corrupt city official(s), rather than, say, bidding rings as in the USA. That side deal may include special help from the land bureau in developing the property as discussed below; and, for which, we provide some corroborating evidence. Given a side-deal, in certain contexts, in maximizing her objective function, the corrupt land bureau official will choose to run a two-stage, as opposed to English auction, to enhance the chances that her corrupt partner wins the auction. Two-stage auctions are very likely to have just one (corrupt) bidder, or no competition (and no second stage). The theory and empirical evidence will suggest that the first stage of a two-stage auction allows that bidder to signal that the auction is "corrupted" with an early first stage bid at reserve price, which deters entry. The result is lower prices paid by the buyer in two-stage auctions, relative to what the same property would sell for in an English auction. This price difference of course could occur because properties with poor unobserved characteristics are sold in two-stage auctions. However we will show empirically that selection in fact is positive. And we will argue theoretically that corrupt land bureau officials are likely to divert "hot" properties to two-stage auctions and leave "cold" properties for English auctions.

An evaluation by the National Audit Office of China in 11 cities reaches the following conclusion as reported in the *Asian Times* in June 2008:

> "Chinese government efforts to clean up land sales, a major source of official corruption…, face a rethink………..according to an investigation published by the National Audit Office (NAO) last week.
> ….*Some cities have given a flexible interpretation to the rules and the auction system has often existed in name only, resulting in a lack of competition among developers and the winning developer being able to secure the land at below its true market value* [italics added]."

The raw data on auctions also suggests something untoward is occurring, particularly in the use of two-stage relative to English auctions. As detailed below, we use data on 2302 auction transactions from 2003 to 2007 in 15 cities, which use both auction types. In these cities English auctions account for 28% of auctions. In Figures 1 and 2 we present patterns in the raw data. Figure 1 shows the distributions of the "spread", defined as the ratio of sales to reserve prices by auction type; and Figure 2 shows the corresponding distributions of unit sales prices (price per sq. meter).

In Figure 1, two-stage auctions tend to be absolutely and relatively massed around 1.0 for spread, so sales equal reserve prices. As we will show later, a ratio of 1 implies that there is just one bidder and thus no competition. Ratios larger than 1 imply multiple bidders and what we term a competitive auction. Although as we will discuss below, properties and buyers are heterogeneous, there should not be a lack of competition in general. Auctions occur in a setting of rapid urban growth, with per capita urban incomes growing at 7-10% a year and local population at 2-5 % a year. Given national restrictions on conversion of rural to urban land at the city fringes, this suggests there should be a high demand for land for new development. Corresponding to Figure 1, Figure 2 shows that the distribution of unit sales prices for English auctions is shifted to the right of that for 2-stage auctions. Of course these suggestive patterns in the raw data are influenced by property characteristics and selection, and the econometric work must account for that.

While the contribution of this paper is in part to improve our understanding of an important public policy issue in China, it contributes to three other literatures. First is the corruption literature (see Rose-Ackerman, 2006). One point is that while significant policy reforms can help in fighting widespread corruption, in a weak institutional environment corrupt government officials and their partners can still find cracks. In the context of China, recent studies have identified other "tricky" cases of corruption and illegal activities, for example, tariff evasion using entrepot trade (Fisman and Wei, 2004, Fisman, Moustakerski and Wei, 2008) and corruption and bribery using travel and entertainment expenses (Cai, Fang and Xu, 2009). Fighting corruption in developing countries like China is a long term process whose success presumably relies on, and is a part of the gradual improvement of the overall institutional environment. Another point is that while corruption, say in the form of bribe payments, is not often observed, a researcher can bring a variety of indirect evidence to establish the case. Here we use simple theory and a variety of evidence beyond auction type price differentials to establish the case. As a preview, such evidence will include the nature of selection, the relevance of particular political instrumental variables in predicting choice of auction type, the evidence of signaling at reserve prices in two-stage auctions as opposed to jump bids (Avery, 1998), ex post information on a sub-set of developments, and the like.

Besides the corruption literature, we contribute to the auctions literature by modeling corruption in auctions in a new way, where corruption takes the form of (1) choice of auction type as opposed to corruption in a give auction format and (2) a side deal between a bidder and the auctioneer in an open auction context (as opposed to sealed bid), without a bidding ring (c.f., McAfee and

McMillan, 1992, Burguet and Che, 2004, Compte, Lambert-Mogiliansky and Verdier, 2005, Menezes and Monteiro, 2006). We believe this form of corruption applies in public auction contexts in other countries. Finally, there is the public finance literature on the Henry George tax, where land rents in a city in principle could fund an efficient level of local public expenditures (e.g., see Atkinson and Stiglitz, 1980). If leasehold sales had been at market prices since the early 1990's and that money had been put into a public investment fund, it could have funded most local public expenditures into the future. That unusual opportunity was clearly squandered.

The paper is organized as follows. We start with background information on land markets, auction formats, and the data. We then present a conceptual framework to model the key differences between the auction formats. Section 3 estimates a reduced form model of price differences between the two auction types, and discusses instruments for auction type used to estimate selection into auction type. In Sections 4 and 5, we split the analysis of price differences into its two key components: whether a property is likely to have multiple bidders and sell competitively or not depending on auction type; and whether there are price differences across auction types, conditional on a property selling competitively. Concluding remarks are in Section 6.

1. Background

How does China's urban land market work? Apart from many conversations with officials and developers connected with land markets in Beijing, we conducted surveys of land bureau officials in 20 cities, asking questions regarding the differences between the two auction formats and reasons for choosing one auction type over another. Our modeling is informed by our survey findings. While detailed procedures may differ somewhat across cities, the typical procedure works as follows. There is a local planning bureau which does long term land use planning. Based on these plans, each year a land use allocation committee decides the use and development (e.g., floor to area ratio) restrictions and the sequencing of sales of leaseholds on properties about to be available for (re)development during the year, from both acquisition of rural lands and assembly of urban lands. Each plot of land is large with, in our sample, a median area of 22,300 square meters and a median sales price of USD $7 – 8 million. The allocation committee is typically a city-wide committee, with members such as the mayor and heads of relevant local bureaus (e.g., planning and land bureaus). Properties are then turned over to the land bureau for clearing (if necessary), choice of auction type and auction. The setting of reserve price is also important (although not critical) to our empirical formulation. Each piece of property is appraised by an independent appraiser, based on comparables. Reserve price is set by the allocation committee given this appraisal (e.g., "minimum market value"), before the property is turned over to the land bureau and choice of auction type is made. Indeed, conditional on property characteristics, in our data, reserve price is uncorrelated with both auction choice and the political variables we use as instruments.

There are three types of auctions used in China's land market. About 97% of sales in major cities are accounted for by two of these, with the third used almost exclusively in Beijing and Shanghai. We ignore this third type and our econometric specifications exclude Beijing and Shanghai which do not hold English auctions.[2] Unfortunately, while for each auction we know auction type, property characteristics, reserve price and the winning bid, we are missing valuable information such as the sequence of bids or even the total number of bidders. The two main types of auction are *guapai* which we call two-stage auction and *paimai* which is an English auction. English auctions are standard ascending bid auctions, usually publicly announced 20 working days before the auction. At announcement, basic details (e.g., use restrictions, reserve price, location) are publicized; and potential bidders can inspect the site and for a small fee can obtain more detailed information. Participation in the auction requires "qualification"-- the key part being a cash deposit, usually about 10% of the reserve price.[3] This is a non-trivial requirement given the large sizes and sales prices of such properties. English auctions are public, often video-taped with the press present. Winning bidders in principle must develop the land themselves. Once into the auction process itself, both types of auctions are clean: participants cannot be arbitrarily excluded or their bids ignored.

As with English auctions, two-stage auctions are announced about 20 working days in advance; details of the plot are made public; and a deposit is required upon participation in the auction. The first stage normally lasts 10 working days after the auction starts. In the second stage, at the end of the 10 working days, if more than one bidder is competing for the property, the

[2] The third type is sealed bid, or *zhaobiao* auction. Sealed bids are submitted to the land bureau, and the winner determined by a complicated score function, in which the magnitude of a submitted bid has only a 20-30% weight. The remaining weight goes to the reputation and financial capacity of the bidder and his "social responsibility" Social responsibility is often a commitment to an upper bound on the housing prices charged in the future development, as part of Beijing's recent attempt to curb rising housing prices.

[3] In addition to cash deposits, qualification involves things like being a China-based firm, not having a criminal record, and not having a record (complaints) of shady development practices in dealing with consumers.

auction ends on the spot with an English auction where active bidders from the first stage participate. In the first stage during the 10 working days between the starting date of the auction and the potential ending English auction, people may enter the auction after obtaining qualification, and submit ascending bids to the land bureau. Bids as they arrive are immediately posted on the trading board of the land bureau, as well as typically on the internet (so that later potential bidders may decide whether to enter the auction or not based on previous bids posted), although the identity of bidders is not posted. If, at the end of 10 working days, there is only one remaining participant bidding, that bidder is assigned the property at his bid price (but not less than the reserve price). Otherwise, with competition, the auction is converted to an English auction.

We will argue the first stage allows for early signaling to non-corrupt potential bidders that the auction has been "corrupted" and will potentially be dominated by a corrupt bidder (in league with the land bureau). Early signaling will have a deterrence effect on entry of non-corrupt bidders, enhancing the chances that the corrupt bidder wins the auction and that the deal with the corrupt official goes forward. The signal is a bid at reserve price by the corrupt bidder, the instant the auction is announced. There are fuzzy parts to the two-stage auction format which we think permit the corrupt bidder to signal with meaning. While the auction is announced *about* 20 working days in advance, the exact date of the start of the first stage of the auction may not be specified. Second, while bidders can apply during the announcement period before the first stage starts, approvals to participate, or qualification can be delayed until after the first stage is under way. Thus the corrupt bidder alone may know the exact time the first stage starts and he alone may be qualified to submit a bid at that time. If there is a bid at reserve price when the auction opens, other bidders will know it is very likely that the auction has been corrupted. This signal has the side advantage that the corrupt bidder is likely to get the property more cheaply, at reserve price.

For signaling to work, the signal must communicate some real advantage to the corrupt bidder (given bidding processes are clean), so other bidders are deterred. That advantage comes in the form of special help the corrupt developer receives in developing the property from the land bureau. Such help includes better clearing of the site to be developed, better provision of local infrastructure, and relaxed interpretation of development restrictions. For example, for a sample of residential developments discussed in Section 1.1 and 3.6, we find that overall floor to area ratio

[FAR] restrictions on the development are more likely to be violated ex post for land acquired through two-stage, as opposed to English auctions.[4]

1.1 Data

We have three different data sets. For econometric analysis, we have data for 2302 completed auctions from 15 cities which held both English and two-stage auctions from 2003-2007.[5] Details of the drawing of the sample are given in the data Appendix. The data are from the Land Bureau of China (or its branches at the city-level). We also obtained the geo-economic characteristics of each piece of land for sale through bendi.google.com. Specifically, we locate each piece of land in the digital map of bendi.google.com using its street address. We then measure the line distance between the land and the CBD of the city and we create dummy variables to indicate, whether within a 2.5 km. radius of the center of the property for sale, there is railway (including light rail and subway) or highway.

For each auction, the land bureau provides detailed information and posts it on its official website www.landlist.cn. Information includes: the address, the area (in square meters), the use restriction (business, residential, mixed), the type of auction, the reserve price, the sales price if the sale is completed, the post date which is the first date bids are accepted, the sale date, and the buyer's identity. Sometimes additional information is given, such as the maximum floor-to-area ratio, the building-density, the green coverage rate, and whether the property is cleared or not. For these additional items, explicit information is only provided in a limited number of cases. As noted above we do not know the total number of bidders, or the sequencing of bids.

The second data set is just for Beijing for the same time period. Beijing is not in the main data set used in econometric analysis because it holds no English auctions. For two-stage auctions in

[4] In the sample discussed in Section 3.6 below, we observe FAR violations by April 2009 in on-going developments (not completed ones) for land sold in our 15 cities in the years 2003-2008. We expect less chance for a development to yet be in violation for land that is sold later, so we want to distinguish year effects. We start with a sample with relevant information of 342 developments; but, because of tiny cell sizes (under 10 by auction type or by violation by year), we drop 2003, 2004 and 2008. Controlling for ask price, the floor to area ratio limit, city and year of sale fixed effects, for land sold in 2005, a property is significantly more likely to be in violation by April 2009 if it was sold at two-stage auction (compared to English), as estimated by a logit. The effects for 2006 and 2007 are positive but t-statistics are only 1.37 and 1.63. We then looked at a Tobit for the extent of violation – the actual floor to area ratio by April 2009 over the limit set at auction—with truncation at a ratio of 1. We find significant increases in the extent of violation for properties sold by two-stage (over English) auction in both 2005 and 2006.

[5] These are Xiamen, Guangzhou, Shenzhen, Nanning, Changchun, Suzhou, Wuxi, Nanchang, Shenyang, Taiyuan, Chengdu, Tianjin, Hangzhou, Ningbo, and Chongqing.

Beijing only, we know the number of bids each day in the first stage. We use these data in the next section, to corroborate certain features of two-stage auctions that are postulated in the theory.

The third data set collected in early 2009 is for ex post residential developments called *loupan*. For our 15 cities, for residential land we were able to match 499 still on-going residential developments with our land auction data, with residential development data coming from www.soufang.com. Given the sizes of the plots of land for leasehold, these are all large scale, multi-year projects. For many of these projects, we have a current price per square meter of floor space, and detailed information on floor to area ratio restrictions, total floor space developed by April 2009, and the specific type of residential development. These data are being analyzed in detail in a separate project, but we use them in this paper to establish two things. First, as noted above floor to area restrictions are more likely to be violated, if the land was sold by two-stage as opposed to English auction. Second, in Section 3.6, we examine how the ex post price per square meter of floor space and the gap between that and auction price vary by auction type.

2. Conceptual framework

In this section we model the choice of the English versus two-stage auctions which the land bureau as auctioneer makes. Apart from analyzing the two types of auction under corruption, we want to understand why both formats are found in the data and, under what circumstances, one format is more likely to be chosen than the other.

2.1 Some basics

Assume for a leasehold auction there are *N* potential bidders, of which some endogenous number *n* pay an entry fee, *C*, and become active bidders.[6] A key issue is how the choice of auction format may influence *n*. We assume auctions are independent private valuation. Specifically, a potential bidder i 's valuation is $V_i = v_0 + v_i$, where v_0 is the (expected) common value that is the same for every bidder (based on property characteristics and local market conditions) and v_i is the private value component only known to bidder i. v_i 's are i.i.d. Since v_0 is common knowledge, auctions are independent private valuation ones. We make the standard assumption that all bidders are risk neutral and maximize their expected payoff. Let $V_i \propto F(V)$ on $[0, \bar{V}]$ be the distribution function of

[6] The entry fee consists of (i) cost of making cash deposit to qualify, (ii) cost of preparing documents to meet the qualification requirements, (iii) other transaction costs (e.g., time, consulting fee).

the bidder i's valuation, and let $f(V)$ be the associated density function. A bidder's payoff when winning the auction with a bid B_i is $U_i = V_i - B_i - C$.

We establish as a benchmark the outcome of an English auction in the absence of corruption. Given an English auction is outcome-equivalent to a second price Vickery auction, the setting is equivalent to that of Tan and Yilankaya (2006), who analyze a simultaneous move entry game in a second price auction with independent price valuations and participation costs. Absent corruption, in a symmetric equilibrium a bidder will decide to enter the auction if and only if his valuation is above a certain value $\hat{V} > r + C$, for r the reserve price and C the entry cost. For a bidder with valuation exactly equal to $\hat{V}$, he gets a rent of $\hat{V} - r$, only if he is the lone bidder in the auction, which happens with probability $F(\hat{V})^{N-1}$ (all other potential bidders have valuations below $\hat{V}$). Therefore, the valuation threshold for entry $\hat{V}$ must satisfy

$$F(\hat{V})^{N-1}(\hat{V} - r) = C. \qquad (1)$$

Equation (1) yields a valuation threshold for entry $\hat{V}$ in equilibrium that depends on $(r, C, N, \bar{V})$. and is increasing in r, C, N. The probability of selling at the reserve price is $NF(\hat{V})^{N-1}[1 - F(\hat{V})]$. One can derive the other usual English auction results, as detailed in Cai, Henderson and Zhang (2009). What happens with corruption?

2.2 Form of corruption

As discussed above, today city officials cannot simply rig auctions, by, for example, arbitrarily completely excluding qualified bidders, or not recognizing certain bids once submitted. They can only operate in the less visible fuzzy areas noted earlier and in the choice of auction type. Thus, we model corruption in the following, stylized fashion.

Under a corrupt sale, the land bureau official(s) reaches an agreement with a particular developer, say, developer 1, so that if he wins the land auction, she will provide special help in exchange for a bribery payment. Let Q be the value of the land bureau official's help to developer 1, and let $q \le Q$ be the bribery payment developer 1 makes to the land bureau official, if he wins the auction. Define $\kappa \equiv Q - q$ as the net benefit to developer 1 from having an under-the-table deal with the land bureau official.

Assume the corrupt land bureau official's payoff function from the sale of a piece of land is given by

$$(1-\lambda)ER+\lambda q\omega . \qquad (2)$$

In (2), ER is the expected revenue from the land auction (that goes to the city coffers). $\lambda\in[0,1]$ measures the weight on corruption income by the official. While λ may reflect pure preferences of the official, it may also reflect the anti-corruption environment or penalties associated with being caught (which could also be added on directly), which will vary over city and time in the empirics. When $\lambda = 0$, the official is non-corrupt and seeks to maximize the expected revenue from the sale of land. As λ becomes larger, the land bureau official cares more about her own expected bribery income, ωq, in the second term in (2) and less about the city's fiscal revenue. ω is the probability of the joint event that developer 1 and the official are in league and that developer 1 enters the auction and wins. For any land sale, we assume with probability p developer 1 and the land bureau official are in league. This reflects the likelihood the land bureau official in charge of a land sale is corrupt and she has a "partner" developer who is potentially interested in the land, where they must trust each other. Only the land bureau official and her partner know about any under-the-table arrangement, although other potential bidders may infer it once two-stage auctions are underway. But a priori, other potential bidders only know with probability p that the auction may be corrupted.

Why do not follow the literature and model bidding rings as central to corruption (e.g., McAfee and McMillian, 1992, Bajari and Ye, 2003, and Athey, Levin and Seira, 2008)? In China, a group of developers could attempt to rig an auction; and a generalization of the model would have developer 1 representing a ring of insiders, with the rest of potential bidders being outsiders. We don't emphasize bidding rings for several reasons. One is that the government's focus on corruption in land markets has not been on collusive bidding, but rather on corruption among officials. Correspondingly, as noted later, the instrumental variables for auction type relate to detection of corruption of government officials. Related, in China, it may be less appealing (more dangerous) for individuals to collude against the state per se, as opposed to collude with the state. Another reason is that there are relatively few repeat winners in land auctions, as noted below. With bidding rings we think of rotation of assigned winners from the bidding ring, in a setting where the same parties are interested in each auction. Leasehold sales in a city involve highly heterogeneous items with different sets of interested parties. For us that also ruled out modeling which assumes a buyer's private valuations may be known by the land bureau. Finally, there seems to be no reason why collusion among bidders would be more successful in two-stage auctions than in English auctions, so collusion among bidders would not explain the substantial difference in the likelihood of non-competitive bidding between the two-stage and English auctions observed in our data. In fact, collusion within a ring might be better enforced in public English auctions.

2.3 English auction under corruption

Before the auction format is chosen for a property, the land bureau either does or does not make a deal with a corrupt potential bidder, bidder 1. Then the land bureau chooses the auction format. If she chooses English auction, then bidders make simultaneous entry decisions. From the point of view of non-corrupt potential bidders, there is a probability of p that the auction is corrupt and there is a corrupt bidder with total valuation of $V_1+\kappa$. With probability of $1-p$ the auction is not corrupt and bidder 1's valuation is V_1. In this case, let $\hat{V}_{1P}$ be the valuation threshold for entry for bidder 1 when corrupt, and let $\hat{V}_{-1}$ be the valuation threshold for entry for all other bidders.

With the possibility that bidder 1 is corrupt, other bidders make entry decisions in an asymmetric bidding game. The entry condition is similar to equation (1) except now a non-corrupt bidder must allow for the fact that there may be a corrupt bidder. Given that, $\hat{V}_{-1}$ must satisfy the following equation:

$$F(\hat{V}_{-1})^{N-2}\Big\{p\Big[F(\hat{V}_{-1}-\kappa)-F(\hat{V}_{1p})\Big]E\Big[(\hat{V}_{-1}-V_1-\kappa)\,|\,V_1\in[\hat{V}_{1p},\hat{V}_{-1}-\kappa]\Big]+ pF(\hat{V}_{1p})(\hat{V}_{-1}-r)+(1-p)F(\hat{V}_{-1})(\hat{V}_{-1}-r)\Big\}=C. \qquad (3)$$

The bracketed expression on the left hand side represents a non-corrupt bidder's expected rent in each of three cases: (i) the corrupt bidder enters but has an evaluation less than the non-corrupt entrant; (ii) the corrupt bidder 1 does not enter; and (iii) bidder 1 is not corrupt and does not enter. Note that the above equation assumes that if bidder 1 is not corrupt, he acts like any other bidder by using the same entry strategy.[7] If there is a corrupt bidder, his valuation threshold for entry $\hat{V}_{1P}$ satisfies

$$F(\hat{V}_{-1})^{N-1}(\hat{V}_{1p}+\kappa-r)+\sum_{m=1}^{N-1}\hat{w}_m=C \qquad (4)$$

[7] This assumption holds when ex ante no one knows the identity of the potentially corrupt bidder. If everyone knows that bidder 1 is corrupt, he is more likely to enter than other bidders, even if in fact he does not have a deal. This is because only bidder 1 knows that no one else is corrupt and all other bidders are worried that bidder 1 is corrupt. This is not that realistic but the analysis will not change much if we allow for this possibility.

where $\hat{w}_m$ is bidder 1's expected rent when his valuation is $\hat{V}_{1P} + \kappa$ and there are m other active bidders, whose valuations are above $\hat{V}_{-1}$ but less than $\hat{V}_{1P} + \kappa$.

In evaluating the influence of corruption on a standard English auction, in the Appendix we show that in equilibrium, $\hat{V}_{1P} < \hat{V} < \hat{V}_{-1}$, where $\hat{V}$ is the entry threshold absent corruption. The intuition is that thanks to the favor from the land bureau official, the corrupt developer 1 has a better chance of having the highest valuation. So he is more likely to enter ($\hat{V}_{1P}$ is lower than $\hat{V}$) than in a non-corrupt auction. Facing the possibility that bidder 1 may be favored, the other potential bidders are less likely to win and thus are less likely to enter ($\hat{V}_{-1}$ is higher than $\hat{V}$).

2.4 Two-stage auction under corruption

In the two-stage auction, if the land sale is corrupted so that bidder 1 and the land bureau official are in league, bidder 1 acts as soon as stage 1 ensues. Since both would like to let all other potential bidders know that this land is "claimed," a simple and natural way to send that signal is for bidder 1 to obtain qualification and to make a bid right after the auction is started, before other potential bidders are granted qualification to bid, and perhaps even before they know that the auction has actually started. Since bidder 1 is only signaling that he has the agreement with the land bureau official, bidder 1 only needs to signal the agreement, by bidding just the reserve price (to increase the rent from winning the auction). When the extra help he gets from the land bureau official, κ, is relatively large, such signaling by bidder 1, if believed by other bidders, will seriously deter entry by other bidders given an entry fee (c.f., Hirshleifer and Png 1990 and Ockenfels and Roth 2002), since they see little hope of outbidding bidder 1.

We consider the following equilibrium. Let $\tilde{V}_C$ be the minimum threshold in which bidder 1 will send a signal by bidding the reserve price. If seeing that bidder 1 bids at the reserve price right after the auction is announced, all the other potential bidders understand that bidder 1's valuation is $V_1 + \kappa$, where $V_1 \in [\tilde{V}_C, \bar{V}]$. As a simplification, other bidders decide simultaneously whether to enter. While other bidders could also decide in some arbitrary sequence in stage 1 whether to enter or not, we collapse that into a simultaneous decision to make calculations tractable. By construction, this staging also eliminates any potential snapping strategy by a non-corrupt bidder to also bid early, but such snapping is highly unlikely in the more general case if κ is large.[8] If $\tilde{V}_0$ is the valuation threshold for all other potential bidders, it satisfies

$$F(\tilde{V}_0)^{N-2}\left[\frac{F(\tilde{V}_0-\kappa)-F(\tilde{V}_C)}{1-F(\tilde{V}_C)}\right]E\left[(\tilde{V}_0-V_1-\kappa)\,|\,V_1\in[\tilde{V}_C,\tilde{V}_0-\kappa])\right]=C\,, \qquad (5)$$

where now a non-corrupt bidder knows if a corrupt bidder has entered ($V_1 \geq \tilde{V}_C$). Second, $\tilde{V}_C$ must satisfy an equation similar to equation (4) with $\tilde{V}_C$ replacing $\hat{V}_{1P}$ and $\tilde{V}_0$ replacing $\hat{V}_{-1}$, yielding

$$F(\tilde{V}_0)^{N-1}(\tilde{V}_C+\kappa-r)+\sum_{m=1}^{N-1}\tilde{w}_m=C\,, \qquad (6)$$

where $\tilde{w}_m$ is the corrupt bidder's expected rent when his valuation is $\tilde{V}_C+\kappa$ and there are m other active bidders, whose valuations are above $\tilde{V}_0$ but less than $\tilde{V}_C+\kappa$. When no one bids at the reserve price right after the auction is announced, then bidders understand that the auction is not corrupted, in which case we have an ordinary English auction with *N-1* potential bidders.

2.5 Comparison of English and two-stage auctions under corruption

With a first day bid at the reserve price signaling a corrupt auction, non-corrupt bidders are less likely to enter a two-stage auction than an English auction and thus there is less likely to be competition. Correspondingly, bidder 1 is more likely to participate in a two-stage auction than an English auction. In the Appendix we show, for the first point, that $\tilde{V}_0 > \hat{V}_{-1}$; and, for the second, that $\hat{V}_{1p} > \tilde{V}_C$. The intuition is that, in the case of an English auction, other potential bidders do not know whether bidder 1 is corrupt. They only know that he is corrupt with probability p , and they make entry decisions simultaneously with bidder 1. However, in the two-stage auction, the other potential bidders know for sure whether bidder 1 is corrupt or not. When he is corrupt, other potential bidders have a much smaller chance of winning the auction if bidder 1 has substantial

[8] The issue is whether a non-corrupt bidder would be tempted to mimic the behavior of bidder 1 to scare away other bidders. Even if this snapper could manage to bid at the reserve price before the true corrupt developer, the latter is likely to make a higher bid in order to reclaim the land as long as κ is relatively large. In such a case, the snapper will lose the auction and waste his entry cost, with an example given in Cai, Henderson, and Zhang (2009) that this would not be an equilibrium strategy. When κ is not sufficiently large, a non-corrupt bidder may try snapping when his valuation is very high with less fear of being outbid by a corrupt bidder. It is possible that in equilibrium, a non-corrupt bidder with very high valuation and a corrupt bidder are pooled in using the same strategy of bidding at the reserve price at the start of the auction (whoever manages to be the first is immaterial). In that equilibrium, a corrupt bidder who does not get the chance to submit a first bid will try to outbid the non-corrupt bidder only when he also has a quite high valuation. What is important, however, is that in such a pooling equilibrium, other bidders are seriously discouraged to enter, either by a very high valuation non-corrupt bidder or by a corrupt bidder.

advantages from having a higher expected valuation given government help and having signaled. This reduces the incentives to enter for other potential bidders. Given that, bidder 1 sees less risk of losing the auction and thus is more motivated to enter a two-stage auction than an English auction.

That the corrupt bidder is more likely but other potential bidders are less likely to enter a two-stage auction implies that the corrupt bidder has a better chance to win in a two-stage auction than in an English auction. In the Appendix we show that under different configurations of his valuation relative to threshold values, the corrupt bidder is at least as likely to win in a two-stage auction and more likely in some configurations, compared to an English auction. Since the corrupt government official can get bribery income only if the corrupt developer wins, ceteris paribus, she is more likely to favor two-stage auctions as the weight, λ, on corruption income rises.

2.6 Hot versus cold properties: positive selection

Now we turn to the issue of positive selection on unobservables into two-stage auctions. The general idea is that, for hot properties, competition from non-corrupt developers makes it more difficult for the corrupt developer to win an English auction. As discussed above, the corrupt developer can fend off competition more easily in the two-stage auction by making a signaling bid. Therefore, a corrupt government official who cares sufficiently about her bribery payment is more likely to favor a two-stage auction over an English auction when the property to be sold is hotter. This suggests positive selection on unobservables into two-stage auctions.

"Hot" can be defined in different ways. A straightforward way is to define it as the number of potential bidders, N, holding constant the common value and distribution function of valuations, and that is the example we use here (with other possibilities discussed in Cai, Henderson and Zhang, 2009). In using N as the measure of hotness, for selection, the key idea is that we expect the positive difference in the probability that the corrupt developer wins the land between a two-stage and an English auction to rise with N, so that the gap in $\lambda q \omega$ terms in the land bureau official's objective function between the two auction formats rises. However, this derivation (e.g., deriving $d\hat{V}_{-1}/dN$ and $d\hat{V}_{1p}/dN$ from equations (3) and (4)) turns out to be very difficult for the general case, so we constructed two examples, presented in the Appendix. The first example is a special case, where in a two-stage auction no other bidders ever enter, but they do so in an English auction with the chances of a corrupt bidder winning declining as N rises. Then hotter properties are more likely to be assigned to two-stage auction.

We then programmed a general example where non-corrupt bidders have some chance of entering either auction type and λ can take all feasible values, comparing regimes where N=2 versus 3. Such calculations even just for N=3 are rather complex. In the Appendix we illustrate that, for low values of λ, English auctions are preferred while, for high values, two-stage auctions are preferred for both values of *N*, as discussed above. However there is an intermediate range where for N=2 English auctions are preferred, while for N=3 two-stage auctions are preferred. That is, there is positive selection into two-stage auctions. For comparative statics, as κ rises, the ranges of λ where two-stage auctions are preferred increases for both values of *N*. Similarly as entry costs rise, the range increases (signaling has a great deterrence effect).

2.7 Auctions without corruption

At the beginning of this section we established the benchmark of an English auction without corruption. Here we compare that outcome with a two-stage auction also in the absence of corruption to suggest two things: (1) initial bids at greater than reserve price should be expected and (2) negative selection into two-stage auctions may be likely. Two-stage auctions without corruption are more difficult, but the analyses are related to the jump bidding literature (see Daniel and Hirshleifer 1997 for the case of private valuation and Avery 1998 for the case of common valuation). We detail analyses in Cai, Henderson and Zhang (2009) with some highlights in the Appendix here. The basic ideas are as follows. Now the first stage is a chance for a bidder, say bidder 1, to signal high valuation, not corruption. In that case, the bid will signal his actual valuation. We show in the Appendix that the bidding function is increasing in his evaluation. The signaling bid discourages subsequent potential entrants from entering, who might have drawn somewhat higher valuations, because they know that, if they enter, the prior signaler is prepared to bid up to his valuation. That inferred valuation then defines the minimum price they have to pay. Thus signaling reduces the expected rent of other potential entrants.

As with corruption, the probability of no sale is lower in a two-stage auction than in an English auction. Bidder 1 can now discourage entry of other potential bidders with an early jump bid, making her more likely to enter in a two-stage auction than in an English auction. The flip side of this is that the probability of competitive bidding (two or more active bidders) is lower in a two-stage auction than in an English auction, because the early entrant may deter later entrants. As a result, in terms of expected revenue, while a two-stage auction has a higher probability of sale, the likelihood of competitive bidding is smaller. Thus, depending on parameter values, the expected revenue of a two-stage versus English auction can be more or less. Thus there are different circumstances where a revenue maximizing land bureau would choose one format or the other.

In Cai, Henderson, and Zhang (2009) we conjecture that when land is cold, the expected revenue of a two-stage auction is greater than that of an English auction. The intuition is that when land is cold, a two-stage auction has a relatively lower threshold entry for bidder 1 and greater likelihood of anyone entering. Thus any sale and some revenue are more likely under a two-stage auction. If land is "hot", so a sale is very high probability, an English auction is likely to attract more bidders and competition, since two-stage auctions may still lead to entry deterrence. Thus we might expect a revenue-maximizing land bureau to steer hot properties towards English auctions. Thus in contrast to the corruption case, absent corruption there would be negative selection on unobservables into two-stage auctions.

2.8 Other auction choice considerations

Another factor which would affect the comparison between English and two-stage auctions is the riskiness of the land to be auctioned. For different properties, the variance of the private value components could differ. For a given reserve price and same expected valuation, absent corruption, suppose for some reason, the land bureau assigns high variance properties to English auction. First note we might expect the opposite assignment. For a given reserve price, high variance properties have fat left tails to the distribution of V_i and thus generally have a lower probability of any valuation being over reserve price. Thus to ensure a sale and some revenue, with fat tails the land bureau might be expected to assign such properties to two-stage auction, with its relatively lower entry threshold. Nevertheless, assuming the assignment suggested, English auctions when a sale occurs would have a higher expected price, a possible explanation for our general results that properties sold by English auction bring a higher price. However, we note that, under this scenario, English auctions should also bring a higher expected price when the auction is competitive (has multiple bidders), something we do not find empirically. Nevertheless, we want to control for a number of observables which could be related to variance of valuations such as property type, size, and distance from the city center.

One additional issue we ignore is the sequence of land sales in a city. While it is true that developers can always bid on the next available land, land auctions differ from on-line auctions of staple goods. There is enormous heterogeneity of land for sale, as well as heterogeneity of developers. Any developer may not easily find readily substitutable pieces of land in a given year;

and different pieces of land attract different bidders, so sequencing has less consequence. Also the issue of the sequencing doesn't seem to fundamentally alter our arguments about auction choices.

2.9 Beijing: The nature of two-stage auctions

In the econometric work as noted earlier, we know only sales and reserve prices and nothing about the bidding process itself—sequence and number of bids. However for Beijing, we have a sample of 195 two-stage auctions, where we know the number of bids each day in the first stage. From that special sample, we learn several things. First, and most critically from Table 1, bidders do not signal valuations with jump bids, as they would in the absence of corruption. In all auctions with just one bid, almost all bids are within 0.5% of reserve price; this is consistent with our corruption story. Once we have 2 or more bids then a spread develops. This also becomes the basis for later defining whether an auction is competitive (has more than one bid) or not, based on spread. Note auctions can be highly contested: in 26 of the cases with 3 or more bids, there are reported to be over 65 bids in each of the auctions.

Columns 1 and 2 of Table 2 show interesting correlations, which are consistent with the theory. Conditional on property characteristics, having a first day bidder is negatively correlated with the number of bids. Having a first day bid, given 10 days to bid, would mechanically raise the number of bids (and a first day bid could indicate selection into better properties). Yet having a first day bid is associated with fewer bids. Similarly, in columns 3 and 4, having a first day bidder makes it less likely that the auction will be competitive, again consistent with the signaling story. [9]

Finally we note that in Beijing there are not strong patterns of repeat winners, where such patterns might be expected if bidding rings are prevalent. From 2004 to 2007, 171 of 258 auctions involve non-repeat winners over the four years. This is consistent with two ideas: there are lots of bidders in the Beijing market but properties are heterogeneous, each with a particular clientele. Twenty-one buyers repeat once, but most of those occur in the same and last year (2007), just before the Olympics at the height of construction frenzy. There are 7 people who win 3 times over 4 years, 2 who win 4 times, and 1 who wins 5 and another 11 (all in 2004).

[9] In Beijing sometimes properties are sold which, contrary to national policy, have not been cleared for redevelopment. For Beijing, we have good data on clearance, with 155 of the observations having an entry for this variable.

3. Baseline effect of auction type on sales prices

In this section we explore the reduced form effect of auction type on unit sales prices. In Sections 4 and 5, we will show that the difference is explained by the fact that, in comparison to English auctions, two-stage auctions are generally not competitive, with sales mostly at reserve price.

3.1 Raw data

Table 3 is summary of basic statistics for the 2302 auctions. In Part a, compared to English auctions, two-stage auctions have significantly lower mean unit sales prices and are significantly less likely to sell competitively (have a spread greater than 1.005), consistent with Figure 1. However they have no significant difference in unit sales price, conditional on a competitive sale. This suggests the main effect of two-stage auctions on prices in through deterring competition.

We note two-stage auctions have a greater proportion of commercial properties. After exploration, we decided that whether a property was designated as commercial was not a key element in the analysis. As Part b of the table reveals, commercial relative to residential and mixed use properties are more likely to be sold through two-stage auction and without competition (60% sold non-competitively versus 40% for residential and mixed use). However unit sales prices across uses are similar, both for those that are sold competitively and for those that are not.

3.2 Reduced form price equation

Based on Section 3, consider the specification

$$\ln sale\ price = \ln common\, value + f\,(potential\ number\ of\ bidders,\ auction\, type,\ \tilde{e}) \quad (6)$$

This specification follows the notion that there is a common value component to any bidders' valuation. Given this common value, ex ante sales price then depends on the number of potential bidders and potentially the auction format, with the ex post sales price dependent on the actual drawings of private valuations (which $\tilde{e}$ encapsulates). In the data, the potential number of bidders and certain determinants of the potential number of bidders (e.g. certain property characteristics) are unobserved. Choice of auction format should be related to unobservables. With corruption, we have argued that there will be positive selection—the setting aside of "delectable morsels" for corrupt participants. We also conjectured that absent corruption, there may be negative selection on properties sold by two-stage auction. Thus finding positive selection is consistent with there being corruption.

In equation (6), we assume reserve price is proportional to common value, with an added error component that is unrelated to any particulars of the sale ("evaluator error" in $\tilde{e}$). As noted above, reserve price is set by an outside committee, using a formula based upon the valuation of the land parcel carried out by an independent land appraiser. In that sense reserve price is an exogenous valuation of property based on characteristics of the property and general local market conditions; the issue of possible non-exogeneity of reserve price will be addressed at various points below. For the same common values to two different properties, the number of potential bidders will vary with the city in question (number of active land developers, controlled below by city and time fixed effects) and aspects of the property. For example, the potential number of bidders may differ for certain types of uses or properties near or further from the city center.

We implement equation (6) with

$$\ln sale\ price_{ijt} = \ln ask\ price_{ijt} + \tilde{X}_{ijt}\beta + d_{ijt}D + u_j + \delta_t + \varepsilon_{ijt} \tag{7}$$

for property *i* in city *j* which is sold at time *t*. $\tilde{X}$'s include observed property characteristics such as use restriction, area, and distance to the city center which may be correlated with the number of potential bidders and the variance of valuations, as well as seasonal dummies . Auction type, d_{ijt} , is whether the land bureau chooses a two-stage auction (=1) or not (=0), so that *D* is the effect of auction type on sales price, which we would like to identify**.** The terms u_j and δ_t capture city and year fixed effects. The arguments in ε_{ijt} are unobserved time-varying city conditions or property characteristics, which, controlling for common value, may increase the number of potential bidders. These conditions may also affect selection of auction type.

3.3 Selection problem and instruments.

To deal with auction selection, for our baseline results, we estimate a Heckman (1978) endogenous dummy variable model, as well as regular IV. Instrumental, or control function variables are ones which we think affect selection of auction type by the land bureau, but not sales price conditional on our covariates.

We rely mostly on two sets of instruments. These are two political variables, which induce the behavior of wanting at particular times to "appear clean" by substituting English auctions for two–stage auctions where the latter are known to engender corruption. The fact that such behavior appears in the data is consistent with the model (over city and time variations in λ) and we see as also being evidence of the greater corruption opportunities under two-stage auctions. Each arises from a pattern in the data which is illustrated for the first set, as follows. In the month before a new party secretary takes office in a city, the land bureau switches more to using English auctions and then a month later it switches back, in fact switching away from English auctions (in effect, catching-up to its usual mix). Figure 3 illustrates for the 17 cases in which a party secretary turns over. Each case is normalized in time, so the month of turnover is zero. We plot the ratio of English to two-stage auctions in our data for 7 months: the month of turnover and then lead and lag for 3 months. In Figure 3, the ratio of English to two-stage auctions is sharply higher in the month before turnover (and the month of turnover) and is sharply lower in the month after, than in other months. We view the Figure 3 outcome as the land bureau showing "respect": temporarily not using an auction format known to be corrupt just before the new party secretary arrives, and then quickly returning to business as usual.

There are two issues with the use of this instrument. First, a change in party secretary must be independent of the month-to-month conditions affecting land markets in cities (given the long term is controlled for by fixed effects). Party secretary changes are political events that have nothing to do with local land market fluctuations in the short run. Second, the use of this variable assumes that the timing of listings is largely exogenous, so that Figure 3 does not disguise some shifting of pre-set auction types across months and political events just affect auction type choices for properties coming up for listing. We did a Poisson of the number of listings per month with city fixed effects, seasonal dummies, year dummies, and the instruments. While as we will see in Table 4 below the month before and after a party secretary takes office strongly affects choice of auction type, it has no effect on the total count of auctions. In fact there is no time pattern in total auction counts around the party secretary taking office (over the 7 month span), other than total auctions dip in the month a party secretary takes office. That may be explained because nothing much happens in a city during that month with its extensive official and unofficial social requirements.

Similar arguments apply to the second set instruments, although the timing is different. For the second set, we have cases that relate to real estate corruption, reported on Google China. Such cases could involve the removal of a major local government official, the indictment of officials, the execution of officials, or a criminal investigation on land transactions. During a month when a case occurs, officials are more careful not to attract attention and schedule more English auctions. A month later they again revert and catch-up to business as usual. A few months after the case, a sanitized report on the case is announced on state run news agencies and picked up by Google China, with 27 cases in our data. The announcements on Google China appear to occur 3 months after the case, in the sense that 3 months earlier English auctions jump up, followed in the next month by a drop down. This timing of the pattern of one month up followed by one month down is found by experimentation in the data, but it is a clear pattern in both situations.

We have two other types of instruments as well and included them in some experiments. These results are in footnotes or mentioned in the text, but not in tables. We have a source on all corruption investigations (not just real estate), which is the number of news reports per month by the main state news agency in China, Xinhua, on corruption in any city *j* (the average is about .9 reports per city per month). The notions are identical to the Google reports, where in this case English auctions increase 2 months before the month of the news report and decrease the next month. This set of instrument is weaker than the first two. Finally, we have a measure of the pressure on the land bureau to raise more money through land sales. Cities have an expenditure budget, E , and on-the-book revenues, R . The gap is met with off-the-book revenues, particularly leasehold sales. The instrument is the lagged growth in the relative gap: $(E_{jt-1} - R_{jt-1}) / R_{jt-1} - (E_{jt-2} - R_{jt-2}) / R_{jt-2}$. With city fixed effects, the instrument is effectively the lagged rate of change in this gap, inducing more English auctions because they yield higher revenues. To be valid, this growth rate must not be connected to city demand conditions that would affect the housing market (given city and year fixed effects). Since this is a questionable assumption, we don't rely on it.

In summary, for the main results, we use just the first two sets of instruments, so our vector of instruments Z consists of 4 variables: dummy variables for any listing which occurs when a new party secretary takes office (one month lead and one month lag) and dummy variables for any listing which occurs when Google reports a land use corruption case (three months lead and two months lead). We now look at first stage results of how instruments affect auction choice.

3.4 Choice of auction type

We examine the choice of auction type, both to see the role of the instruments and to analyze the choice itself. Results are in Table 4, Columns 1 and 2 are the probit results, for 4 and 7 instruments respectively. In column 3, we also present linear probability results for the 4 instruments we rely on. In the last two columns, we examine the (non) effect of instruments on total auctions per month and setting of reserve price. Focusing on the first two columns, in both, the effect of reserve price on auction type is essentially zero, which is consistent with the idea that reserve price setting is independent of auction choice. Choice of auction type is significantly influenced by land use, where the base case, commercial land, is much more likely to be sold in two-stage auction, consistent with

Table 3. Commercial land consists of smaller plots, which may be of more interest to specialized neighborhood developers within the city and may have fewer potential bidders. Also, more likely to be sold at two-stage auction is land near rails (probably land urbanized in the Maoist era) but not near highways (land urbanized more recently).

Of particular interest is how instruments influence auction choice. In column 1, the variables for the change in party secretary and for announcements of land corruption cases have the hypothesized patterns and are generally significant. In column 1, the *F*-statistic based on the change in the value of the LLF from adding instruments to the probit is 8.1. For the linear probability model in column 3, the partial-*F* is over 10.0. Although these partial-*F*'s are not as high as one would like, they are reasonable in a context where we have city fixed effects. In column 2 the other three instruments are added in and have the hypothesized effects as well. However, going to seven instruments lowers the 1st stage *F*-statistic, one reason for settling on four instruments.

Column 4 of Table 4 shows that the count of auction listings per month is uncorrelated with the instruments. In column 5, we look at what is correlated with unit reserve price. As urban models predict, reserve prices decline with distance from the city center; and they also decline with property size for these very large properties. Conditioning on other covariates, use type does not affect reserve price, so in essence there is equalization in unit valuations across uses. Most critically reserve prices are uncorrelated with the instruments. The number of auction listings and the setting of reserve prices are determined by planning and assessment procedures outside the control of the land bureau. These political instruments affect just auction choice in the relevant months. As such the fact that these political events affect auction choice but not other aspects of the land allocation process itself is an indicator of corruption in the land bureau.

3.5 Sales price results

We estimated the sales price equation by OLS and by Heckman MLE where auction type is an endogenous dummy variable (Heckman, 1978). As specification checks, we also estimated the model by regular 2SLS and LIML IV (given relatively weak instruments) and experimented with allowing heterogeneous auction effects (Wooldridge, 2007).[10] Sales price results are in Table 5. In all specifications, a 1% increase in reserve price raises sales price by just over 0.9%. Why is the

[10] We experimented with adding interactions of auction type with covariates to the IV specification, allowing auction effects to vary with covariates. But the effects are not instructive, especially given we already have a reduced form specification. In OLS the interactions are not significant. In the IV (2SLS) results, the interactions are somewhat statistically stronger and the average treatment effect rises from -.53 (with 7 instruments) to -.81. However there is little variation in treatment responses as covariates go from low to high values.

elasticity less than 1? A higher reserve price also contains an effect to discourage entry of potential bidders (where we assume appraisers set a reserve price that is common value plus an idiosyncratic error component). Property characteristics are interpreted to affect the number of potential bidders, conditional on reserve price. Sales prices are distinctly lower for larger plots which may be less manageable and have fewer experienced developers who would try to utilize them.

The key variable is choice of auction type. In OLS estimation, prices are lower for two-stage auctions by 17%. With correction for selection, the coefficient has a much larger negative value. The Heckman MLE estimate is about -0.70, about 4 times larger in absolute value. The fact that the treatment effect coefficients are significantly larger than under OLS suggests positive selection: not accounting for selection understates the size of the treatment effect. Correspondingly, for direct evidence on selection, the coefficient on correlation of the error terms in the Heckman MLE results is positive and significant. The theory section suggested positive selection would be a marker of corruption, and the results indicate that positive selection into two-stage auctions is a significant force.

Two concerns are the functional restrictions of the Heckman MLE model and sensitivity of results to choice of instruments. In the table we also show LIML IV results, where the treatment effect coefficient (standard error) when the first stage simply uses the 4 instruments (i.e., linear probability) is similar to Heckman MLE, -.646.[11] When estimated by 2SLS the coefficient is -.58. In terms of the effect of numbers of instruments, with the party secretary variable alone the Heckman MLE coefficient is -.69 and with all 7 instruments it is also -.69. These magnitudes are similar, and suggest that the OLS estimate of 17% loss surely serves as a conservative lower bound, with positive selection being clearly indicated.

As additional checks on validity of instruments, in IV estimation, the Sargan p-value of .15 is acceptable but low. We believe the low value is due to model specification error (see next section) rather than unsuitability of instruments per se. Informally, if we add to column 1 (the OLS specification) our 4 instruments as covariates, the coefficient on auction type goes from -.1697 to -.1624, a tiny change. If instruments were correlated with unobservables affecting sale prices, assuming that auction type is correlated with unobservables, the added instruments would absorb some of the correlation of unobservables with auction type, affecting its coefficient. That the coefficient is unchanged is consistent with instruments being orthogonal to unobservables. We also

[11] For this model the Kleibergen-Papp *F*-statistic on weak instruments is over 11.2.

note that instruments have no significant effect on sales price, direct evidence that the instrumented events are not connected with economic events in the city that would influence sales prices.

Finally, we note that, if we drop the reserve price variable and use property characteristics (and city and time fixed effects) to represent both common value and demand considerations, all coefficients become much more negative.[12] For example, the OLS coefficient goes from -.17 (with a reserve price control) to -.34 (without a reserve price control); the Heckman MLE coefficient goes -.92; and the LIML IV coefficient is -.80. The *rho* in MLE remains positive and significant, so results without a reserve price control also suggest positive selection.

3.6 Other evidence

As discussed in Section 1.1, for our 15 cities, for residential land we were able to match on-going residential developments with some of our land auction data. For 302 properties, we have detailed information on floor to area ratio restrictions, prices and type of residential development. For these we looked at the determinants of the premium: the log of the 2009 price per square meter of residential space in the development minus the log of auction sales price per square meter of land. Controls are land reserve price and year of land auction sale, city fixed effects, and type of residential property, with the simple model and details in the footnote.[13] Premiums are significantly higher by 19.3% for land that was sold at two-stage auction compared to English auction. This is consistent with the OLS reduced form land price result of a 17% reduction in land price by two-stage auction, corroborating evidence of under-pricing in two-stage auctions. Given the very limited sample size, our instruments were too weak to pursue IV work, but the OLS result makes the point.

With the same data, it is possible to obtain corroborating evidence on two other issues, apart from violation of floor to area ratios discussed in Section 1. First for the same data we looked at the determinants of unit housing sale price rather than the premium, using the same covariates (but now

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[12] These reported results done earlier in the project are for 7 instruments.

[13] Consider a Cobb-Douglas production function where land has a quality *q*, and the shift factor, *A* contains housing type and technology by city (terrain, weather) information. Assume zero profits apply to housing produced by land of each quality sold by English auction, while land sold by two-stage is effectively subsidized at a rate *t*. The prices of housing, land of quality *q*, and capital respectively are $\boldsymbol{p}, \boldsymbol{p}_{l,q}$ **and** $\boldsymbol{p}_k$. Then the ratio of unit house price in the market to land price paid in two stage auction is given on the RHS of the estimating equation by $[(p_{l,q})^{\alpha} p_k^{1-\alpha} A^{-1} \alpha^{-\alpha} (1-\alpha)^{\alpha-1}] / (p_{l,q}(1-t))$. We use reserve price to control for price by land quality and have city dummies (to control for *A* differences for example) and controls for 4 house types and the extent to which the interior is finished. In the double- log formulation, on the RHS, ln(*1-t)* is represented by a dummy variable for the treatment effect of two-stage auction.

with no need to know final land sales price on the LHS). For this sample of 342, unit house prices are significantly higher by 9.6% for properties where land was sold at two-stage auction. This is consistent with the idea of positive selection of land properties into two-stage auction. Second, as noted in the theory section, some of our results might be consistent with a non-corruption environment where English auctions have higher variances on the valuation distribution (which we don't observe), although some results are not consistent with this idea. What we can establish in the ex post data is that the variances (based on residuals) for the unit housing price equation just discussed are significantly higher for the two stage part of the sample ($\hat{s}^2_{2-stage}$ =.0683, n=221) compared to the English ($\hat{s}^2_{english}$ =.0308, n=113), which would not support the high variance English auction scenario. Average unit housing prices are also higher for two-stage auctions and the normalized variances are similar.

3.7 What is missing in the reduced form approach

In the data, if an auction is non-competitive, price equals reserve price; a spread only emerges with competition. In essence, the price equation has a kink and thus is misspecified. Further, we believe that if multiple entrants emerge in the second stage of a two-stage auction, the outcomes for English and two-stage auctions for that property will be similar. In both cases once into the English auction portion, the sales price will simply be the valuation of the second highest valuation bidder. Of the 2302 auctions, only 1235 are ex post competitive, or have more than one bidder as inferred from the degree of spread. We already saw in Table 3 that raw unit price differences between English and two-stage auction are insignificant for competitive auctions.

To understand the nature of workings of corruption in auction choice better, we examine the two components. How does auction type affect the probability that an auction will be competitive or not? Second, if auctions are competitive does the choice of auction format still affect sales price?

4. The effect of auction type on competition

What is the effect of auction type, on whether an auction will be competitive or not, defined as whether there appears to be more than one bidder because spread exceeds 1.005? A simple probit of competitive or not with auction type as a potentially endogenous dummy variable faces the same selection problem as in the sales price estimation. Properties may be negatively or positively selected into two-stage auctions, and such selection itself will affect the potential for competition. The literature handles this in different ways. One is to use the bivariate recursive probit (Greene, 1998, Evans and Schwab, 1995), as an MLE solution. Another is to estimate a linear probability model (Angrist, 1999), where we instrument for auction type with *Z*'s. We do both.

The bivariate recursive probit is a two equation MLE model where action is a dummy endogenous variable which is a function of X and Z. Auction type affects the event: competition or not. That is,

$$d_{ijt}^{*} = Z_{ijt}\alpha + X_{ijt}\theta + u_{ijt}\,, \tag{8}$$

$$s_{ijt}^{*} = X_{ijt}\lambda + d_{ijt}\gamma + v_{ijt}\,, \tag{9}$$

with

$$d_{ijt} = \begin{cases} 1 & if\ d_{ijt}^{*} > 0 \\ 0 & o.w. \end{cases}, \tag{10}$$

$$s_{ijt} = \begin{cases} 1 & if\ s_{ijt}^{*} > 0 \\ 0 & o.w. \end{cases}. \tag{11}$$

where d_{ijt} denotes whether an auction is two-stage (1), or not (0), and s_{ijt} denotes whether an auction is competitive (=1) or not (=0). The *X*'s include city fixed effects, year dummies, seasonal dummies, and ln(*ask price*) and observed property characteristics in all equations (cf., equation 7). The recursive structure allows identification in a standard bivariate probit framework (Greene, 1998). In the next section we will add a continuous equation, for sales price in competitive auctions; at that point we will offer more details on estimation.

Results are in Table 6 which shows marginal direct and indirect effects for the bivariate recursive probit. The variable of interest, two-stage auction, has only a direct effect. In the ordinary probit in column 1, the marginal effect of two-stage auction on the probability of being competitive is -.34, consistent with the raw data in Table 3. In the recursive formulation that marginal effect in column 3 is 26% stronger, at -.43.[14] This is again suggestive of positive selection into two-stage auctions: the two-stage auction's negative effect on competition is understated because properties with better unobservables are selected into two-stage auctions. Consistent with this, the *rho* measuring the degree of correlation between the error terms is positive (.38), and significant. The auction effect when estimated by LIML IV in column 4 using a linear probability model (both first and second stages) suggests an even bigger auction effect of -.650; the 2SLS coefficient is -.649. This might suggest that the -.43 in the bivariate probit is a conservative estimate.

[14] Use of 7 instruments yields a negative effect of -.49.

In terms of other variables, in columns 2 and 3, relative to the base case of commercial use, sales of residential and mixed use land are likely to be more competitive, while large properties away from the city center are less likely to have competitive bidding. Total marginal effects on competition or not include direct [15] and indirect effects[16] through the effect of covariates on auction type and hence competition. Indirect effects seem strongest for land use variables, reinforcing the fact that commercial use properties face fewer takers and are less likely to be competitive. Removal of reserve price as a covariate in both equations has little effect on results, consistent with the fact that its coefficient is insignificant in Table 6.

5. Effect of auction type on sales prices, for competitive sales

If properties sell competitively, is there a remaining effect of auction type on sales price? Examination of this question faces two problems. First there is the auction selection problem discussed earlier, but now there is a second selection issue. Being competitive is endogenous, and there is selection on unobservables into competition that are surely correlated with price. Such selection is mediated by the auction process, so it is not the standard problem in Lee, Maddala and Trost (1980), but rather one modeled in the labor literature (Fraker and Moffitt 1988, Goux and Maurin, 2000) and more recently in firm growth models (Reize, 2001).

We tackle the problem in two ways. We estimate a parametric specification modeling the two selection issues using MLE with a trivariate normal, as in the literature cited above. But such structure is restrictive. As a less parametric approach, we wanted to do identification-at-infinity (Heckman, 1990), by examining auction effects for samples where the predicted probability of a non-competitive sale is small (less than 0.2 or 0.15). This isolates a sample where, ex ante, we expect sales to be competitive regardless of auction type, so we only need to worry about selection into auction type not competition. The problem is that in this sample, as we will see, we lack cities with competitive sales in both auction formats. So instead we focus on the raw data and ask

[15] Marginal direct effects are calculated based on the estimated coefficients in the second equation of the bivariate recursive probit, as well as the predicted probability of being competitive at the mean level of covariates, i.e., P=0.4817. For a continuous variable, its marginal effect is equal to the product of the density of normal distribution at P=0.4817 and its estimated coefficient. For a discrete variable, its marginal effect is equal to $\Phi(\Phi^{-1}(0.4817)+\theta)-0.4817$, where $\Phi(\cdot)$ (or $\Phi^{-1}(\cdot)$) is the cdf (or inverse of cdf) of the normal distribution and θ is the estimated coefficient.

[16] The marginal indirect effect of each covariate is obtained from the product of the estimated coefficient of two-stage auction in the second equation of the bi-probit regression, the estimated coefficient of this covariate on auction type in the first equation, and the two pdf's. We calculate the standard errors using the delta method approach. The variance-covariance matrix is obtained through post-estimation of the bi-probit model.

whether, conditional on the predicted probability of being competitive, prices diverge between auction types.

5.1 Comparative prices under competition: the raw data

For each auction type *separately*, we estimate the probability that an auction is competitive; specifically that the spread (ratio of sales to reserve price) is greater than 1.005 (cf, Mulligan and Rubinstein, 2007). The covariates in these simple predictive probits are the *X*'s including reserve price and city fixed effects, but not the instruments. Given estimation is separate by auction type, for two-stage auctions for example, the predicted probability of competition is made in the context of signaling and selection. We then look at the raw data on spread and unit prices in two ways. First, for each auction type, we order the predicted probabilities and break the two-stage auction rankings into 40 equal size bins and the English (with the smaller sample) into 20. For each bin, we calculate the average predicted probability and the median and mean spread and price.

Results for the mean and median are similar and Figure 4 shows the plots for medians. Over the whole range of predicted probabilities, for spread in Figure 4a, in the relevant interval of predicted probabilities, the plots for two-stage and English auction spreads overlap each other. There is no difference in unit prices for the same probability of being competitive, consistent with our hypothesis. Note a key difference between two-stage and English auctions is the lack of points for English auctions at low probabilities of being competitive and the lack at very high probabilities for two-stage auctions. Thus spread is 1 (price equals reserve price) until predicted probabilities hit about 0.5 and then spread rises with predicted probabilities. For unit prices, the plots for two-stage auction are actually higher than for English, but those price differences are not significant.

For the second analysis of raw data, in Table 7, we divide predicted probabilities into 0.05 intervals and ask whether there are significant differences in spread and prices between the two auction types. As Figure 4 suggests, we need to truncate the exercise in the lower half and at very upper end of the predicted probability range because of lack of observations of one auction format or the other. Note the extreme differences in counts of the two auction types in the tails of the predicted probability range. In general in Table 7, differences in median spread and price are not significant. Thus, the raw data suggests that, conditional on the predicted probability of being competitive, English auctions definitely do not bring better prices.

For implementing identification at infinity, the problem is apparent from Table 7. There are just too few two-stage auctions to use a typical cut-off of greater than 0.8 probability of being competitive. With too few cities left in the sample which use both auction types, our instruments (for auction type) loose their power. Thus we turn to a traditional parametric approach.

5.2 Trivariate MLE estimation of selections into competitive and two-stage auctions

To the model in equations (8) – (11), we now add a third equation for price

$$y_{ijt} = X_{ijt}\beta + d_{ijt}D + \varepsilon_{ijt} \quad if \ s_{ijt} = 1, \qquad (7a)$$

where y_{ijt} is sales price in logs. The structure imposes a trivariate normal error

$$\sum = Var\begin{pmatrix} \varepsilon \\ u \\ v \end{pmatrix} = \begin{pmatrix} \sigma_\varepsilon^2 & \sigma_{\varepsilon u} & \sigma_{\varepsilon v} \\ \sigma_{\varepsilon u} & 1 & \sigma_{uv} \\ \sigma_{\varepsilon v} & \sigma_{uv} & 1 \end{pmatrix}, \qquad (12)$$

so as to estimate the parameter set $\Theta = \left(\beta \; D \; \alpha \; \theta \; \lambda \; \gamma \; \sigma_\varepsilon \;\; \rho_{\varepsilon u} \; \rho_{\varepsilon v} \; \rho_{uv}\right)$. The LLF is in the Appendix and we estimate the model by MLE.

In Table 8, we present simple OLS price equation and MLE results for the 1235 competitive auctions. The OLS coefficient on auction type in column 1 is -0.03 and insignificant. Column 2 gives the MLE results for the price equation, along with the covariance structure. Estimates for the discrete choice part of the three-equation MLE model are almost identical to those in Table 6. They may be found in Cai, Henderson, and Zhang (2009). In column 2, the coefficient for the auction type effect on price in competitive auctions is small and insignificant as hypothesized.[17] In the covariance structure, as before, there is strong positive selection into two-stage auctions. The error term on the price equation has low correlation with the error terms in the discrete events.

Summary. Whether we approach the problem as a parametric one with strong assumptions or use a non-parametric look at the raw data, it seems that, once auctions become competitive, price is not affected by auction format. Auction format matters at the margin of whether auctions are competitive or not, consistent with the corruption signaling hypothesis for two-stage auctions

6. Conclusions

To the best of our knowledge, this paper is the first to investigate empirically corruption in auctions beyond simple price-fixing among bidders, to allow corrupt auctioneers and signaling activity, which we believe has relevance in other contexts. The paper also builds a case based upon indirect evidence using both theory and empirics to argue that corruption exists in a particular form.

[17] The results are the same if we use 7 instruments.

Consistent with corruption, two-stage auctions have first bids at reserve price, rather than the jump bids expected absent corruption and there is positive rather than negative selection of properties into two-stage auctions. We also see that officials switch to English auctions in contexts where it is important to appear clean. Two-stage auctions lead to less competitive bidding and thus substantially smaller revenue than English auctions in China's land market.

The obvious policy recommendation is that the option to use two-stage auctions should be eliminated. Local officials resist such a reform. One repeatedly cited objection in our survey of land bureau officials is that English auctions yield irrational biding and too high prices. We have a different interpretation to such objections by local officials.

What would be the revenue gains if properties sold at two-stage auction were instead sold at English auction (ignoring any general equilibrium effects of the resulting increases in prices paid for land)? The reduced form price equation in Section 3 suggested revenues would be 17% higher in OLS and 65-70% higher in IV results if properties sold at two-stage auction were shifted to English auction, but that equation is misspecified. Thus we also use the full MLE model in Section 5.2 with its modeling of selection effects to generate an estimate.

In our data, for properties sold at two-stage auctions, the predicted revenue is 227.7 billion Yuan.[18] In this MLE calculation, the unit sales price calculation is based on the predicted probability of selling competitively if sold at two-stage auction ($\text{prob}\left(s_{ijt}=1 \mid d_{ijt}=1\right)$) times the predicted price if sold competitively, plus the predicted probability of selling non-competitively at two-stage auction times the reserve price. The predicted price if sold competitively is from the price equation adjusted for the two selection terms as given in the Appendix. Revenue is based on predicted prices times quantities

The predicted revenue from switching to English auction for these properties is the predicted probability of these properties selling competitively if switched to English auction times the predicted price when sold competitively, plus the predicted probability of not selling competitively if switched to English auction times the reserve price. The predicted probability of selling

[18] The actual revenue from properties sold at two-stage auctions is 239.6 billion, about 5% higher than predicted, indicating an issue with mediating unit sales price predictions by lot sizes to get sales revenue per property.

competitively is enhanced by the treatment effect of English auction on competition.[19] The predicted revenue is 299.6 billion Yuan. This is 32% higher than the model predicted revenue if sold by two-stage auction. Given MLE gives a relatively low increase in predicted probability of being competitive when switching to English auction, we see this number as a lower bound on the expected revenue gain. The gain in revenue for these properties is illustrated in Figure 5. The 45^{o} line is for model predicted prices if sold still by two-stage auction, while the scatter plot is for the predicted prices if sold at English auction.

Appendices

<u>Theory appendix</u>:

1. English auctions under corruption

That $\hat{V}_{1P} < \hat{V} < \hat{V}_{-1}$ can be shown as follows. Given equation (1) holds, by comparing equations (3) and (4), we have $\hat{V}_{1p} < \hat{V}_{-1}$. If $\hat{V}_{-1} \geq \hat{V}_{1p} + \kappa$, then for equation (1) to hold, equation (4) implies that $\hat{V}_{-1} > \hat{V}$ (note then that all $\hat{w}_m$'s are zero). If $\hat{V}_{-1} < \hat{V}_{1p} + \kappa$, then for equation (1) to hold, equation (3) implies that $\hat{V}_{-1} > \hat{V}$ (note that the first term in the bracket is zero). Comparing equations (1) and (4) reveals that if $\hat{V}_{-1} \geq \hat{V}$, then $\hat{V}_{1p} < \hat{V}$.

2. Comparing English and two-stage auctions under corruption

First we show that $\tilde{V}_0 > \hat{V}_{-1}$ and that $\hat{V}_{1p} > \tilde{V}_C$. Since equation (1), (4) and (6) hold, if $\tilde{V}_0 > \hat{V}_{-1}$, then $\hat{V}_{1p} > \tilde{V}_C$. Suppose counterfactually $\tilde{V}_0 \leq \hat{V}_{-1}$, then it can be shown that the left hand of equation (5) is less than that of equation (3), which yields a contradiction (right hand sides are the same).

Second, we want to show that in all relevant cases the corrupt bidder has at least as good a chance of winning a two-stage auction as an English auction, and sometimes a better chance. When the corrupt bidder's valuation, V_1, is smaller than the entry threshold in the two-stage auction, $\tilde{V}_C$, then the corrupt developer will not enter no matter what auction format is chosen. For the case where $V_1 \geq \tilde{V}_C$ but $V_1 \leq \hat{V}_{1P}$ (the entry threshold in the English auction), so the corrupt developer will enter only if the corrupt government official chooses the two-stage auction, the corrupt developer can win only if a two-stage auction is chosen. Then there is the case where $V_1 > \hat{V}_{1P}$ so that the corrupt developer enters no matter what the auction format is. Let X_1^{N-1} denote the highest valuation of all N-1 non-corrupt potential bidders. The probability of the corrupt developer wining the auction depends on the realized value of X_1^{N-1}. If $X_1^{N-1} \leq \hat{V}_{-1} < \tilde{V}_0$, where we recall $\hat{V}_{-1}$ ($\tilde{V}_0$) is the entry threshold of a non-corrupt bidder in the English (two-stage) auction, then none of the non-corrupt bidders will enter either auction format in this event and the corrupt developer wins the

[19] Let us denote the probability of selling competitively under the switch as $\text{prob}[s_{ijt} = 1 | d_{ijt} = 1, d'_{ijt} = 0]$. Then $\text{prob}[s_{ijt} = 1 | d_{ijt} = 1, d'_{ijt} = 0] = \Phi\left(\Phi^{-1}(\text{prob}[s_{ijt} = 1 | d_{ijt} = 1]) - \hat{\gamma}\right)$.

auction without contest. If $\hat{V}_{-1} < X_1^{N-1} < \tilde{V}_0$, then the non-corrupt bidder with the highest valuation will enter the English auction but not the two-stage auction. In this event, the corrupt developer wins without contest if the two-stage auction is chosen, but may face competition from some non-corrupt bidders and may lose the auction if $X_1^{N-1} \geq V_1 + \kappa$. Finally, if $\tilde{V}_0 \leq X_1^{N-1}$, then the non-corrupt bidder with the highest valuation will enter to contest the corrupt developer under either auction format. No matter what the auction format is, whether the corrupt developer wins depends on whether $V_1 + \kappa$ is greater than X_1^{N-1}. In summary, in all relevant cases, the probability of the corrupt developer winning the auction is not less and sometimes greater under the two-stage auction than under the English auction. Therefore, when λ is close to one, a corrupt government official will choose the two-stage auction over the English auction.

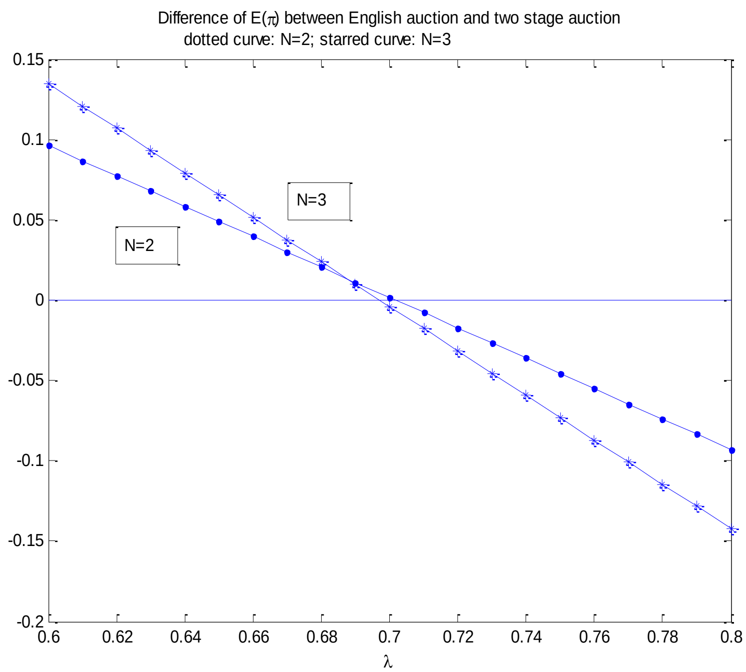
3. Hot vs. cold property example, under corruption.

Example 1. First is a special case to illustrate the principle. Assume λ is close to 1 so that the land bureau official is focused almost exclusively on corruption income and that κ is sufficiently large, so that we are at or near a corner solution for two-stage auctions where $\tilde{V}_0$ is near or greater than the upper bound on valuations, $\bar{V}$. In this case, non-corrupt bidders will not enter the two-stage auction once they believe that a corrupt developer has secured an agreement with the corrupt government official. In this case, $\tilde{V}_C = C + r - \kappa$, and the corrupt developer wins the land with probability one as long as his valuation is above $\tilde{V}_C$. The value of the official's objective function under two-stage auctions doesn't vary with N (for $\lambda = 1$).

However things are different for English auctions. Note, from the analysis above that $\hat{V}_{-1} < \tilde{V}_0$, so that non-corrupt bidders' entry point into English auctions may be well below $\bar{V}$. Assuming $V_1 > \hat{V}_{1P}$ so that the corrupt developer is motivated to enter the English auction despite potential entry by other bidders, when $V_1 < \hat{V}_{-1} - \kappa$, the corrupt developer wins the land in the English auction with probability of $F^{N-1}(\hat{V}_{-1})$. It can be shown that this is decreasing in N. When $\hat{V}_{-1} \leq V_1 + \kappa$, the corrupt developer wins the land with probability of $F^{N-1}(V_1 + \kappa)$ in the English auction. Clearly, as N becomes larger, the corrupt developer is less likely to win the land in the English auction. Thus the gap in corruption income for two-stage auctions over English auctions will grow as N grows and there is positive selection on unobservables (the number of potential bidders) into two-stage auctions.

Example 2. For this example, for English auctions, equations (3) and (4) are used to solve for threshold values of $\hat{V}_{-1}$ and $\hat{V}_{1p}$. Equation (5) and (6) for two-stage auctions are used to solve for $\tilde{V}_0$ and $\tilde{V}_C$. For N=3, the expressions for equations (4) and (6) must account for the possibilities that any of bidders 1-3 may have the highest bid, that either of the remaining two may be the 2nd highest bidder, and that either or both of bidders 2 and 3 may enter. Once we have solved for threshold values, then the auctioneer's objective function under each auction format must be evaluated. In the comparison, we examine the situation where the corrupt bidder 1 enters if it is a two-stage auction ($V_1 > \tilde{V}_C$) (but may or may not enter the English auction given $\tilde{V}_C < \hat{V}_{1p}$). The auctioneer only gets bribe income if bidder 1 wins and the auction income depends on who enters and has the second highest bid if there are multiple entrants. For N=3, the expressions are very long, since they have to account for all the ways the corrupt developer can win and lose and all the relevant winning valuation and 2nd highest valuation possibilities.

We solve the example where $\bar{V} = 9$; $r = 2$; $\kappa = 1.9$, 2 and 2.1; $p = .8$; $C = .75$, 1 and 1.25; $q = 2.45$, and λ lies between 0 and 1. The graph below shows the solution for $C = 1$ and $\kappa = 2$. The horizontal axis is λ and the vertical is the value of the land bureau official's objective function under English auction minus that under two-stage auction. As one can see, for low λ, English auctions maximize the auctioneer's objective function, while, for high λ, two-stage auctions dominate for both values of *N*. However for a small interval of λ values in the neighborhood of .7, English auctions are preferred if N=2 (see where the N=2 line intersects the horizontal line at 0), but two-stage are preferred if N=3.



4. Two-stage auctions without corruption

In a non-corruption context, entrants, in arbitrary sequence, have a first opportunity to submit a bid. Sequencing could be based on the arbitrary times at which potential bidders learn the auction has started and decide to enter in the first stage, and have had their application to bid approved. Solving the general case with endogenous first stage entry is daunting—whether an early entrant signals with what bid function, whether later entrants with higher valuations enter or not, and the complicated interactions between early and later signalers. We work with a special case where of the *N* potential bidders, only one randomly selected person, labeled bidder 1, has the option to enter and bid early. This case models the general situation in which *N* = 2 as typically formulated in the jump-bid literature (e.g., Daniel and Hirshleifer, 1997). In Cai, Henderson, and Zhang (2009), we solve for a separating, signaling equilibrium, where bidder 1 signals his true valuation. Here we give some highlights.

Bidder 1 chooses to enter in stage 1 by using a strictly increasing bidding schedule $B(V_1)$ when his valuation is $V_1 \in [\tilde{V}, \bar{V}]$. For $V_1 < \tilde{V}$, bidder 1 will choose to not enter the auction. Suppose his valuation is exactly $\tilde{V}$. Based on the Riley argument in the signaling literature, bidder

1 will use the lowest possible signal, the reserve price r. Once bidder 1 bids r and reveals that his valuation is $\tilde{V}$, other potential bidders will enter only if their valuation is above $\hat{V}_S(\tilde{V})$, the solution to equation (1) with $\tilde{V}$ replacing r and $N-2$ replacing $N-1$. That is, for the other potential bidders, *the effective reserve price increases to* $V_1 = \tilde{V}$. Bidder 1 can win the auction only if no other potential bidders enter, so $\tilde{V}$ satisfies

$$F(\hat{V}_S(\tilde{V}))^{N-1}(\tilde{V} - r) = C. \qquad \text{(A1)}$$

Note that since $\hat{V}_S(\tilde{V}) > \tilde{V} + C$, comparing (A1) and (1) reveals that $\tilde{V}$ is smaller than $\hat{V}$, so bidder 1's threshold entry level is lower in a two-stage than English auction. If bidder 1 does not enter in the first stage, the other $N-1$ potential bidders play the same game as in an English auction, with a threshold for entry, denoted by $\hat{V}_{NS} = \hat{V}(r, C, N-1, \bar{V})$. Note that $\hat{V}$ is increasing in N, thus $\hat{V}_{NS} < \hat{V}(r, C, N, \bar{V})$, which is the equilibrium entry threshold in the case of an English auction with N potential bidders. So overall the two-stage auction has a greater chance of any sale.

What happens if bidder 1's evaluation V_1 exceeds $\tilde{V}$? When bidder 1 has valuation $V_1 \in [\tilde{V}, \bar{V}]$, he has a bidding function that is strictly increasing in V_1 and truthfully reveals his valuation. Such a bidding function satisfies the single crossing property, so it isn't beneficial for lower valuation bidders to pretend to be higher types.

When bidder 1 enters in stage 1 with a bid B_1, the other potential bidders can infer bidder 1's valuation $V_1 > B_1 + C \geq r + C$ from his bidding schedule $B(V_1)$. Except for this, the same game is played by the other $N-1$ potential bidders as in the case of an English auction. The valuation threshold for entry can be solved as $\hat{V}_S(V_1) = \hat{V}(V_1, C, N-1, \bar{V})$. Since $V_1 > r$, we have $\hat{V}_S(V_1) = \hat{V}(V_1, C, N-1, \bar{V}) > \hat{V}(r, C, N-1, \bar{V}) = \hat{V}_{NS}$, given the entry deterrence effect of bidder 1's signaling.

For $V_1 \in [\tilde{V}, \bar{V}]$, suppose for a bid of B, other potential bidders other potential bidders believe his valuation is $\vec{V}_1$. Then his expected payoff is

$$U(V_1, \vec{V}_1, B) = F(\hat{V}_S(\vec{V}_1))^{N-1}(V_1 - B) - C.$$

Clearly this payoff function is increasing in bidder 1's true valuation V_1 and the belief of the other potential bidders $\vec{V}_1$, but decreasing in his bid B. In equilibrium, bidder 1 should "tell the truth" by bidding his equilibrium bid $B(V_1)$ and we can show that this truth-telling constraint satisfies the single crossing condition, so lower valued bidders have no incentive to misrepresent their valuations. From the truth-telling constraint, the differential equation that characterizes the strictly increasing bidding schedule is

$$\frac{dB}{dV_1} = \left[\frac{(N-1)f(\hat{V}_S(V_1))(V_1 - B)}{F(\hat{V}_S(V_1))}\right]\left[\frac{F(\hat{V}_S)}{F(\hat{V}_S) + (N-2)f(\hat{V}_S)(\hat{V}_S - V_1)}\right]. \qquad \text{(A2)}$$

where the second bracketed expression comes from applying the implicit function theorem to equation (1) and $\hat{V}_S(V_1) = \hat{V}(V_1, C, N-1, \bar{V})$. Along with $B(\tilde{V}) = r$, equation (A2) characterizes the strictly increasing signaling schedule.

<u>Data appendix.</u>

Our base data for 15 cities consists of 4016 listings for 2003-2007, where a listing is a property put up for auction whether the auction is completed and results in a sale, or not. Our 4016 listings exclude industrial use land (about 7% of total listings). As in the USA, industrial land use has a low and highly variable unit price; regressions using USA data which examine the determinants of sales prices for industrial land have low explanatory power (DiPasquale and Wheaton, 1996). More critically in China, such properties are often sufficiently far from the city center stretching into peri-urban areas, that we couldn't get location characteristics from bendi.google.com.

Of the 4016 listings, 607 have no recorded sales data. Another 1107 record sales but do not have information on either reserve price or sales price, or both. We focus on the remaining 2302 which are completed auctions with full price information. Does this sample differ from those with missing data or no recorded sale? First from the Table A.1 below, a comparison of columns I and III (with tests of differences given in column V) suggests sales with missing sale or reserve price data are similar to those in our estimating sample. They have similar auction type and use proportions and when data is available have similar reserve and sales unit prices. Properties without full price information tend to be older listings and (related) nearer the city center. We view these differences in samples for sales with full versus limited price information as "innocent," as city officials get better with time at fulfilling reporting requirements.

Table A.1 Comparing the estimating sample with samples of unsold properties and of properties with missing information

	I. Base sample N = 2302	**II. Unsold N = 607**	**III. Sold: missing price data. N= 1107**	**IV. Unsold Diff (t-stat.) I-II**	**V. Missing price Data. Diff (t-stat) I-III**
Two-stage auction	.72	.61	.69	5.11	1.66
Area (sq. m.)	54861	54113	53831	-.09	.25
Distance (km.)	19.3	46.4	13.4	-13.6	7.68
Unit sale price (10,000 yuan)	.62	n.a	.58 (n=824)	n.a.	.53
Unit reserve price	.37	.21	.31 (n=200)	5.01	.50
Mixed use	.38	.52	.39	-6.03	-.54
Commercial use	.31	.27	.28	1.99	1.76
Residential use	.31	.21	.33	4.99	-1.14
No. quarters since listing until Dec. 2007	8.17	4.74	9.31	19.8	-6.25

However, properties with no listed sale compared to our working sample of 2302 show distinct differences. A comparison of columns I and II (with tests of differences given in column IV) suggests these properties are more distant from the CBD (related to listing date), have a lower reserve price; and are more likely to have been offered at English auction. A probit of auction type on sale listed or not, with controls for property characteristics including reserve price and city and year fixed effects, suggests two-stage auctions have a .076 higher probability of a listed sale, potentially evidence of positive selection into two-stage auctions. In terms of sales dates, unsold properties are more recent listings, and many could have been sold but the data not entered yet. For those that are truly unsold, we suspect they are eventually removed from public listing on the internet, perhaps rebundled, and then relisted, which makes statistical analysis of sale versus no sale difficult, since we don't know which properties are being offered for the first versus second time. We think unsold properties are not evidence of a lack of demand per se, but more of heterogeneity and thinness in parts of the market.

Technical Appendix: Likelihood function for trivariate MLE, controlling for selections into competitive and two-stage auctions

The LLF is[20]

$$\ln L = \begin{cases} \ln(\Phi_2[-Z_{ijt}\alpha - X_{ijt}\theta, -X_{ijt}\lambda - d_{ijt}\gamma, \rho_{uv}]) & if\ d_{ijt}=0,\ s_{ijt}=0 \\ \ln(\Phi_2[Z_{ijt}\alpha + X_{ijt}\theta, -X_{ijt}\lambda - d_{ijt}\gamma, -\rho_{uv}]) & if\ d_{ijt}=1,\ s_{ijt}=0 \\ \ln(\Phi_2[-p_{dijt}, p_{sijt}, -\rho_{ds}]) - \frac{1}{2}\ln(2\pi) - \ln(\sigma_\varepsilon) - \frac{1}{2}\left(\frac{y_i - X_{ijt}\beta - d_{ijt}D}{\sigma_\varepsilon}\right)^2 & if\ d_{ijt}=0,\ s_{ijt}=1 \\ \ln(\Phi_2[p_{dijt}, p_{sijt}, \rho_{ds}]) - \frac{1}{2}\ln(2\pi) - \ln(\sigma_\varepsilon) - \frac{1}{2}\left(\frac{y_i - X_{ijt}\beta - d_{ijt}D}{\sigma_\varepsilon}\right)^2 & if\ d_{ijt}=1,\ s_{ijt}=1. \end{cases}$$

$\Phi_2(.)$ is the cumulative density function of the bivariate normal distribution. And

$$p_{dijt} = \frac{Z_{ijt}\alpha + X_{ijt}\theta + \frac{\rho_{\varepsilon u}}{\sigma_\varepsilon}(y_i - X_{ijt}\beta - d_{ijt}D)}{\sqrt{1-\rho_{\varepsilon u}^2}},\ p_{sijt} = \frac{X_{ijt}\lambda + d_{ijt}\gamma + \frac{\rho_{\varepsilon v}}{\sigma_\varepsilon}(y_i - X_{ijt}\beta - d_{ijt}D)}{\sqrt{1-\rho_{\varepsilon v}^2}}, \text{ and}$$

$$\rho_{ds} = \frac{\rho_{uv} - \rho_{\varepsilon u}\rho_{\varepsilon v}}{\sqrt{(1-\rho_{\varepsilon u}^2)(1-\rho_{\varepsilon v}^2)}}.$$

For the expected revenue calculation, the price equation is

$\hat{y}_{ijt} = X_{ijt}\hat{\beta} + d_{ijt}\hat{D} + \hat{c}_{u,ijt}\hat{\sigma}_{\varepsilon u} + \hat{c}_{v,ijt}\hat{\sigma}_{\varepsilon v}$, where $\hat{c}_{u,ijt}, \hat{c}_{v,ijt}$ are the predicted values for the expressions

$$c_{u,ijt} = \phi[Z_{ijt}\alpha + X_{ijt}\theta]\frac{\Phi[X_{ijt}\lambda + d_{ijt}\gamma - \rho_{uv}(Z_{ijt}\alpha + X_{ijt}\theta)]/(1-\rho_{uv}^2)^{1/2}}{\Phi_2[Z_{ijt}\alpha + X_{ijt}\theta, X_{ijt}\lambda + d_{ijt}\gamma, \rho_{uv}]} \text{ if } d_{ijt}=1$$

$$= \phi[-Z_{ijt}\alpha - X_{ijt}\theta]\frac{\Phi[X_{ijt}\lambda + d_{ijt}\gamma - \rho_{uv}(Z_{ijt}\alpha + X_{ijt}\theta)]/(1-\rho_{uv}^2)^{1/2}}{\Phi_2[-Z_{ijt}\alpha - X_{ijt}\theta, X_{ijt}\lambda + d_{ijt}\gamma, -\rho_{uv}]} \text{ if } d_{ijt}=0$$

$$c_{v,ijt} = \phi[X_{ijt}\lambda + d_{ijt}\gamma]\frac{\Phi[Z_{ijt}\alpha + X_{ijt}\theta - \rho_{uv}(X_{ijt}\lambda + d_{ijt}\gamma)]/(1-\rho_{uv}^2)^{1/2}}{\Phi_2[Z_{ijt}\alpha + X_{ijt}\theta, X_{ijt}\lambda + d_{ijt}\gamma, \rho_{uv}]} \text{ if } s_{ijt}=1$$

$$= \phi[X_{ijt}\lambda + d_{ijt}\gamma]\frac{\Phi[-Z_{ijt}\alpha - X_{ijt}\theta + \rho_{uv}(X_{ijt}\lambda + d_{ijt}\gamma)]/(1-\rho_{uv}^2)^{1/2}}{\Phi_2[-Z_{ijt}\alpha - X_{ijt}\theta, X_{ijt}\lambda + d_{ijt}\gamma, -\rho_{uv}]} \text{ if } s_{ijt}=0$$

[20] We thank Frank Reize for access to his STATA code on MLE estimation of the model, to check ex post against our STATA code, although in the end we reprogrammed the model in MATLAB. There seems to be a minor error in Reize (2001) in specification of the LLF.

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Figure 1. Distribution of spread, the sale/reserve price ratio, by auction type
Orange (solid) is two-stage auction; white (blank) is English auction

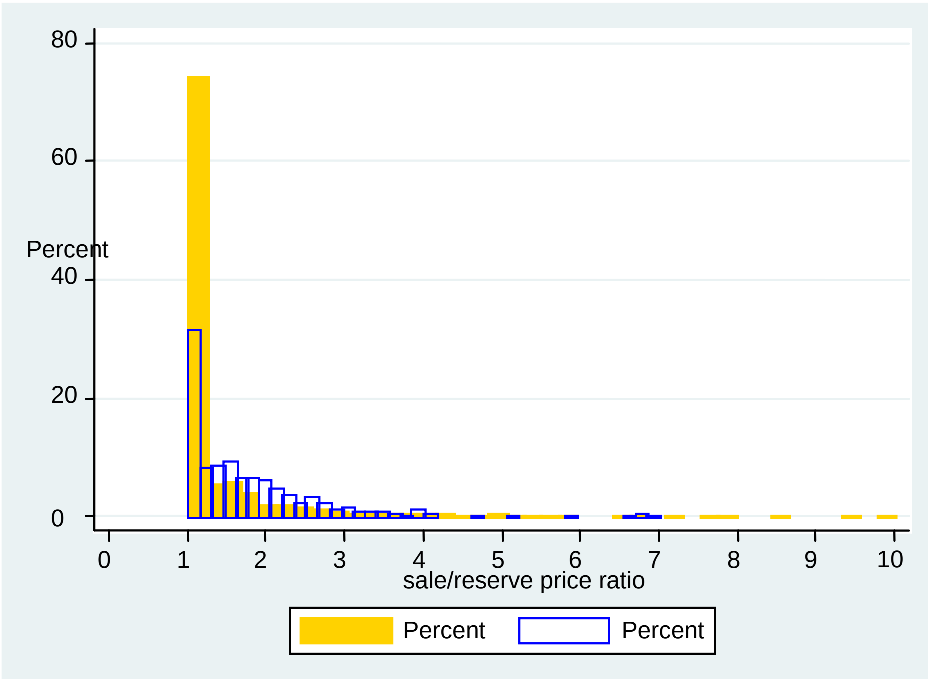


Figure 2. Distribution of unit sales prices (in 10,000 yuan), by auction type
Orange (solid) is two-stage auction; white (blank) is English auction

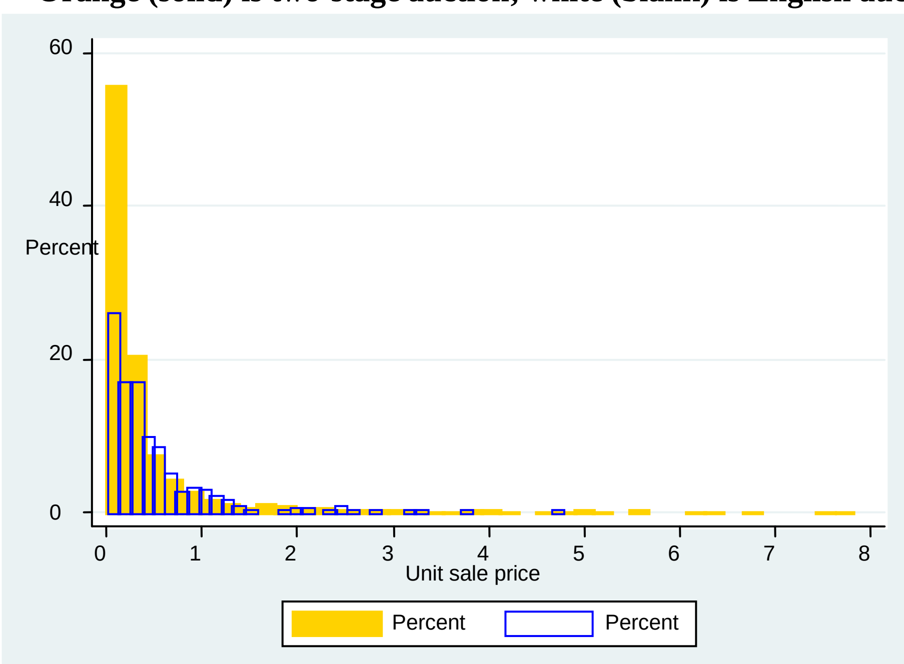


Figure 3. Timing of party secretary turnover and auction choice

Ratio of English to total auctions

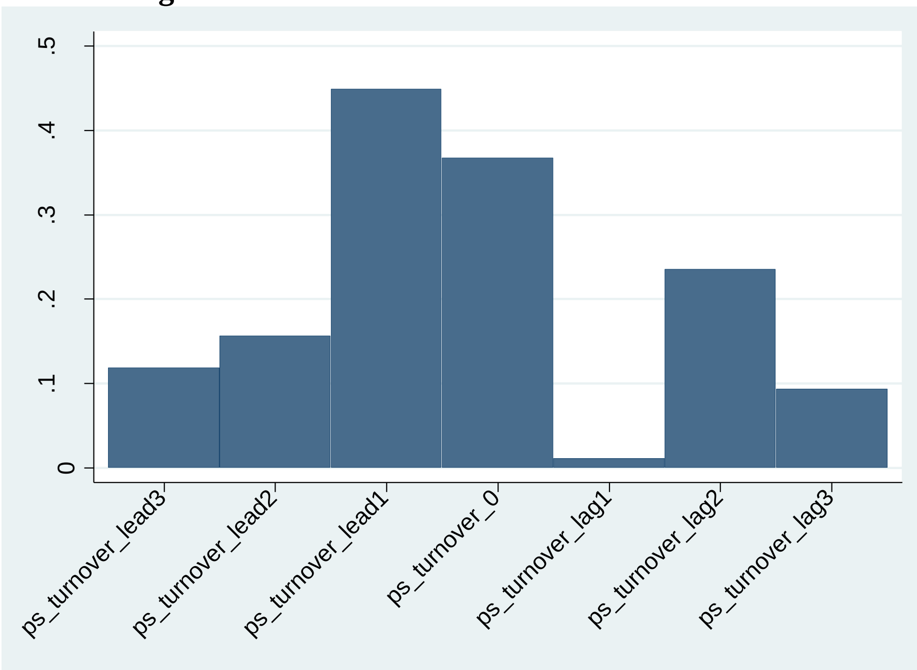
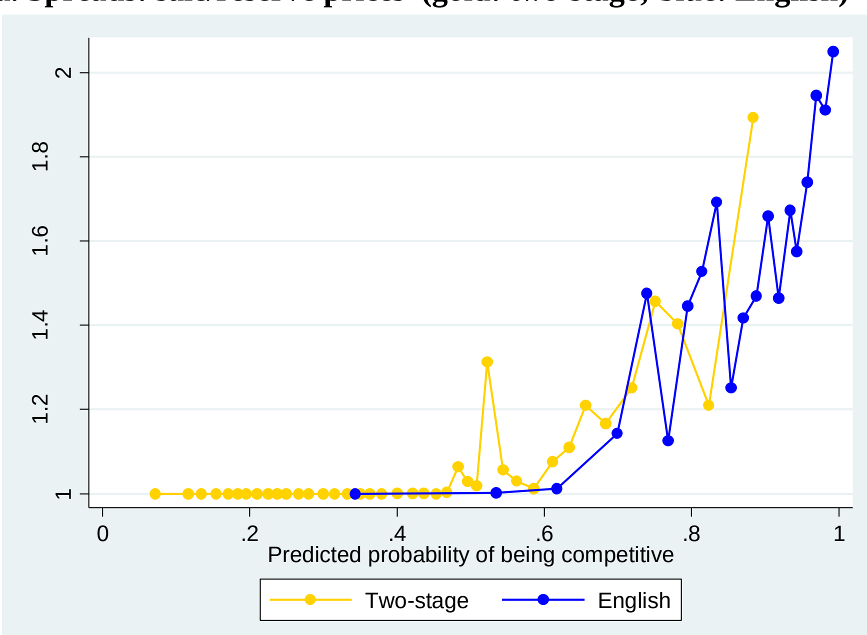


Figure 4. Conditional on the predicted probabilities of being competitive, spreads and prices for English versus two-stage auctions

a. Spreads: sale/reserve prices (gold: two-stage; blue: English)



b. Unit sale prices (in 10, 000 yuan; gold: two-stage; blue: English)

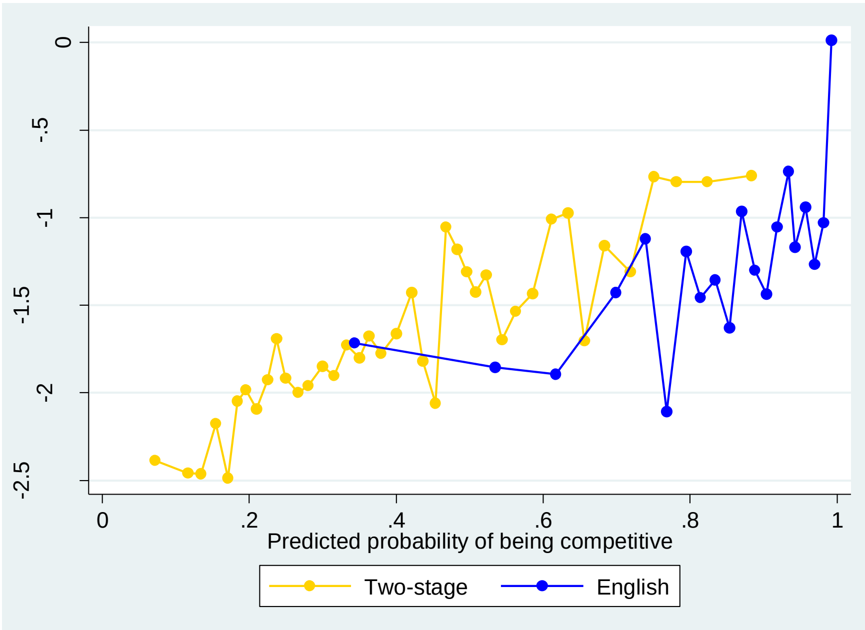


Figure 5. For two-stage auction sales: predicted unit price (in 10, 000 yuan) if sold by two-stage (45^o line) versus switching to English auction

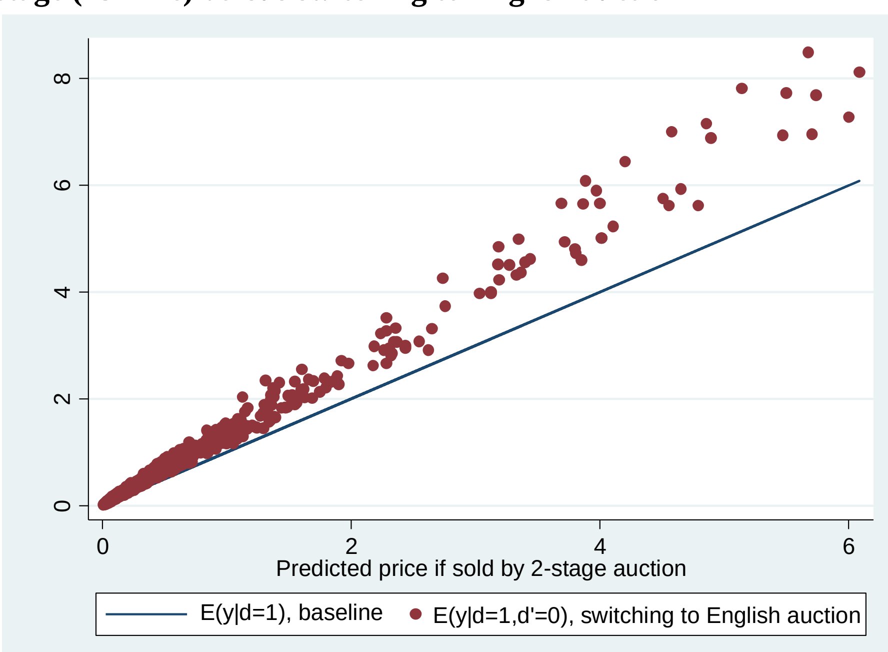


Table 1. Beijing two-stage auctions

Number of bids	Number of cases: Sales-reserve price ratio ≤ 1.005	Number of cases: Sales-reserve price ratio > 1.005
1	**104**	**1**
2	**3**	**6**
3 or more	**0**	**75**

Table 2. Beijing count and spread estimations

	Poisson: Number of bids (robust s.e.'s)		Probit: Sales/reserve price ratio > 1.005 (marg. effects)	
Bidder on first day, or not (167 of 195)	-.731** (.344)	-8.28** (.310)	-.142 (.103)	-.224* (.117)
Residential use		1.04** (.352)		.272** (.106)
Mixed use		.772* (.429)		.213** (.105)
Ln (area)		.131 (.085)		.027 (.035)
Ln (distance to CBD)		-.735** (.186)		-.186** (.079)
Ln (reserve price)		-.487** (.130)		-.045 (.059)
Property is cleared, prior to auction		1.63** (.591)		.292** (.135)
N	195	155	189	155
Pseudo Rsq	.030	.260	.007	.129

* significant at 10% level; ** significant at 5% level or higher

Table 3. Data on auctions

a) Two-stage vs. English auctions

	Two-stage auction: Mean (N=1661)	**English auction: Mean (N=641)**	**Difference**	**t-stat.**
Unit sales price (in 10,000 yuan)	.47	1.0	-.53	-2.64
Proportion non-competitive	.574	.178	.396	-20.4
Unit price if competitive (in 10,000 yuan)	.73 (n =708)	1.13 (n = 527)	-.40	-1.62
Area (in sq. meter)	55289.96	53751.1	1538.86	.30
Distance to CBD (in km)	19.9	17.8	2.1	1.86
Commercial use	.38	.14	.24	13.3

b) Commercial vs. residential and mixed use properties

	Commercial: mean (N=716)	**Residential and mixed use: mean (N= 1586)**	**Difference**	**t-stat.**
Unit sales price (in 10,000 yuan)	.617	.615	.002	.026
Unit price if competitive (in 10,000 yuan)	.98 (n=289)	.88 (n=946)	.09	.55
Area (in sq. meter)	31354.72	65473.59	-34118.87	-8.52
Distance to CBD (in km)	18.47	19.67	-1.20	-1.03
Proportion two-stage auction	.88	.65	.23	13.17
Proportion non-competitive	.596	.403	.193	8.72

Table 4. Two-stage auction, or not[1]

	Probit: marg. effects	Probit: marg. effects	Linear prob. model	Poisson count: Total listings/ month	OLS, Ln (reserve price)
Ln (reserve price)	-.040 (.031)	-.041 (.030)	-.031 (.026)		
Dummy: Residential use	-.255** (.058)	-.250** (.055)	-.167** (.058)		.050 (.083)
Dummy: Mixed use	-.245** (.064)	-.241** (.062)	-.160** (.055)		.193* (.101)
Ln (dist. To CBD)	-.044 (.038)	-.044 (.037)	.-033 (.029)		-.571** (.043)
Ln (area)	-.0015 (.013)	-.0037 (.013)	-.0026 (.011)		-.145** (.043)
Dummy: railway within 2.5 kms.	.055* (.028)	.057* (.030)	.038* (.021)		.127 (.129)
Dummy: highway within 2.5 kms.	-.066** (.021)	-.069** (.022)	-.044** (.015)		-.158* (.084)
Lagged change in fiscal strain		-.544** (.236)			
Xinhua corruption report, 2 month lead from listing		-.016 (.016)			
Xinhua corruption report, 1 month lead		.021* (.012)			
Party secretary turnover, 1 month lead	-.300** (.127)	-.314** (.131)	-.215** (.092)	.051 (.399)	.035 (.116)
Party secretary turnover, 1 month lag	.157** (.022)	.162** (.018)	.161** (.045)	-.253 (.253)	-.084 (.253)
Google report, Land corrupt. case, 3 month lead	-.212* (.136)	-.207* (.129)	-.211* (.112)	-.165 (.230)	.051 (.220)
Google report, Land corrupt. case, 2 month lead	.183** (.040)	.186** (.037)	.150** (.070)	.207 (.215)	.238 (.177)
Season, year, city dummies	Yes	Yes	Yes	Yes	Yes
N	2302	2302	2302	283	2302
(Pseudo) Rsq	(.37)	(.36)	.41		.40
Implied *F*-Statistic From adding instruments	8.1	6.6	10.0		

* significant at 10% level; ** significant at 5% or higher level.
All standard errors are robust clustered by city-code, except for LIML where are errors are robust.

Table 5. Baseline case: Unit sales prices [ln (sales price/area)]

	OLS	**Heckman MLE**	**LIML-linear prob. 1st stage**
Dummy: two-stage auction [2SLS]	-.170** (.037)	-.707** (.217)	-.646** (.267)
Ln (reserve price)	.923** (.028)	.907** (.025)	.909** (.018)
Dummy: Residential use	.023 (.049)	-.068 (.078)	-.058 (.056)
Dummy: Mixed use	.078** (.034)	-.0091 (.059)	.0008 (.054)
Ln (dist. To CBD)	.0083 (.037)	-.010 (.037)	-.0083 (.021)
Ln (area)	-.069** (.011)	-.070** (.013)	-.070** (.011)
Dummy: railway within 2.5 kms.	-.025 (.035)	-.0034 (.035)	-.0059 (.028)
Dummy: highway within 2.5 kms.	-.067 (.038)	-.089* (.046)	-.087** (.025)
Season, year, city dummies	Yes	yes	yes
N	2302	2302	2302
Rsq	.85		.94
***rho* {Sargan *p*-value}**		.641** (.235)	{.15}

* significant at 10% level; ** significant at 5% level or higher.
All standard errors are robust clustered by city-code, except for LIML where are errors are robust

Table 6. Probability sale is competitive

	Ordinary probit	Bivariate recursive probit MLE		LIML, Linear probability
	Marginal effects	Marginal indirect effects	Marginal direct effects	
Dummy: two-stage auction	-.338** (.079)	n.a.	-.427** (.085)	-.650** (.191)
Ln (reserve price)	.-016 (.027)	.085 (.067)	-.023 (.024)	-.028** (.012)
Dummy: Residential use	.216** (.055)	.405** (.131)	.172** (.062)	.126** (.041)
Dummy: Mixed use	.205** (.049)	.405** (.156)	.161** (.069)	.117** (.041)
Ln (dist. To CBD)	-.028 (.021)	.094 (.085)	-.035* (.022)	-.036** (.014)
Ln (area)	.-045** (.012)	.002 (.028)	-.045** (.011)	-.035** (.0070)
Dummy: rail within 2.5 kms.	.013 (.036)	-.123* (.076)	.023 (.039)	.027 (.025)
Dummy: highway within 2.5 kms.	-.019 (.029)	.137** (.067)	-.028 (.029)	-.025 (.023)
Season, year, city dummies	Yes	Yes	Yes	Yes
N	2297		2297	2297
Rho			.383** (.157)	
Rsq {Sargan p-value}	.22			{.20}

* significant at 10% level; ** significant at 5% level or higher. All standard errors are robust clustered by city-code, except for LIML where are errors are robust

Table 7. Auction price differences under competition: data

Probability of being competitive	No. of 2-Stage	No. of English	Spread: Difference in Medians. Chi sq p-value*	Price: Difference in Medians. Chi sq p-value*
<0.40	805	20	.67	.83
0.4 - 0. 45	120	10	.74	.74
0.45 - 0.50	142	10	.33	.74
0.50 – 0.55	122	16	.06	.18
0.55 – 0.60	91	23	.16	.64
0.60 – 0.65	89	12	.38	.38
0.65 – 0.70	76	20	.80	.80
0.70 – 0.75	60	41	.93	.75
0.75 – 0.80	63	56	.92	.002
0.80 – 0.85	40	78	.01	.33
0.85 – 0.90	35	88	.21	.21
>0.90	14	240	.78	.78

*Yates continuity corrected

Table 8. Sales prices: "Competitive" sales only

All sales where spread > 1.0005		
	OLS	**MLE (selection on auction type and competition)** (eqs. 7a – 11)
Dummy: two-stage auction	-.031 (.071)	-.137 (.414)
Ln (reserve price)	.870** (.041)	.867** (.051)
Dummy: Residential use	-.157* (.075)	-.162 (.103)
Dummy: Mixed use	-.061 (.042)	-.065 (.068)
Ln (dist. To CBD)	.025 (.048)	.020 (.047)
Ln (area)	-.097** (.027)	-.098** (.032)
Dummy: there is railway within 2.5 kms.	-.049 (.052)	-.049 (.053)
Dummy: there is highway within 2.5 kms.	-.102 (.064)	-.110 (.077)
Season, year, city dummies	Yes	Yes
N	1235	1235
σ_{ε}		.510** (.060)
$\rho_{u\varepsilon}$		.114 (.437)
$\rho_{v\varepsilon}$		.088 (.212)
ρ_{uv}		.374** (.186)
Rsq	.82	

Significant at 10% level; ** significant at 5% level or higher. OLS s.e.'s are robust, city clustered.