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# Government Supply of Land in a Dual Market

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**Abstract.** A dual land market is one in which the government owns a significant portion of developable land while real estate development is done primarily by the private sector. This paper examines Singapore's experience with its system of government land supply in a dual market, focusing on its response to market signals as well as the interaction with the significant private supply of land. This example is relevant to the general problem of government disposition of valuable assets. The private supply of developable land behaves in line with expectations. The government behavior does not replicate that of private landowners. Despite the stated goals of government policy, though, the government's land supply behavior exhibits inconsistent responses to leading and contemporaneous price signals.

## **1. Introduction**

Many countries have gone through or will go through phase in which they have a dual land market, where the government owns a significant portion of developable land while most real estate development activity is undertaken by the private sector. The success of economic development often hinges on the way that large government land holdings are transferred to the private sector. Governments must balance competing goals of economic efficiency, real estate market stability, raising revenues, and stimulating low income housing or small business development. Researchers have long been concerned with squatting and ownership transfer issues (De Meza and Gould, 1992; Hoy and Jimenez, 1991) and the development consequences of property rights institutions and title systems (DeSoto, 2000; Colin and Ayouz, 2006; Miceli, et al., 2000). But while there is an extensive literature on government regulation of urban land markets in both developed and developing countries, the consequences of government ownership in dual markets have received little attention.

This paper examines the government supply of land to the Singapore residential real estate market. The Singapore land market is a dual market as defined above; while there is privately owned vacant land available for development, the government controls, as a consequence of its past slum clearance and other policies, a large part of the supply of developable vacant land in the economy. The fundamental question is: how does the government's role as the largest single owner of developable land affect the real estate market? The stated goal of the government is to ensure an adequate supply of land to meet the development needs of the economy without destabilizing the real estate market.

The government supplies land to the market through auctions, a popular channel in the private sector as well. The relevant question therefore resolves to: does the government time its auctions much like private suppliers? Or, does its auction timing behavior reveal underlying motives that differ from the profit oriented private owners, reflecting perhaps other goals like market stabilization? Singapore provides an opportunity to also examine how private and government land supplies interact and affect each other. The results yield insight into the possible underlying motivation for government policy as well as its affect on the private side of the market.

Singapore has grown into a stable market economy. The past 15 years in particular represent a period of development of government institutions, income growth, and emergence of other characteristics typical of developed economies. The country also enjoys a long tradition of the rule of law and functioning real estate markets. Many less developed countries are trying to move towards greater reliance on markets as an integral part of their economic development plans. It is therefore likely that many emerging third world and post-communist countries will find it necessary to pass through a phase with a dual land market similar to Singapore's.<sup>1</sup>

Additional advantages from studying Singapore include the fact that the 15 year sample period is long enough to include all phases of the business cycle, which allows us to examine all phases of the property market cycle. Finally, the majority of vacant land, whether government or privately owned, is supplied to the market through sealed bid auctions. As a practical matter, the highly visible nature of such auctions makes it easier

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<sup>1</sup> The Chinese Government passed legislation in 2007 establishing private property rights in urban land similar to the government land leaseholds sold to private developers in Singapore.

to pinpoint the individual parcels of land being sold as well as when they are brought onto the market.

This study focuses on the residential land market. Housing is a major policy concern in Singapore, as elsewhere, and therefore the residential property market is arguably the most important real estate market from a broad policy perspective. Nonetheless, our focus on residential land is at least in part driven by the data; complete data are not available for a sufficient number of nonresidential real estate development projects for empirical analysis.

Even though this study focuses on the Singapore residential land market, we believe that the results are relevant both beyond Singapore and the specific market. The problems addressed by Singapore's government land supply program have broader application in the general area of government disposition of valuable assets. The Singapore experience is more relevant to the problems faced by developing economies today than, for example, the nineteenth century homestead laws that were used to transfer extensive land holdings to private owners in the U.S.

This paper examines the factors affecting the timing of auctions for both government and privately owned land. The estimates clearly reveal that the government land sales program does not mimic private market release of land to developers. The government tends to exhibit a stronger response to price signals from preceding auctions than do private landowners. While private landowners exhibit behavior consistent with profit maximization, the government's auction timing response to expected sales prices runs counter to profit maximization. This is a curious inconsistency, given its response to price signals from preceding auctions. We cannot determine if the government's behavior

is because of an inability to ascertain expected current prices with confidence or because of policy inconsistencies. Nonetheless, we can rule out the notion that the government times land sales to either maximize or stabilize revenues; land sales revenues account for a miniscule portion of the public finances and, as revealed in Table 1, the timing generates wide revenue swings from this source.

The paper is organized as follows. Section 2 explains relevant institutional background. Section 3 describes the sample and provides preliminary analysis of the determinants of auction timing in the market under study. Section 4 extends the empirical modeling to take into account possible endogeneity of both auction timing and realized prices. Section 5 presents the conclusion.

## **2. Institutional Background**

There are two sources of vacant land for residential development in Singapore: government owned land and privately owned land. This section briefly describes the two sources of land to the market.

***Government land sales.*** The Singapore property market suffered a variety of afflictions in the early 1960s following independence: overcrowding, dilapidated housing, large numbers of squatters, poor hygiene and sanitation, limited social amenities and congested traffic. Recognizing the importance of involving the private sector to transform the urban landscape of the new nation, the Singapore Government initiated a land sales program. Under this program, the government used its compulsory powers to acquire fragmented

urban land plots, amalgamating them and then offering them free of encumbrances to the private sector for development.

All of the government's land sales are handled by the Urban Redevelopment Authority (URA) and the Housing and Development Board (HDB), with the URA handling 58% of development sites and the HDB handling 42%. The HDB is primarily responsible for sales of sites located within the boundary of public housing estates, which are usually designated for lower end private housing or suburban style commercial development. The URA, on the other hand, handles the sale of sites that are located outside the public housing estates. For residential developments, the URA sites are usually located within established private residential areas.

The land is sold through a first-price sealed-bid auction. The process is, briefly, as follows. When a development site is released for sale, interested bidders are invited to purchase a Developer's Packet containing the planning and design guidelines for the site and other specific conditions for the sale. The residential sites usually entail a leasehold tenure of 99-years. Depending on the complexity of the proposed development and regulatory constraints, interested bidders are given between two and four months to carry out their due diligence and prepare the tender submission. By noon on the closing date of the auction, the bidders must deposit their sealed-bid together with a deposit equivalent to 10% of the bid amount. The bids are opened and the names of all bidders and their respective bids are posted on the same day. The site is then awarded to the highest bid exceeding the reserve price. While the first auctions considered planning concepts, design merits and other tender conditions, the current auction system (relevant to our sample) bases awards on price alone. The reserve price, which is not revealed to bidders, is set

equal to 85% of the Chief Valuer's assessed market value for the development site. The valuation, which is submitted by the Chief Valuer in a sealed envelope before the tender closing date, is opened at the same time as the received bids. Sealed-bid is the preferred method of sale in Singapore (instead of an open auction) because it is believed to reduce the probability of collusion among potential bidders.

Once the highest bidder has been awarded the site, the government agency monitors the development progress closely in order to ensure that the outcome is in accordance with the planning and technical requirements stipulated in the auction submission. The successful bidder is also prohibited from selling the leasehold to outside parties. In addition, the bidder must complete the development within the specified time frame in order to avoid punitive fines for late completion.

In total, 223 GLS sites were sold for residential development for our 1990-2005 sample period (see Table 1). No government sales took place between 1998 and 1999 during a property market slump. On average, each government auction attracted approximately 6 bids. The most popular site attracted 20 bids and the 14 least popular sites attracted only one bid each. (Note, though, that even single bidders must bid against the unannounced reservation price so that single bidder auctions resemble a 2 bidder auctions.)

The majority of government residential sites was for high-rise multiple-unit residential developments--either as apartments (with minimal communal facilities), condominiums (larger developments with a full range of communal facilities), or executive condominiums (with a 10-year restriction on resale and occupation). A smaller set of sites were designated for low-rise or

landed developments (lower density housing in the form of bungalows, detached, semi-detached, and linked houses).

***Private land sales.*** Our sample also includes private land supplied to the market. The private auctions sample is drawn from transactions reported in the press, namely the Business Times and Straits Times, during 1994-2005. In total we have an initial sample of 277 observations on private land auctions. In contrast with the 99 year leasehold in the government sample, our sample of private transactions entails freehold land tenure or its equivalent. With the exception of the residential zoning restriction, private land sales are subject to no other systematic constraints on development or resale.

### **3. The Determinants of Auction Timing**

***Auction timing determinants.*** We begin with a simple model of the empirical determinants of auction timing. The dependent variable in this regression is the time lag between the current and previous land auction. The various determinants fall into two categories: observable outcomes from the preceding auction and current real estate market conditions.

The first determinant is the sales price established in the previous auction, *PREV PRICE*. A greater realized price in the preceding auction signals, ceteris paribus, a greater demand for new residential development; a negative coefficient on this variable indicates more frequent auctions in response to this price signal. But since the most profitable time to sell land to developers is any time up to the planned development time for the most profitable use, a coefficient equal to zero also is consistent with profit maximizing

landowners in market equilibrium.<sup>2</sup> A significantly positive coefficient indicates that the supply of land through the combined government and private auctions responds perversely to these land market price signals.

Broader real estate market conditions are reflected in the property price index, *PPI*, and the percentage change in the index, *PPI CHANGE*. Including these controls in the regression ensures that the *PREV PRICE* coefficient reflects the effects of greater demand for new development relative to the current market for existing real estate assets.

We also include variables capturing publicly available information from previous auctions to see how such information affects the timing of subsequent auctions. Private auctions do not release as much information about offered bids as do government auctions, so the variables pertaining to proffered bids are for the previous government auction: *PREV PREMIUM* is the difference between the highest and next highest bid; *PREV BID RANGE* is the difference between the maximum and minimum bids; and *PREV BIDS* is the number of bids forthcoming. As a set, these variables measure the intensity of bidding observed in the preceding government auction. A smaller premium and greater number of bidders indicate that there will be greater unfulfilled developer demand for land from the previous auction. Negative coefficients on these variables mean that suppliers are inclined to bring their land to the market more quickly in response to these signals. A greater range of bids, however, might be indicative of greater disagreement among developers regarding the future profitability of the projects they

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<sup>2</sup> Denote the optimal development time for a parcel of land as  $T$  and the market price of the parcel at time  $t$  as  $p(t)$ . In competitive market equilibrium, the price of land ensures equal present value of land profit regardless of when the landowner sells to a developer. That is, when the holding cost is  $cp(t)$  and the interest rate is  $r$ , the land value evolves following  $p(t) = p(T)\exp\{(r+c)(t-T)\}$  for  $t \leq T$ . Thus, the optimal time for the landowner to sell is any  $t \leq T$ . Introduce the shift parameter  $\phi$  such that  $\phi > 1$  gives the effect of an increase in the demand for developed land. In this case,  $p(t) = \phi p(T')\exp\{(r+c)(t-T')\}$  where  $T' < T$  is the new optimal development time. It is now optimal for the landowner to sell to a developer at any  $t \leq T'$ .

have in mind. If this interpretation is correct, then greater uncertainty tends to increase the option value of postponing development (Titman, 1985; Capozza and Li, 1994), and therefore is likely to slow the supply of land to developers in the market.

The variable *DISTANCE* measures the distance (in kilometers) between the immediately preceding auction and the current auction properties; *REL SIZE* measures the amount of land being sold in the current auction relative to the previous auction; and *REL FAR* is the allowed floor area ratio (FAR) for the current auction divided by the FAR for the preceding auction. Both of these variables are included in the model to capture the extent to which the properties sold in the sequential auctions differ. A negative coefficient on *DISTANCE* indicates that land suppliers are spreading auctions more evenly across the metropolitan area; a positive coefficient indicates that the supply of land through these auctions tend to be spatially clustered in the urban area within a given window of time. The coefficient on *REL SIZE*, on the other hand, indicates whether the land suppliers are more inclined or less inclined to bring relatively larger plots of land to the market more quickly. With respect to *REL FAR*, a positive coefficient indicates that these land suppliers are bringing forth less restricted properties more rapidly to the market; a negative coefficient indicates that suppliers are bringing forth the heavily restricted properties more rapidly to the market. Of course, what is essential to our analysis of the empirical results is how the coefficients on these three variables differ for government and private auctions.

The variable *QTR SUPPLY* measures the total quantity of land sold in the market during the same quarter as the auction. This variable is included to control for the aggregate effect of all other auctions as competing sources of land supply relative to the

current auction. A positive coefficient indicates substantial clustering of auctions within a quarter while a negative coefficient indicates a tendency to spread the land supplied by these auctions more evenly over time.

Finally, we include a dummy variable, *PRIVATE*, for private auctions, as well as a complete set of interactive variables with this dummy variable in order to identify how private auction timing differs from government auction time, if at all. When interpreting the results, our maintained hypothesis is that the private land suppliers are motivated by expected profit maximization. Any deviations between government and private auction timing will reveal differences in the underlying auction motives.

After omitting observations with missing data, our final sample comprises 363 sites, of which 40.5% are private land sales and 59.5% are GLS transactions. Table 2 reports relevant sample statistics for these and other variables used in the empirical analysis. The private and government sites are interspaced throughout the main residential areas of Singapore, with about 5.5% in what are widely regarded as prime locations in terms of surrounding property and accessibility to the central business district (CBD). The price of the land parcels sold during the sample period ranges from a minimum of S\$1.6 million to S\$ 1,796.2 million, with an average of S\$ 90.9 million. The average parcel size is about 14,126 m<sup>2</sup> and the average FAR is 2.20.

Singapore has a small physical area. The greatest distance of a sold plot from the nearest subway station is only slightly above 4 km. Similarly, the development site farthest away from the CBD is 23 km. In view of the short distances involved, we expected a relatively flat rent gradient in Singapore. Over the sample period, the average quarterly change in the property price index is 1.0%, ranging from -4.3% to 14.0%. The

average time interval of land parcels sold between 1990 and 2005, which is the main focus of our empirical investigation, ranges from a minimum of 1 day to a maximum of 241 days, with an average of 24 days.

*Empirical estimates.* Table 3 reports the parameter estimates. Model (1) is the base model. The significant negative coefficient on *PREV PRICE* shows that government auctions tend to be timed closer to previous auctions with higher realized prices. The combined *PREV PRICE* and *PRIVATE\*PREV PRICE* effect on auction timing is not, however, significantly different from zero. This indicates that the timing of private auctions does not respond to the relative scarcity signaled by realized price of preceding auctions. The private auction timing result is surprising and appears to contradict our maintained hypothesis that private suppliers time their auctions to maximize profits. In contrast, the government auction timing result indicates behavior consistent with the law of supply. Still, this is only a partial picture; other signals from preceding auctions must also be considered.

Looking at the variables that capture information from the preceding government auction bidding pattern, though, the significant coefficient on the bid premium by itself indicates that government auctions are timed more frequently when the two highest bids are closer together—one measure of strength of the unfulfilled demand from the preceding auction. The range of bids is not significant nor is the number of bidders for the preceding auction; these variables appear to not yield additional signals beyond the winning bid and the difference between the highest and second highest bids.

For the interactive terms capturing differences between private and government auctions, only the *PRIVATE\*PREMIUM* variable is significant in model (1). This size of the coefficient and the standard error coupled with the *PREMIUM* coefficient and standard error again indicates that private auction timing does not appear to respond significantly to the price signals in the difference between the highest and next highest bids for the previous government auction. This much is consistent with our conclusions from the previous price variable. Further, none of the other previous bid information variables is significant for private sales.

Neither the relative plot size nor the distance from the previously auctioned plot affects either government or private auction timing. The *REL FAR* does, however, affect both types of sellers in the same way. The coefficient on this variable is significantly negative, indicating that both types of land suppliers offer land more rapidly to the market when the land is subject to less stringent density regulation.

The broad market conditions variables are *PPI*, *PPI CHANGE*, and *QTR SUPPLY*, and the interactive terms indicating private sales. Neither type of auction appears to be affected by the quarterly land supplied. Looking at the coefficients on the price index variables coupled with their interactive terms counterparts, we see that government land sales occur more frequently when real property prices are higher in the broader market while private land sales are unaffected. Nonetheless, both types of auctions are less frequent when real property prices are rising faster in the broader market; this result is somewhat surprising unless greater *PPI CHANGE* corresponds to greater real property price volatility. Since greater price volatility is normally expected to slow the most profitable pace of land development (Titman, 1985; Capozza and Li,

1994), the slowing of both private and government auction timing found here is consistent with this profit-oriented outcome.

Finally, the *PRIVATE* dummy variable is significantly negative, revealing that private suppliers do not wait as long between auctions as do the government agencies. In this sense, the government is generally a slower supplier of land to the market than the private sector.

Model (2) introduces a dummy variable, *PREV GLS*, indicating that the preceding auction is a government land sale. This variable does not significantly affect auction timing for either government or private land.

In sum, these results point out that the government and private land auction timing differ in important ways. Perhaps most interesting at this point is the observation that government timing appears to follow more closely what we expect of a profit-maximizing supply side than does private sector auction timing. We will return to this observation in the next section.

One weakness in this type of qualitative determinants analysis is that, while it does reveal important relationships, it does not fully control for endogeneity or other implications of theory. For example, one important factor driving profit maximizing suppliers is likely the expected sales price of the land when auctioned. At the same time, the expected price is affected by the characteristics of the property as well as the competing supply of land from other auctions, measured by how soon the auction is being held to the preceding auction. The next section takes a careful look at the empirical implications of these issues.

#### 4. Endogenous Auction Price and Timing

*Auction timing equation.* The analysis in the previous section overlooks the expected selling price as one potentially important determinant of auction timing. Using vector  $\mathbf{x}$  to denote the timing variables introduced in the previous section, the time lag between the current auction and the preceding auction is

$$(1) \quad TIME = \beta\mathbf{x} + \delta \ln PRICE + \varepsilon$$

where *PRICE* is the expected price of the land in the current auction.

We consider the auction timing decision of a landowner the same as any other investment timing sequence in a competitive market. It can be shown that—regardless of whether developed land earns location-specific rents or not—the competitive development pace drives the incremental return from development equal to the annualized construction cost (Turnbull, 2005). A greater return to developed property hastens the planned development date. The profit maximizing time for the landowner to sell to a developer is before or at the optimal development time. Therefore, a higher expected price, reflecting a greater return to development, either has no effect on the profit motivated landowner’s planned time of sale when the optimal development time is after the planned land sales time or hastens the planned time of sale when the planned sales time is at the optimal development time. As a consequence, the expected coefficient on *PRICE* is zero or negative for profit oriented landowners. Thus, a significantly positive  $\delta$  rejects the underlying profit maximization hypothesis in terms of auction timing.

***Auction price equation.*** Sealed bid land auctions, like those in our sample, provide a land pricing mechanism that closely resembles neoclassical urban bid rent theory (Ooi, Sirmans, and Turnbull, 2006a). Following this argument, the price of land sold in the auction is determined by the parcel characteristics like size and location, land use regulations, and conditions in the broader real estate market. Differences in the bundle of property rights attendant with the government versus privately owned land implies that government and private auctions will generally yield different price outcomes for otherwise identical parcels of land (Ooi, Sirmans, and Turnbull, 2006b). We include all of these property characteristics, regulatory, and ownership variables in the vector  $y$  explained below.

The amount of land being brought to the market for development is also expected to affect returns to development hence land prices. To control for this, we also include the time lag between the current auction and the previous auction, *TIME*. Less frequent auctions indicate that less land is being brought onto the market for development (recall that the empirical model controls for parcel size). Therefore, for given developed land demand conditions, we expect that such a restriction on supply will raise the expected price from the auction. A significantly negative coefficient on *TIME* is consistent with this view.

Adding the stochastic error term  $v$  to the expected price, we have the empirical form for the observed price of land sold in the current auction as

$$(2) \quad \ln PRICE = \alpha y + \gamma TIME + v$$

The variables in vector  $y$  are: parcel size (*SIZE*); location variables for location in the prime residential district (*PRIME*), distance to the central business district in kilometers

(*CBD KM*), and distance to the nearest subway station in kilometers (*METRO KM*); the maximum floor area ratio (*FAR*) allowed for the plot of land, the presence of further restrictions on development configuration as bungalows, etc. (*LANDED*); and the real property price index (*PPI*). The dummy variable *GLS* indicates that the auction is part of the government land sales program.

***Empirical estimates.*** Table 4 reports 2SLS estimates of the price equation (2). In all versions of the auction timing equations considered below, the price equation estimates follow what we expect. Land price rises with proximity to the CBD or metro stations and tracks the real property price index. The maximum allowed FAR and other density regulations are binding; relaxing these restrictions leads to a higher land price. Land sold in government auctions obviate the need to deal with assembly problems, which enhances its value, but it also comes with restrictions on the pace and pattern of subsequent development and resale, which reduces its value. The coefficient on the *GLS* dummy variable shows that the net effect is lower prices from government supplied land relative to privately supplied land, a typical result for this market (Ooi, Sirmans, and Turnbull, 2006b). Finally, the *TIME* coefficient is negative as expected, although it is only significant at the 10% one tail level.

The auction timing equation estimates are of central interest to this study. Table 5 reports these estimates. Consider model (3) in the first column. Most of the parameter estimates are similar to what we found in the OLS determinants model in the previous section. Introducing the endogenous expected price from the auction does not appear to modify many of the results. Some differences in results are modest; for example, the ratio

of the preceding auction FAR to the current auction FAR is no longer significant. There is, however, one important difference. Once we control for the endogenous expected price from the auction, we find that private auctions are spaced even closer to preceding auctions than are government auctions in response to a higher previous auction price. This implies that, although the government auctions respond to higher land values signaled by previous auction prices following the law of supply, the government response is weaker than that of private land suppliers. The expected price itself does not have a significant effect on auction timing. A zero or negative coefficient is consistent with our expectations, so this result is not surprising.

Model (4) adds the dummy variable *PREV GLS* indicating that the previous auction is a government auction. Nothing of consequence changes with this additional variable. Model (5), however, also includes an interactive term *PRIVATE\*PRICE* to allow for differences in the private and government auction timing responses to expected price. This change in the empirical model affects some of the key conclusions from model (3). In particular, the coefficient on the interactive term *PRIVATE\*PREV PRICE* is now significantly positive, indicating that private suppliers respond more slowly to higher prices in previous auctions than does the government. Combined with the coefficient on *PREV PRICE*, though, the net effect of the previous auction price is to still accelerate private auction timing. (The joint t-statistic is not reported in the table, this effect is significant.)

The coefficients on *PRICE* and *PRIVATE\*PRICE* in model (5) separate the auction timing effects of expected price into government and private supply responses. The significantly positive coefficient on *PRICE* indicates that government land is brought

to the market more slowly in response to higher expected price. The coefficients on *PRICE* and *PRIVATE\*PRICE* together are not significantly different from zero, indicating that there is no stable relationship between the pace at which private land is brought to the market and the expected sales price. The government and private supply behave differently in this regard. In light of our earlier discussion of the timing equation (1) in the simultaneous system, this combination of coefficients is consistent with private suppliers who are motivated by profit maximization but rejects profit maximization by the government.

## **5. Conclusion**

The government land sales program in Singapore does not simply follow or reinforce private market supply of vacant land. In fact, the government land supply behaves differently than private land supply. The government share of land supply brought to the market is large enough to affect real estate market conditions. Implies that government must be careful to neither feed hot markets nor further depress declining markets.

Government land sales do not appear to be motivated by the need to generate revenue in Singapore. Land sales generate on average only 5.3% of total government operating revenues; the annual contribution ranges between 0.2%-21.7%. In emerging economies, however, revenue needs may drive land or other property sales by the government. Such cases raise the danger of the government inadvertently destabilizing real estate markets by selling more property when real estate prices are low in order to

stabilize its revenue. This can be a particularly sensitive issue when the government vacant land supply represents as large of a portion of the total market as in Singapore.

Our empirical estimates show that, whatever the government land program goals are, the two government agencies involved in releasing land for development exhibit land supply behavior that differ significantly from the private supply. Government auction timing responds more strongly to price signals than does private auction timing. The government speeds the supply of land to the residential market in response to leading price signals from preceding auctions, but slows the pace of supply in response to current price signals. The government and private land supplies, however, both respond the same to greater real price appreciation in the broader residential real estate market.

Singapore is different from most other countries in that its economy is entirely urban. While we have no reason to expect rural real estate markets to behave differently than urban markets, that possibility must be allowed for when considering government land sales in countries with substantial rural/agricultural components. Some of the results found here need not translate well to those cases.

Singapore has a fairly well-developed economy governed by the rule of law. It has well-defined private property rights and well developed financial institutions that facilitate the flow of private investment capital. In these regards, Singapore differs from many emerging economies. It's experience, however, reinforces DeSoto's (2000) rationale for the rule of law, private property, and an effective title system as a necessary first step for economic development and sustained growth. When that prescription is followed, Singapore's experience with government land sales illustrates one way that governments can implement significant transfers of land to private use in a manner

consistent with a well-functioning private market. Singapore's experience with government land auctions is also relevant to the general problem of government disposition of non-real estate assets.

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**Table 1. Sample sites sold for residential development in Singapore (by year)**

Year	GOVERNMENT SITES		PRIVATE SITES		WHOLE SAMPLE	
	No.	Total Value	No.	Total Value	No.	Total Value
1990	5	127.07	0	0.00	5	127.07
1991	6	236.98	0	0.00	6	236.98
1992	5	286.76	0	0.00	5	286.76
1993	17	808.29	0	0.00	17	808.29
1994	30	3,075.40	7	601.94	37	3,677.34
1995	27	1,473.96	20	904.26	47	2,378.22
1996	38	3,893.41	50	2,807.80	88	6,701.22
1997	36	4,638.31	35	2,201.02	71	6,839.33
1998	0	0.00	1	57.70	1	57.70
1999	0	0.00	63	3,801.40	64	3,973.70
2000	23	2,382.30	25	1,687.87	48	4,070.17
2001	13	1,091.30	0	0.00	14	1,175.25
2002	7	932.51	9	275.55	16	1,208.06
2003	3	489.30	13	1,022.15	16	1,511.45
2004	3	131.21	16	1,154.17	19	1,285.38
2005	10	4,146.57	38	2,211.52	48	6,358.09
Total	223	23,713.37	277	16,725.37	502	40,694.99

*Notes: The exchange rate for US\$1 is equivalent to S\$ 1.53 in March 2007.*

**Table 2. Variable definitions and descriptive statistics**

<b>Variable</b>	<b>Mean</b>	<b>Std.Dev.</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Definition</b>
<i>TIME</i>	24.386	39.282	1.000	231.000	The time interval between current and previous land auction.
<i>PREV PRICE</i>	8.2049	0.6170	6.1020	9.3989	Natural log of sales price established in the previous auction (S\$ psm of allowed floor area)
<i>PPI</i>	138.701	29.073	58.700	181.400	Property price index
<i>PPI CHANGE</i>	0.0097	0.0369	-0.0436	0.1401	Percentage change in property price index
<i>PREV PREMIUM</i>	0.1315	0.1244	0.0000	0.6725	Percentage difference between the highest and next highest bid
<i>PREV BID RANGE</i>	0.3544	0.1792	0.0000	0.8024	Percentage difference between the maximum and minimum bids
<i>PREV BIDS</i>	6.1792	3.3785	1.0000	26.0000	The number of bids
<i>DISTANCE</i>	8.8890	5.2089	0.0000	27.1400	Distance (in km) between the immediately preceding auction and the current auction properties.
<i>REL SIZE</i>	3.3370	7.1258	0.0216	58.3174	The amount of land being sold in the current auction relative to the previous auction.
<i>REL FAR</i>	0.1482	0.6965	-0.8833	3.6429	The percentage difference between the allowed floor area ratio (FAR) for the current auction and the FAR for the preceding auction.
<i>QTR SUPPLY</i>	329495.0	175900.0	0.0000	722902.0	Total quantity of land sold (in sq m of allowed floor area) in the market during the same quarter
<i>PRIVATE</i>	0.4050	0.4916	0.0000	1.0000	Binary variable for private auctions.

*Note: The descriptive statistics are based on the final sample of 363 observations.*

**Table 3. OLS estimates of auction timing determinants**

	Model 1 <sup>a</sup>			Model 2 <sup>a</sup>		
	Coeff.	Std.Err.	<sup>b, c</sup>	Coeff.	Std.Err.	<sup>b, c</sup>
<i>CONSTANT</i>	272.3460	33.921	***	229.7160	34.811	***
<i>PREV PRICE</i>	-24.7104	4.197	***	-18.1631	4.189	***
<i>PPI</i>	-0.3336	0.158	**	-0.4089	0.164	**
<i>PPI CHANGE</i>	79.9086	52.267		90.4566	53.713	*
<i>PREV PREMIUM</i>	111.4210	23.891	***	118.5590	24.657	***
<i>PREV BID RANGE</i>	6.8014	21.905		5.1298	22.673	
<i>PREV BIDS</i>	-1.3452	0.810	*	-1.4195	0.842	*
<i>DISTANCE</i>	0.0132	0.346		0.3339	0.353	
<i>REL SIZE</i>	-0.0065	0.148		-0.1532	0.148	
<i>REL FAR</i>	-5.0191	2.616	*	-3.7932	2.543	
<i>QTR SUPPLY</i>	-0.000012	0.000		0.0000	0.000	
<i>PRIVATE</i>	-245.1450	44.797	***			
<i>PRIVATE*PREV PRICE</i>	23.7875	5.325	***	-6.5079	3.131	**
<i>PRIVATE*PPI</i>	0.3402	0.169	**	0.3816	0.184	**
<i>PRIVATE*PPI CHANGE</i>	-74.1665	68.094		-64.5728	77.594	
<i>PRIVATE*PREV PREMIUM</i>	-109.1200	29.450	***	-108.4450	33.283	***
<i>PRIVATE*PREV BID RANGE</i>						
<i>RANGE</i>	-8.7221	25.123		5.8890	28.072	
<i>PRIVATE*PREV BIDS</i>	1.8129	0.906	**	1.5840	0.973	
<i>PRIVATE*DISTANCE</i>	-0.0906	0.482		-1.4744	0.449	***
<i>PRIVATE*REL SIZE</i>	-0.2547	0.477		0.1766	0.575	
<i>PRIVATE*REL FAR</i>	4.2888	3.162		1.9178	3.492	
<i>PRIVATE*QTR SUPPLY</i>	-0.000012	0.000		0.0000	0.000	
<i>PREV GLS</i>				-4.6227	3.867	
Observation	363			363		
Adj R2	0.5286			0.5046		
F-statistic	20.33	***		18.56	***	

Notes:

<sup>a</sup> TIME is the dependent variable. The dependent and independent variables are defined in Table 2.

<sup>b</sup> White's heteroscedastic robust standard errors.

<sup>c</sup> \*\*\*, \*\* and \* denote significance at the 1.0%, 5.0% and 10.0% level (one tail), respectively.

**Table 4. 2SLS estimates for auction price equation in simultaneous system <sup>a</sup>**

<b>Explanatory Variables</b>	<b>Coeff.</b>	<b>Std.Err.</b> <sup>b, c</sup>		<b>Variable Definitions</b>
<i>CONSTANT</i>	7.5652	0.2600	***	Intercept
<i>SIZE</i>	1.0436	0.0248	***	The area of the land in square meters.
<i>PRIME</i>	0.1245	0.0897		A binary variable indicating that the site is in one of the traditional prime residential districts (district 10 or 11).
<i>CBD KM</i>	- 0.0483	0.0057	***	The distance in kilometers to the Central Business District.
<i>METRO KM</i>	- 0.0838	0.0256	***	The distance in kilometers to the nearest metro subway station.
<i>FAR</i>	0.2570	0.0200	***	The maximum allowed floor area-land area ratio for development on the site.
<i>LANDED</i>	- 0.5253	0.0617	***	A binary variable indicating land parcels that are designated for low density single family dwelling units, such as detached or linked houses, bungalows, or townhouses.
<i>PPI</i>	0.0077	0.0010	***	Property price index
<i>GLS</i>	- 0.4749	0.0547	***	A binary variable indicating land parcels sold un the Government Land Sale (GLS) program.
<i>TIME</i>	- 0.0018	0.0011	*	The time lag between current and previous land auction.
Adj R2	0.87507			
F-statistic	278.85 <sup>***</sup>			

*Notes:*

<sup>a</sup> LnPRICE is the dependent variable. The independent variables are defined in the last column.

<sup>b</sup> White's heteroscedastic robust standard errors.

<sup>c</sup> \*\*\*,\*\* and \* denote significance at the 1.0%, 5.0% and 10.0% level (one tail), respectively.

**Table 5. 2SLS estimates for auction timing equation in simultaneous system**

	Model 3 <sup>a</sup>			Model 4 <sup>a</sup>			Model 5 <sup>a</sup>		
	Coeff.	Std.Err.	<sup>b, c</sup>	Coeff.	Std.Err.	<sup>b, c</sup>	Coeff.	Std.Err.	<sup>b, c</sup>
<i>CONSTANT</i>	210.7180	24.590	***	229.7590	30.301	***	96.1494	34.818	***
<i>PREV PRICE</i>	-16.4726	3.757	***	-18.1732	4.073	***	-25.1515	3.979	***
<i>PPI</i>	-0.3825	0.102	***	-0.4090	0.105	***	-0.3881	0.099	***
<i>PPI CHANGE</i>	91.7989	46.748	**	90.4418	46.691	*	62.7082	44.228	
<i>PREV PREMIUM</i>	121.3990	20.228	***	118.5460	20.371	***	120.0830	19.213	***
<i>PREV BID RANGE</i>	5.6305	19.048		5.1260	19.024		4.0541	17.942	
<i>PREV BIDS</i>	-1.3918	0.817	*	-1.4198	0.816	*	-1.5938	0.770	**
<i>DISTANCE</i>	0.2561	0.388		0.3344	0.395		0.2555	0.372	
<i>REL SIZE</i>	-0.1298	0.231		-0.1535	0.232		-0.5886	0.228	***
<i>REL FAR</i>	-3.6137	2.575		-3.7961	2.577		-9.7377	2.586	***
<i>QTR SUPPLY</i>	-0.000019	0.000		0.0000	0.000		0.0000	0.000	
<i>PRIVATE*PREV PRICE</i>	-5.4827	2.702	**	-6.4032	2.831	**	15.8247	4.252	***
<i>PRIVATE*PPI</i>	0.3247	0.157	**	0.3757	0.164	**	0.4170	0.154	**
<i>PRIVATE*PPI CHANGE</i>	-59.2398	113.535		-63.6229	113.429		-70.1809	106.980	
<i>PRIVATE*PREV PREMIUM</i>	-110.4190	41.629	***	-108.4410	41.604	***	-114.2590	39.246	***
<i>PRIVATE*PREV BID RANGE</i>	4.3746	30.451		5.5668	30.423		-1.8243	28.713	
<i>PRIVATE*PREV BIDS</i>	1.5259	1.093		1.5849	1.092		1.8860	1.031	*
<i>PRIVATE*DISTANCE</i>	-1.4432	0.594	**	-1.4829	0.594	**	-0.5320	0.578	
<i>PRIVATE*REL SIZE</i>	0.2723	0.999		0.1876	1.001		0.3219	0.944	
<i>PRIVATE*REL FAR</i>	2.4287	4.580		2.0037	4.590		8.1828	4.426	*
<i>PRIVATE*QTR SUPPLY</i>	0.000004	0.000		0.0000	0.000		0.0000	0.000	
<i>PRICE</i>	0.0039	0.012		0.0041	0.012		10.8378	1.613	***
<i>PREV GLS</i>				-4.6510	4.338		-5.3350	4.093	
<i>PRIVATE*PRICE</i>							-10.8351	1.613	***
<i>Observation</i>	363.0000			363.0000			363.0000		
<i>Adjusted R2</i>	0.5333			0.5347			0.5862		
<i>F-statistic</i>	18.4600***			17.6700***			20.7800***		

Notes:

<sup>a</sup> TIME is the dependent variable. The dependent and independent variables are defined in Table 2.

<sup>b</sup> White's heteroscedastic robust standard errors.

<sup>c</sup> \*\*\*, \*\* and \* denote significance at the 1.0%, 5.0% and 10.0% level (one tail), respectively