Can the visible and invisible hands coexist in land pricing?

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Abstract

This study addresses state intervention in land pricing. Theoretical modelling identifies risk aversion as the determining factor for the coexistence of the visible and invisible hands. Our empirical tests using Chinese data confirm the absence of this coexistence. Exploring the micro-foundation of this "two-hand" model and extending the Lucas critique, we illustrate the impossibility of this coexistence under the land regime of state ownership in a market environment: state interference in land pricing causes people to drastically alter their expectations and neutralizes their risk aversion, leading to the deactivation of the stochastic discount factor and the market mechanism. This work provides a "risk aversion" approach to the causes of "state failure" and implies that under state ownership of land, the distortion of land prices is inevitable.

Keywords: land pricing, state ownership of land, state failure, the Lucas critique, risk aversion.

JEL codes: G12, H71, Q24.

1. Introduction

This study was initially motivated by an empirical phenomenon in China: the explosion of real estate prices has been a major event in China's economic development. According to standard asset pricing models, the growth of an asset price is determined by the stochastic discount factor that reflects income and consumption growth. If the driving force of land prices is the market force, this is not a concern, since it leads to general equilibrium. However, as China's land is owned by the state, and land pricing is to a large extent determined by the "the visible hand", albeit able to generate short-term booms, this can cause long-term economic disequilibrium, such as over-investment in the real estate sector, to the detriment of other sectors.

With the evolution of research, a more theoretical question emerged: given that Chinese state intervention is in a market environment, is the coexistence of the visible and invisible hands in land pricing possible? How to methodologically address this issue? Finally, how to make the theoretical model testable? Theoretical and econometrical investigations are lacking on this

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important topic. While asset pricing models have become commonly used tools, they are rarely applied to land assets. Moreover, land pricing under various types of land regimes remains unexplored topic in the literature.

The public property regime of land covers a large part of the world today. Together with China, there are at least five socialist countries with state land ownership in the Marxist tradition. Among ex-socialist countries, shares of state-owned land remain large. In Russia, by 2003, 42% of agricultural land was still owned by the government (Lerman and Shagaida 2007). Until 2009, of Russia's industrial land, nearly 96% was owned by the government (William Pyle, 2009). The other seven ex-Soviet bloc countries and fourteen member-countries of the ex-Soviet-Union are, to varying degrees, similar to Russia. State-owned land is common in Africa (Gérard Chouquer 2011). Even in the most developed states, a noteworthy share of land, called public land, is held by central or local governments. In the United States, the federal government owns about 28% of the nation's land (Vincent, Hanson and Argueta 2017). These lands are at once exposed to market transactions and subject to discretional governmental actions.

A number of studies have either used land as asset to model asset pricing (Holmström and Tirole 2001), or applyed asset pricing model in land pricing (Barry1980, Capozza and Schwarm 1989, Chavas and Thomas, 1999, among others). We start with a benchmark consumption-based capital asset pricing model describing a typical private land ownership-based model as reference. In this model, only the stochastic discount factor, reflecting the invisible hand, determines land pricing. Then, inspired by the Chinese case, we construct a model incorporating the key factors under a state-owned land system within a market environment. Owing to state ownership, the government, in order to make up for increasing budget deficits, has an incentive to raise land prices. It exerts power to fix reserve prices that shape the growth of land prices. This model, called the two-hand model, provides a framework to study the possibility of the coexistence of the visible and invisible hands in land pricing.

Inspired by the Lucas critique, we focus on exploring the micro-foundation of the two-hand model. In it, individual risk aversion is found to play a crucial role in altering the role of the invisible hand in land pricing. Borrowing from the analysis of a portfolio with one risky asset and one risk-free asset, we establish that risk aversion is endogenously affected by and decreases in governmental intervention in land pricing. As land prices are driven above free-market-determined prices, individuals drastically reduce their expectations of risk in land investment, and shift from risk-averse to risk-neutral. As the market mechanism relies on varying intertemporal marginal rates of substitution (MRS), with zero risk aversion, individuals become indifferent between the current and future consumption. Facing a constant MRS, the market arbitrage on land prices stops working, leading to the impossibility of the coexistence between the visible and invisible hands in land pricing.

The key equation of the two-hand model, including the main determinants of land pricing, is then transformed into an econometrically testable equation. China provides a good case for testing, because besides its state ownership of land, there is a vast market for the real estate sector and for land-use rights transactions. Using land data on more than 286 Chinese cities between 1998 and 2014, we construct variables and operate several longitudinal regressions. The key variable reflecting the inferences of the visible hand is conveniently built on the basis of the adaptive expectations hypothesis and a two-stage instrumental variables regression method.

The empirical evidence, as expected, confirms our theoretical finding: while local government-reserved growth rates had a strong effect on land price growth, in all regressions, consumption growth, reflecting the stochastic discount factor, does not have the expected significant positive effect. In other words, the invisible hand was effectively expelled by the visible hand in China's land pricing.

This study contributes to the literature by attempting to shed light on an old theoretical topic. State intervention in the presence of the "market failure" has been justified in welfare economics (Pigou 1932). Since the classic work of Oskar Lange (1936, 1937) on the possibility of simulating the market mechanism by central planning, the feasibility of the "visible hand" has been questioned from the incentive aspects on the ground of property right theory (Alchian and Damsets 1972), from the limits in the collection and treatment of information (Hayek 1935), or from a public choice perspective on the deviation of the state from the general interests (Buchanan and Tullock 1965). Rarely has the role of dealing with risk in "state failure" been addressed. This study can yield insights into this topic from a new perspective.

This research also provides straightforward policy implications: it is an illusion to believe in the existence of a system in which the visible and invisible hands coexist, each playing its proper role in optimizing land pricing. With the deactivation of the market, the distortion of land prices will inevitably lead to factor misallocation. The privatization of land ownership is the only solution.

The paper is organized as follows: Section 2 introduces the benchmark consumption-based model, builds the two-hand land pricing model, and lays the micro-foundation of the coexistence between the visible and invisible hands. Section 3, on empirical tests, derives the equation for testing, introduces the methods to deal with the data and constitute the variables, and presents the results. Finally, Section 4 concludes.

2. Theoretical framework

2.1. Land pricing in a free-market economy: the benchmark model

In a private ownership context, the pricing of an asset can be conveniently derived with dynamical stochastic general equilibrium (DSGE) models. The commonly used consumption-based capital asset-pricing model (C-CAPM) is one of the most popular applications of these models (Breeden 1979). The C-CAPM is applicable to land, because land is a typical asset in the sense of it being a factor of production, as well as a form of capital in real estate investment. We now introduce such a model with an asset specified as land.

The representative household maximizes:

$$V_t = \sum_{s=0}^{\infty} {\beta_t}^s E_t[U(c_{t+s})] \quad (1)$$

where V_t is the present value of current and future utilities. Utility is a function of consumption, c, and is discounted by the time discount factor $0 < \beta_t < 1$. Assuming the future is uncertain, future utilities $U(c_{t+s})$ take the form of conditional expectations.

The budget constraint is:

$$\Delta a_{t+1} + c_t = x_t + r_t a_t \quad (2)$$

where x_t is income, r_t is land return, and a_t is the real stock of land.

The logic behind the model is that the household trades off between current and future consumption. For the increase of future consumption, the household must choose to invest in land. The investment in land is motivated by three factors: 1) buying land, the household can increase consumption in a direct way. This is the case if land is used for improving housing and other conditions of habitability (for example, building a garden); as construction takes time, it is more convenient to consider the improvement increasing consumption in the future; 2) like other types of investment, a household? can use land for agricultural, industrial, or commercial purposes, and in this case it gains rents; 3) as the owner of land a household can expect to gain returns from the rise of land prices. Thus, investment in land is a way to increase future utilities.

The stochastic dynamic programming solution for this problem is a Euler equation:

$$E_t\left[\beta_t \frac{U'_{t+1}}{U'_t}(1+r_{t+1})\right] = 1 \tag{3}$$

where $E_t\beta_t \frac{U'_{t+1}}{U'_t}$ is the stochastic discount factor. Discounting the future by β_t captures impatience. The stochastic discount factor is also called the intertemporal marginal rate of substitution (MRT): the rate at which the investor is willing to substitute consumption at time $t+1$ for consumption at time t.

Developing Equation (3), assuming $\beta_t = 1/(1+\theta)$, and rearranging the equation, finally we get:

$$E_t r_{t+1} = \frac{1+\theta+E_t\frac{U'_{t+1}}{U'_t}+Cov\left(\frac{U'_{t+1}}{U'_t}, r_{t+1}\right)}{E_t\frac{U'_{t+1}}{U'_t}} \tag{4}$$

The expected rate of return of land assets is a positive function of the time discount factor θ, of the intertemporal MRT, and of the covariance between two random variables evaluated on the basis of past information. The stochastic discount factor is the signal of the market mechanism (for a more technical presentation see Cochrane, 2005). In a competitive market context under private land ownership, land price growth is uniquely determined by the "invisible hand", and there is not a role for the "visible hand."

2.2. The working of the "visible hand" under state ownership of land

This section presents land pricing under China's land regime of state ownership. China is a representative case for a theoretical generalization, due to its land pricing with state intervention in a market environment.

All lands are owned by the state in China. Firms, farmers, and households lease lands from the state for housing, commercial, industrial and agricultural uses. A land user obtains only the right of land use. The price of land is the price of land use rights. In strict terms, the price of land use is the present value of the sum of rents for a certain parcel of land during a certain period of the lease. As the terms of leases are long (70 years for housing, 40 years for commercial and tourist uses, and 50 years for industrial uses), this value is similar to conventional land prices.

With state ownership, China's land system has traversed two periods: before the 1980s, land use rights were distributed by the state or collectives without the possibility of resale or transfer of land use rights. This is typical of a system of central planning. Since the 1980s, these resale and transfer have been allowed. Thus, land pricing can be potentially influenced by the market, because the demand for land is to a large extent determined by the demand for real estate in industry, commerce and, especially in housing, in terms of users' purchasing power. All land users, however, are aware that the state, as land owner, has discretional power in land pricing.

Since the 1990s, Chinese local governments have applied massive expansionist economic development projects and largely increased their expenditures in industrial plantations, transport, administration and other infrastructures. Meanwhile, the Chinese central government launched a tax-sharing system reform aimed at centralizing tax revenues. The percentage of national financial revenues that local governments received decreased from 78% to 50%, while their share in national financial expenditures increased from 71.7% to 85% between 1993 and 2010. [2] In the face of huge accumulated budgetary deficits, local governments were allowed by the central government to sell lands under their administration. This is the origin of what is called "Land Finance" in China.

Most parcels of land are sold through public bids and auctions. However, all bidders are constrained by the reserve price of land, whose formal name is "the reserve price of land use rights". This price is unpublished and at the discretion of local governments. Although unpublished, it is often revealed in informal ways. It can also be estimated by a lower, published price, called the "marked price of land". Therefore, governmental reserve price sets the tone for bids and auctions. The rise of the reserve price is indexed in the real price. Therefore, it is crucial to look at how this administrated price is established.

The fixation of a marked price of a certain land parcel is accomplished through the application of the land datum value method, initiated in 1978. In our time, nearly all cities and towns have established their systems of land datum value. A town is divided into several zones around the center. Within each zone, there are similar land conditions, and land prices in the same

[2] "China's tax-sharing system reform in 1994" (in Chinese). https://zh.wikipedia.org/wiki/%E4%B8%AD%E5%9B%BD1994%E5%B9%B4%E5%88%86%E7%A8%8E%E5%88%B6%E6%94%B9%E9%9D%A9.

zone are in the same price range, determined by the zone's land grade and the purpose of use. The land datum values of all urban zone areas can be found in the government's promulgated manuals. These prices are fixed for several years and are then subject to modification. The periodical adjustments of the coefficients determining the land datum value are the first channel through which local governments influence land prices.

This method to adjust land datum value is recommended with the following formula： $V = V_{\circ} \times (1 \pm \sum K_i) \times \prod k_j$, where V is the marked price of the parcel to evaluate. $V_{\circ}$ is the land datum value of the zone to which the parcel belongs, which, as stated above, is periodically adjustable by the local government.

$\sum Ki$ are a serial of correction coefficients parcel-specific factors that influence the prices, such as the proximity of business centers, roads, public traffic, schools, hospitals, green spaces, gardens, population, urban planning, and so on. This constitutes the second channel by which local governments are able to influence land prices, since these coefficients are subject to local government adjustments.

$\prod k_j$ are three coefficients to modify, which are relative to the valuation date, the plot ratio (or floor area ratio (FAR)) and maturity date. The last factor is parcel-specific and does not depend on the local government's valuation. The modifications of the coefficient relative to the valuation date and FAR constitute the third channel through which local governments influence land prices. In the guidance on how to adjust this coefficient, users are often asked to automatically index land price growth of the previous period. This is conditional on the evaluator's subjective valuations. The more important factor is the determination of the FAR. Increasing FAR is a strong driver of land price. This increase often coincides with the interests of the officials in charge of public bids and auctions. In many revealed instances of corruption, the officials concerned have been accused of raising this ratio for their own interests.

Finally, as previously stated, the local government fixes the reserve price. Formally, this valuation by the local government is on the basis of the micro locational factors of the parcel and its form, size, etc. This is the fourth channel through which local governments influence land prices.

To summarize, due to their increasing financial deficit, local governments have an incentive to raise land prices. As landowners, they have the right to do so. Finally, through the application of the land datum value method and the local government's discretional power in fixing the reserve prices, the influences of local governments on land pricing have become institutionalized. Just before the public auction process, through several channels, a reserve price is fixed by the local government with which they set a "desired" growth rate. The extent to which state power dominates market power depends on the state's behavior, financial needs, and market reactions in different macroeconomic situations.

2.3. Modelling two-hand land pricing

On the basis of Chinese practice, a land system with state ownership is now modeled as having the feature of competitive monopolistic pricing. Unlike in competitive pricing, where any individual owner's influence to price is close to zero, the state is able to shape land pricing in parallel with the market force.

As in the benchmark model, we assume that a representative household with the same objective function defined with Equation (1), buys a quantity Δa_{t+1} of land, for housing, agricultural, industrial or commercial purposes.[3]

Relating to the budget constraint of Equation (2), first, to model the fact that the government fixes a reserve price, we assume the existence of a government-reserved growth rate of land prices t_t, that is targeted in the reserve price. In other words, t_t is the indicator of the presence of the visible hand in land pricing. Therefore, to buy Δa_{t+1}, the cost for the household is $(1 + t_t)\Delta a_{t+1}$. It is reminiscent of the tax rate over a free market good, but with a meaningful difference. First, while for ta free market good, the extent to which the tax is indexed into the price is dependent on market demand, state-reserved growth of land prices is fully indexed into the future price, just as in the case of a monopolistic price; in this, the land buyer is just a "price taker". Second, as land is an asset and the buyer has the possibility of reselling, the increased part of the buying cost is recoverable. Furthermore, this increase will convey into the prices of the overall land market so that all owners of land assets will potentially benefit from this increase. A home owner sees the value of his house doubled without selling it if his neighbor sells his house for double the price. Therefore, the government's setting of a reserve price could give rise to a wealth effect for all land owners.

The wealth effect is dealt with in our model in the following way: a household pays $t_t \Delta a_{t+1}$ more for a newly added land asset. In the case of the sale of the asset, not only $t_t \Delta a_{t+1}$ is able to recover, but also a gain of $t_t a_t$ is made.

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[3] This purchase of land from the government is representative, because all other transactions between individuals can be considered as merely applying the prices set by this process.

With all of these considerations, we get the new budget constraint under state land ownership:

$$(1+t_t)\Delta a_{t+1} + t_t a_t + c_t = x_t + r_t a_t \tag{5}$$

Rearranging Equation (5), the final constraint becomes:

$$c_t + (1+t_t)a_{t+1} = x_t + (1+r_t)a_t \tag{6}$$

Comparing Equation (6) with the constraint in the benchmark model in Equation (2), if $t_t = 0$, two constraints become the same.

To maximize the objective function formulated by Equation (1), subject to the constraint defined by Equation (6), rewriting the objective function equation as a recursion, and using the two-period budget constraint obtained by combining the budget constraints for periods *t* and *t* + 1, the following Euler equation can be readily derived from the first-order condition (for more details, see Wickens 2011, Chapter 11):

$$E_t\left[\beta_t \frac{U'_{t+1}}{U'_t}\left(\frac{1+r_{t+1}}{1+t_t}\right)\right] = 1 \tag{7}$$

The DSGE solution for our model is:

$$E_t r_{t+1} = \frac{(1+\theta)(1+t_t) + E_t\frac{U'_{t+1}}{U'_t} + Cov\left(\frac{U'_{t+1}}{U'_t}, r_{t+1}\right)}{E_t\frac{U'_{t+1}}{U'_t}} \tag{8}$$

Comparing with the reduced-form solution for land pricing in the free market case expressed in Equation (4), Equation (8) has an adding term: $\frac{(1+\theta)t_t}{E_t\frac{U'_{t+1}}{U'_t}}$ reflecting the extent to which the government drives up land prices. The interpretation of Equation (8) is straightforward: the expected land price growth rate is coordinately determined by the state-reserved price growth rate and the stochastic discount factor, or expressed differently, by both the visible and invisible hands. Seemingly, this is consistent with logical reasoning: the market mechanism is able to adjust relative to the state's intervention on price. If, for instance, the market equilibrium price growth is ten percent, in the case of a five percent growth increase fixed by the visible hand, the market will coordinately give rise to a five percent increase; thus, the result remains the same.

Nevertheless, this inference is open to doubt if the government's actions in pricing, t_t, alter the expected marginal rate of substitution, $E_t \frac{U_{t+1}^{'}}{U_t^{'}}$. This doubt is firmly grounded on the Lucas critique. Lucas (1976, p.41) argues: "Given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models". According to Lucas, macro-economy is shaped by the "deep parameters" relating to preferences, technology, and resource constraints that are assumed to govern individual behavior. With the change in governmental policy, individuals will rationally change their expectations, leading to the changes in the coefficients of econometrical models. This argument fits well to our case. With t_t taking a significant and tendentious value, the individual may change their expectations of risk in the land market, because land pricing is less likely to be subject to market volatility, and government-reserved prices reduce future uncertainty and provide insurance on the individual's investment. As the expected MRS is derived from an individual utility function, we must now question the micro-foundation of this two-hand macroeconomic model.

2.4. The micro-foundation of the two-hand model

The exploration of the micro foundation focuses on the mechanism by which the state's actions in pricing affect risk bearing, which, in turn, affects the working of the invisible hand.

First, a Taylor series expansion of the U_{t+1}' about $c_{t+1}= c_t$ yields:

$$E_t \frac{U_{t+1}'}{U_t'} \cong 1 - \sigma_t E_t \frac{\Delta c_{t+1}}{c_t} \tag{9}$$

where σ_t is the coefficient of relative risk aversion (CRRA) defined as $\sigma_t = -c_t \frac{u_t''}{u_t'}$.

While Equation (8) puts forward the role of the expected intertemporal marginal rate of substitution in the two-hand model, this equation illustrates the crucial importance of risk bearing in the expected MRS. It tells us that this rate is a function of the growth rate of consumption, shaped by the level of risk aversion. With a certain positive level of risk aversion, $E_t \frac{U_{t+1}'}{U_t'}$ varies with consumption growth. Higher (lower) expected consumption growth implies a lower (higher) future marginal utility, or higher (lower) current marginal utility; hence, the MRS decreases (increases).

The level of risk aversion also negatively impacts the MRS. The higher (lower) the risk aversion, the lesser (greater) importance the individual gives to future consumption, leading to lower (higher) MRS. As such, market demand on land is reflected by changing MRS, and market arbitrage on price in function of land supply and demand could occur. This is why the stochastic discount factor, or more generally, the market mechanism is shaped by risk aversion.

Using Equation (9), Equation (8) becomes:

$$E_t r_{t+1} \cong \frac{\theta+(1+\theta)t_t+\sigma_t[E_t\frac{\Delta c_{t+1}}{c_t}+Cov\left(\frac{\Delta c_{t+1}}{c_t},r_{t+1}\right)]}{1-\sigma_t E_t\frac{\Delta c_{t+1}}{c_t}} \quad (8.1)$$

with $\frac{\partial E_t r_{t+1}}{\partial t_t} > 0$, $\frac{\partial E_t r_{t+1}}{\partial E_t \frac{\Delta c_{t+1}}{c_t}} > 0$, and $Cov\left(\frac{\Delta c_{t+1}}{c_t}, r_{t+1}\right) > 0$.

In this equation, the covariance is a positive risk premium, as happens in a business cycle. For example, in the recession phase, both returns and consumption growth are low, whereas in the boom phase both are high. As Equation (8.1) still remains a macroeconomic relationship, we continue to explore micro-economically the factors that could affect risk aversion.

Risk aversion is often dealt with as a constant. Nonetheless, decreasing risk aversion is more consistent with experimental and empirical evidence (Bellemare and Zachary, 2010). The most straightforward implications of decreasing risk aversion occur in the context of forming a portfolio with one risky asset and one risk-free asset (Arrow 1965, Pratt 1964). Following Arrow and Pratt, the increase of an individual's wealth leads his risk aversion to decrease and he will then invest proportionally more in the risk asset.

In the same way, we are able to show that risk aversion is increasing in investment risk or decreasing in state intervention in land pricing: the decrease of investment risk leads an individual to invest proportionally more in the risk asset as the result of reinforced state intervention in land price. To illustrate this, assuming that the individual chooses between a risky asset: land, which leads to c_{t+1}, and actual consumption c_t, with $E_t(c_{t+1}) = [(1+g)c_t]$, and g is a certain growth rate of consumption. $E_t(c_{t+1}) = \pi_t(t_t)c_1 + (1-\pi_t(t_t))c_2$, with $c_1 > c_2$, and π_t, the probability of getting c_1, reflects the risk level. The higher π_t is, the lower the future risk. Expected future consumption, via π_t, is a function of t_t, this is a faithful expression of the Lucas critique: state action changes individual expectations. Expanding $E_t[u(c_{t+1})]$ at $g = 0$,

$$E_t[u(c_{t+1})] \approx u(c_t) + \frac{1}{2}{c_t}^2 V(g)u'' \quad (10)$$

where $V(g)$ is the variance of g. In the presence of future risk, the utility function is conventionally convex, so that $E_t[u(c_{t+1})] < u(c_t)$ and $u_t^{"} < 0$. Using the definition of relative risk aversion, Equation (10) can be rearranged to:

$$\sigma_t \approx \frac{2\{u(c_t) - E_t[u(c_{t+1})]\}}{c_t V(g) u_t'} = \frac{2\{u(c_t) - E_t u[\pi_t(t_t)(c_1 - c_2) + c_2]\}}{c_t V(g) u_t^{'}} \tag{11}$$

Equation (11) builds up the micro-foundation of the land pricing equation (8.1), in which risk aversion is a variable. From it, we get $\frac{\partial \sigma_t}{\partial \pi_t}\frac{\partial \pi_t}{\partial t_t} < 0$, or risk aversion is a decreasing function of t_t. This result can be broken down into two effects. $\frac{\partial \pi_t}{\partial t_t} > 0$ implies the effect of the Lucas critique: facing the government-reserved growth of land prices, individuals reduce their expectations on risk and increase their expected future gains. $\frac{\partial \sigma_t}{\partial \pi_t} < 0$ indicates that the reduction of risk leads risk aversion to decrease. The increase in future consumption may also affect $V(g)$ and u_t' positively. Thus, its impact on σ_t via $V(g)$ and u_t' is also negative. When t_t is so high that $\{u(c_t) - E_t[u(c_{t+1})] = 0$, $\sigma_t = 0$.

2.5. Why the visible hand expels the invisible hand under a land regime of state ownership

In light of Equation (11), we are able to modify Equation (8.1) as:

$$E_t r_{t+1} = \frac{\theta + (1+\theta)t_t + \sigma_t(t_t)[E_t \frac{\Delta c_{t+1}}{c_t} + Cov\left(\frac{\Delta c_{t+1}}{c_t}, r_{t+1}\right)]}{1 - \sigma_t(t_t) E_t \frac{\Delta c_{t+1}}{c_t}} \tag{8.2}$$

where σ_t is reformulated as $\sigma_t(t_t)$, with $\partial\sigma_t/\partial t_t$<0.

From Equation (8.2), risk aversion is endogenously affected by governmental intervention. The model, while inspired by China's case, is also extendable to explain state intervention in land pricing under private land ownership. In this case, t_t can be interpreted as the tax rate on land purchase.

Under a land regime of private ownership, the coexistence of the visible and invisible hands is possible if state intervention presents two features: 1) it is unpredictable in the sense that the state's actions are random, and go in either positive or negative directions; 2) it is moderate: it lets the market do the main job and, and acts just in the occurrence of market failure.

Unpredictable and moderate state intervention leads t_t to remain at a level low enough that σ_t, is kept at a certain positive level, albeit with some decrease due to state action. In this case, both t_t and the stochastic discount factor are at work, or the coexistence between the visible and invisible hands remains possible. Meanwhile, Equation (8.2) implies that whenever the state intervenes in land pricing, it weakens the role of the invisible hand through weakening individual risk aversion.

By inference, it must be that $\sigma_t(t_t) \in (0, \sigma_{tm})$. σ_{tm} is the level of risk aversion in free market conditions. If t_t=0, $\sigma_t(t_t) = \sigma_{tm}$, In this case, Equation (8.2) is reduced to Equation (4), or more precisely:

$$E_t r_{t+1} = \frac{\theta + \sigma_{tm} E_t \frac{\Delta c_{t+1}}{c_t} + \sigma_{tm} Cov\left(\frac{\Delta c_{t+1}}{c_t}, r_{t+1}\right)}{1 - \sigma_{tm} E_t \frac{\Delta c_{t+1}}{c_t}} \tag{4.1}$$

Risk aversion could equal to zero. From Equation (9), whenever risk aversion becomes zero, $\frac{U'_{t+1}}{U'_t} \cong 1$. As individuals become indifferent between current and future consumption, the changes in expected consumption growth fail to give a market signal to land market supply and demand decisions. Consequently, facing a constant MRS, the invisible hand loses its role in land pricing.

This is just what happens under the land regime of state ownership as the state must act as a monopoly and tends to amplify its role in land pricing. Consequently, moderation and unpredictability are inevitably violated. This is for several reasons: 1) as the land owner, the state tends to manage land as a public good in which it possesses strong discretionary power; 2) also as the land owner, the state could easily consider land as a revenue source. With financial deficits in a persistent state, driving land prices to rise becomes an readily available device for filling in these deficits; 3) unlike a typical consumption good to which the state intervention on price is limited by consumers' budget constraints, the rise of land prices results in a wealth effect that relieves these constraints, thereby allowing a higher demand and giving the state a larger degree of freedom to raise land prices.

For these reasons, the state's reserve prices would be necessarily set to give rise to land prices higher than the prices under free market conditions. This is logical, since otherwise the state would prefer to step aside and let the market play. With state-driven land returns higher than free-market determined returns, individuals, assured risk cover, become risk neutral between risky and risk-free assets, or shift from risk averse to neutral. With$\sigma_t(t_t) = 0$, Equation (8.2) becomes:

$$r_{t+1} = \theta + (1 + \theta) t_t \tag{8.3}$$

The growth of land prices is entirely determined by the growth of reserve prices fixed by the state. This allows us to confirm the impossibility of the coexistence of the visible and invisible hands in land pricing under state ownership of land.

3. Empirical tests

In what follows, we operate econometric estimations and expect to find some evidence that under a land regime of state ownership, the visible hand expels the invisible hand.

3.1. Deriving the equation for econometric tests

Equation (8.2) expresses land pricing with two key determinants: the state-reserved price growth rate and expected consumption growth rate, plus the covariance between consumption growth and price growth, reflecting the risk premium. Taking Tylor expansion at $\frac{\Delta c_{t+1}}{c_t} = 0$, this non-linear equation is transformed into a linear equation:

$$E_t r_{t+1} \cong \theta + (1+\theta)t_t + \sigma_t(1+\theta)E_t\frac{\Delta c_{t+1}}{c_t} + \sigma_t Cov\left(\frac{\Delta c_{t+1}}{c_t}, r_{t+1}\right) - \sigma_t^2 E_t\frac{\Delta c_{t+1}}{c_t}\left[Cov\left(\frac{\Delta c_{t+1}}{c_t}, r_{t+1}\right)\right] \quad (12)$$

As the last term is crossing and can be assumed to be fairly small, it is put into the constant. Thus, this equation can be expressed as an econometrically testable equation:

$$r_{t+1} = A + \beta_1 t_t + \beta_2\frac{\Delta c_{t+1}}{c_t} + \beta_4 Cov\left(\frac{\Delta c_{t+1}}{c_t}, r_{t+1}\right) + \delta_t \quad (13)$$

where, as the past data are available, we removed the expected expressions by assuming that the real terms are all rationally expected. In interpretations, the variables in $t+1$ are always understood as expected terms.

On the basis of the theoretical analysis, to test if market force determines land pricing is to know whether expected consumption growth is positively significant to explain land price growth. If this is not the case, it implies that local governments' actions in land pricing are so strong as to make risk aversion too low, leading the stochastic discount factor to stop working.

3.2. Data and variables

To test Equation (13), longitudinal data on land prices are required. Since 1999, China has published *Chinese Land and Resources Statistical Yearbooks*, which contain data on "the areas and values of the sales of state owned construction lands" by city and year. From these yearbooks, from 1999 to 2015, we get the land prices by city and year from 1998 to 2014, in total 17 years, with these values divided by the corresponding areas.

Land prices of all cities are highly volatile because the sold lands are geographically specific, with large differences in factors that affect land prices. The conventional smoothing method is applied, just as dampening the fluctuations in the monthly data. Smoothing creates an approximating function that captures important patterns in the data, while leaving out noise or other fine-scale structures and rapid phenomena. This process produces a representative land price trend of each city. The Stata 453R2eh robust nonlinear smoother, written by William Gould (1992), was used for this purpose. The land prices, after smoothing, are used for calculating the land returns, or the growth rates of land prices, which constitute the dependent variable.

The next task is to get the growth rates of land reserve prices fixed by local governments by year for all cities. The key difficulty is that even though local governments have the right, motivation and means to raise land prices, their actions are hidden, and there is no data disclosure reflecting their land price manipulations. Our strategy for constituting this variable, called *T-rate*, is composed of two stages.

At stage one, on the basis of the observations over the process of the formation of land prices and the channels by which land prices are altered, local governments are assumed? to rely on information over the past growth of land prices for actual adjustments. Thus, we assume that the price manipulations by local governments, whenever they occur, are grounded on the adaptive expectations, or the *T-rate* is formed as a mean of past observations with geometrically declining weights. We use the past three-year average increased amount over the current-year land price, namely $\frac{1}{3}\sum_{\tau=t}^{\tau=t-2} \Delta p_{\tau}/p_t$ as the guessed *T-rate* at the starting stage, where p_t refers to the land price of the current year. This is an approximate application of the adaptive expectations hypothesis because, in this way, a farther past year is weighted less than a nearer past year.

The guessed values of the *T-rate* are then subject to some adjustments according to three rules: 1) if higher than the realized growth rate of land prices in the next year, they will be reduced to be equal to the latter; 2) they will be assigned to be zero if the growth rate of land prices in the following year are negative; 3) if negative, they will be assigned to be zero. The assumption underlying these rules is that local governments are able to anticipate land prices of the next year, and their manipulation is constraint by this anticipation.

At stage two, this "guessed" variable will be dealt with in the regressions as an endogenous variable instrumented with three variables. The choice of this strategy is based on the following argument. The dependent variable, the expected returns of land, and the *T-rate* are simultaneously determined by some unobservable, hence, omitted variables specific to cities, such as geographic, climatic, and regional-specific cultural features. Thus, the *T-rate* may be correlated with the error term, a typical symptom of endogeneity. To correct for the endogeneity of the model, the instruments correlated to the *T-rate*, but not to the expected returns, are needed.

Since the main cause of the *T-rate* is local governments' financial difficulties, three instrumental variables are chosen: 1) the growth rate of the ratio of public expenditure to GDP; 2) the growth rate of the ratio of the local governmental deficit to public expenditures; 3) the growth rate of the ratio of public employment to total employment. These growth rates are assumed to be positively correlated to the extent to which local governments raise the *T-rate* in order to relieve their financial constraints. These data are available in the *China City Statistical Yearbooks*.

The next variable is the growth rate of consumption, which is measured with the growth rate of per capita "total retail sales of consumer goods" from the *China City Statistical Yearbooks*. For robustness, we also transform consumption growth $\frac{\Delta c_{t+1}}{c_t}$ into $\frac{\Delta c_{t+1}}{c_t - c_{t-1}}$ to obtain an alternative variable in habit-persistence form (see Constantinides, 1990, Campbell and Cochrane, 1999), which increases the variability of consumption growth.

As stochastic discount factor can be a function of aggregate variables (such as the growth rate of consumption, market return, aggregate consumption), and consumption growth, in fact, reflects all macroeconomic factors associated with GDP and income growth, multi-factor models are applicable (Dai and Singleton, 2000). Thus, we also use the growth rates of per-capita GDP and per-capita net savings in the place of consumption, as robust tests. Savings is a useful variable because in general, it has a negative relationship to consumption. Together they provide an alternative representation of consumption growth.

The covariance between land price growth and per capita consumption growth (or per capita GDP and saving growth, respectively) is time-invariant and is individually regressed with the data of each city over the period 1999-2013.

Finally, we construct several control variables. The growth rate of the population of the city is to control for the migration effect that was prominent during the period; the growth rate of real foreign direct investment reflects the potential prosperity of the city; the growth rates of passenger transportation, healthcare services and education services reflect the attractiveness of the city from an infrastructure perspective. Three dummies are used: 1) if the city is direct- controlled municipalities by the central government; 2) if the city is the provincial capital; 3) if the city is located near one of the four most famous mountains (Tai, Emei, Huang, and Lu mountains) or on coastal land. The first two features are assumed to positively impact land prices. The last is for capturing landscape effects.

In *Chinese Land and Resources Statistical Yearbooks*, the number of cities and regions varies from 324 (1998) to 348 (2014), while in the *China City Statistical Yearbooks*, this number varies from 318 (1998) to 358 (2014). Only 286 cities have the required data in both yearbooks. With 15 years of data (1999-2013), the balanced panel should have 4290 observations. With some cities missing data for some years and some cities having appeared or disappeared during the period, due to administrative reorganizations, the final observations total 4,125.

Table 1 presents the descriptive statistics of the variables used for our tests.

Table 1 Descriptive variable statistics

Variable	Mean	Std. Dev.	Min	Max
Ereturn= the expected returns (or expected growth rate) of land prices	0.160	0.123	-0.194	0.590
T-rate (starting values): the local government-reserved growth rate of land prices	0.092	0.056	0	0.333
Vpub-expenditure-rate = the growth rate of the ratio of public expenditure in GDP	0.209	0.844	-0.884	9.999.
Vdeficit-rate = the growth rate of the ratio of the local governmental deficit in public expenditure	0.037	1.056	-9.999	9.999
Vpub-employ-rate = the growth rate of the ratio of public employment in total employment	0.025	0.225	-0.958	2.999
Evconsum = the expected growth rate of consumption	0.142	0.057	-0.143	0.313
Evconsum-habit = *Evconsum* in habit-persistence form	1.333	0.929	-8.236	13.168
Evgdp = the expected growth rate of per capita GDP	0.139	0.077	-0.299	0.299
Evsaving = the expected growth rate of per capita savings	0.181	0.118	-0.391	0.499
Cov-Ereturn-Evconsum	0.014	0.537	-2.112	1.988
Cov-Ereturn-Evconsum-habit	0.001	0.008	-0.042	0.077
Cov-Ereturn-Evgdp	0.073	0.301	-0.817	1.572
Cov-Ereturn-Evsaving	0.071	0.534	-0.532	8.332
Vpopulation = the growth rate of the population of the city	0.008	0.023	-0.299	0.299
Vforeign_invst = the growth rate of per capita real foreign direct investment	0.453	1.847	-9.99	9.99
Vtransp_passenger = the growth rate of per capita transportation of passengers	0.094	0.332	-0.499	2.999
Vhealthcare = equally weighted growth rates of per capita numbers of hospital beds and doctors in the city	0.034	0.106	-0.299	0.299
Veducare = equally weighted growth rate of per capita university, middle and primary school teachers	0.050	0.097	-0.299	0.299
DCM=1 if direct-controlled municipalities by the central government; =0 otherwise.	0.0145	0.120	0	1
Province Capital=1 if provincial capital; =0 otherwise	0.080	0.271	0	1
Mountain_sea=1 if near the Tai, Emei, Huang, or Lu mountains) or coastal; =0 otherwise	0.172	0.377	0	1

Notes: 1) All expected values are measured as the real values of the following year; 2) The observation number is 4125 for all variables.

3.3. Results

Table 2 presents the results of our panel regressions. The generalized two-stage least squares random-effects instrumental variables model (hereafter G2SLS-RE-IV) is applied. The small Rho values for all regressions imply that the individual (city) level fixed effects are very weak. Therefore, a fixed-effects model is not appropriate and both pooled OLS and random-effects GLS are valid and provide similar results. In these models, Wald Chi^2 values are quite high; the values of R^2 are all fairly satisfactory.

	(1)	(2)	(3)	(4)	(5)
	GLS-RE-regression	G2SLS-RE-IV regression	G2SLS-RE-IV regression	G2SLS-RE-IV regression	G2SLS-RE-IV regression
	Ereturn	*Ereturn*	*Ereturn*	*Ereturn*	*Ereturn*
T-rate (instrumented with: *Vdeficit-rate*, *Vpub-expend-rate*, *Vpub-emploi-rate*)		1.463 (0.162)***	1.295 (0.169)***	1.266 (0.188)***	1.372 (0.185)***
Evconsum	-0.045 (0.045)	-0.086 (0.031)***	-0.077 (0.032)**		
Cov-Ereturn-Evconsum	-0.002 (0.004)	-0.001 (0.003)	-0.001 (0.003)		
Evconsum-habit				-0.001 (0.002)	
Cov-Ereturn-Evconsum-habit				-0.029 (0.193)	
Evgdp					-0.025 (0.026)
Cov-Ereturn-Evgdp					-0.003 (0.005)
Evsaving					0.053 (0.018)***
Cov-Ereturn-Evsaving					0.007 (0.002)***
Vpopulation	0.064 (0.082)		0.093 (0.057)	0.103 (0.057)*	0.105 (0.056)*
Vforeign_invst	0.001 (0.001)		0.000 (0.001)	0.000 (0.001)	0.000 (0.001)
Vtransp_passenger	0.001 (0.005)		0.000 (0.004)	0.000 (0.004)	0.000 (0.004)
Vhealthcare	-0.036 (0.015)**		-0.012 (0.011)	-0.018 (0.011)	-0.010 (0.011)
Veducare	-0.007 (0.018)		-0.014 (0.014)	-0.013 (0.014)	-0.021 (0.014)
DCM	0.071 (0.017)***		0.031 (0.008)***	0.032 (0.008)***	0.031 (0.008)***
Province Capital	0.025 (0.008)***		0.009 (0.005)*	0.009 (0.005)*	0.008 (0.005)*
Mountain_sea	0.005 (0.006)		0.007 (0.004)*	0.007 (0.004)*	0.008 (0.004)*
Constant	0.162 (0.007)***	0.037 (0.015)**	0.049 (0.015)***	0.042 (0.017)**	0.025 (0.014)*
Observations	4125	4125	4125	4125	4125
Number of groups	286	286	286	286	286
R-sq					
Within	0.002	0.450	0.450	0.449	0.452

Between	0.076	0.669	0.682	0.678	0.680
Overall	0.010	0.471	0.473	0.471	0.475
Wald chi^2 (prob>chi^2 in parentheses)	35.93	81.64	254.53	229.06	402.38
	(0.000)	(0.000)	(0.000)		(0.000)
Rho (fraction of variance due to u_i)	0.032	0.014	0.019	0.012	0.000

Notes: 1) * p(>|z|)<0.10; ** *p*(>|*z*|)<0.05; *** *p*(>|*z*|)<0.01. 2) Robust standard error in parenthesis. 3) The group variable is the city.

Regression (1), a random-effects GLS regression, is for testing the antithesis of what we have developed: China's land-pricing is determined by the invisible hand. To do this, we just use the expected growth rate of consumption and the control variables to explain the expected returns of land prices. The result clearly reject this antithesis: the expected growth rate of consumption is insignificant and its coefficient is negative.

Regression (2), without using control variables, consists of a direct test for the theoretical model and shows a strongly significant positive effect of *T-rate* on the expected growth of land prices, confirming the presence of the visible hand in land pricing. This effect of expected consumption growth is even significantly negative.[4]

In the theoretical model, the covariance between land price growth and consumption growth is positive, in the form of risk premium. In this regression, the covariance is insignificant. The absence of risk premium in China's land market has an inductive interpretation: all people over-neglect this risk and expect the land boom to last infinitely.

In regressions (3), the control variables are introduced into the regression. Even though the Wald chi2 is more than tripled, the R-square stays nearly the same. All key explanatory variables, while having lower absolute coefficient values, maintain similar signs and significance levels. This indicates the robustness of regression (2), purely grounded on the theoretical model.

In regression (4), also as a robust test, consumption growth in habit-persistence form is applied in the place of conventional consumption growth, together with all control variables. The results are basically the same as those of the first regression, except for the effect of *Vconsum-habit* becoming insignificant.

[4] An available explanation is linked with a specificity of China: in the less developed cities with lower consumption growth rates, local governments possessing fewer financial sources have a stronger incentive to raise land prices than those of rich cities, leading to negative effects of the expected consumption growth on the expected growth of land prices.

Finally in regression (5), in the place of expected consumption growth, *Evgdp*, the expected GDP growth rate, and *Evsaving*, the expected saving growth rate, are employed. It is found that *Evagdp* has a negative sign and is insignificant, while *Evsaving* is positively significant. Regarding the fact that consumption equals GDP less saving, and consumption and saving having opposite signs, the joint effect of GDP and saving confirms that, at least, the expected consumption growth does not have a significant positive impact on expected land price growth.

All of these estimations back up the conclusion that land price growth in China is not determined by the invisible hand.

4. Conclusion

This study proposed a consumption-based land pricing model and provided a framework for analyzing the possible coexistence of the visible and invisible hands in land pricing. We tested the derived equation with the data of 286 Chinese cities over 17 years. The empirical findings suggest that, while local governments' price management strongly affects land pricing, the growth rate of consumption reflecting the role of the invisible hand does not have the expected effects predicted by the model.

Upon rechecking, we find that in the theoretical model, the coefficient of the relative risk aversion constrains the role of the invisible hand in land pricing. Through exploring the factors which determine the decrease of risk aversion, we reach the conclusion of the impossibility of the coexistence of the visible and invisible hands in land pricing under state ownership of land. Extending the Lucas critique, the anticipation of governmental action changes individuals' expectations of risk in land investment, and risk aversion becomes endogenously affected by governmental intervention in land prices, leading individuals to shift from risk averse to risk neutral. In this case, the stochastic discount factor becomes a constant, and market conditions or expected consumption growth, cease to work in land pricing.

The policy implications of this study appear to be quite straightforward. Under state ownership, it is an illusion to believe in efficient or quasi-efficient land pricing. Price distortion inevitably gives rise to over-investment in land and resource misallocation. Over-investments could be stopped only by the sudden appearance of an economic crash as the result of the lasting accumulated disequilibrium. This explains why real estate speculations have become the most dynamic activity in China. All economic actors are led to over-investing in real estate. All of this brings the efficiency of the land market under state land ownership into question. The only solution appears to be the privatization of land.

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