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What Drives House Building
The collateral effect with evidence from China

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Abstract

This paper proposes a dualism of hypothesis derived from dynamic Cournot competition on whether house building is driven by credit constraint corresponding to collateral value. Using monthly data from Jan 2004 to May 2016 of 26 Chinese provinces and 4 direct-controlled municipalities, the empirical test suggests that collateral value do drive house building.

JEL Classification: R31; G31; L74
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1 Introduction

Edward E. Leamer (2007,[1]) wrote: Housing is the Business Cycle. In this unpublished paper, he empirically showed that a U.S. recession is usually

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preceded by a fall in house trading volume. While real estate cycle is the story for developed economies, in China, the major part is still growth rather than cycle. First, we do had experienced slow-downs in economic growth, yet none of which was "bad" enough to be named "recession". Second, due to property right issue under welfare-housing, real estates in China was hard to sell before the housing reform in 1998. Third, the boom of real estate development industry took place mainly in the 21st century, alongside with rapid urbanization. People are buying brand new homes rather than second-hand homes. The trade volume has been small during these years, relative to the total purchase. Hence what housing in China has been going through is building boom rather than trading cycle.

1.1 The building boom

Figure 1 shows two stock-flow ratios. The stock is summation of all real estate projects under construction in area. The two flows are total area of new projects and that of finished projects. Size of stock-flow ratio are greater than one since most project last for more than one year. Yet it's just part of the story. We see $\frac{under\ construction}{finished}$ is above $\frac{under\ construction}{new}$ with a widening gap. Relative position of these two lines indicates growth of total size of new projects, as finished projects are converted from new projects before. The widening gap part is interesting. There are two possible channels that will increase the gap between these two lines. The first is that number of projects grows over time. The second is size of individual projects grows over time. Let's look at an illustrative example. Suppose both are growing at time-variant rates $g_{num}(t)$ and $g_{size}(t)$, and all project last for $k > 12$ month. Let number of project started at time t be X_t, size being S_t, then at time $\tau + k$, the two ratios are:

- $\frac{under\ construction}{finished} = \sum_{s=0}^{k} X_{\tau+s} S_{\tau+s} (X_\tau S_\tau)^{-1}$
- $\frac{under\ construction}{new} = \sum_{s=0}^{k} X_{\tau+s} S_{\tau+s} (X_{\tau+k} S_{\tau+k})^{-1}$

where D_{num} is a dummy variable that takes 1 if number of project grows, D_{size} is its counterpart whenever size of project grows.

Since

$$X_{\tau+k}S_{\tau+k} = [X_\tau \prod_{s=0}^{k}(1+g_{num}(\tau+s)D_{num})][S_\tau \prod_{s=0}^{k}(1+g_{size}(\tau+s)D_{size})]$$

difference between the two ratios is:

$$\frac{\sum_{j=0}^{k} X_{\tau+s}S_{\tau+s}}{X_\tau S_\tau}(1-[\prod_{s=0}^{k}(1+g_{num}(\tau+s)D_{num})(1+g_{size}(\tau+s)D_{size})]^{-1})$$

To implement the widening gap, we need

$$\prod_{s=0}^{k}(1+g_{num}(\tau+s)D_{num})(1+g_{size}(\tau+s)D_{size})$$

to be increasing over time. Which means there has to be at least one active growth channel exhibit "growing growth rate."

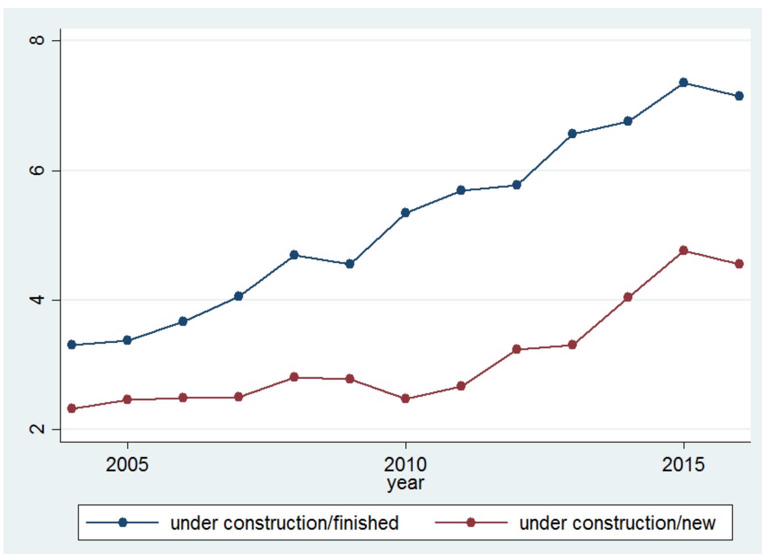

Figure 1: Area ratios: under construction over new & under construction over finished

Given the "growing growth rate," we may be interested in whether they build just "fatter" buildings and/or more buildings in an individual project, or do they build taller buildings? Figure 2 seems to supposrt the latter. Although the total size of new projects experienced downturns in the 2010s, the ratio between size of new projects and land purchase continued to rise. Catch-up of house quantity in the world's largest emerging economy is accomplished through establishing taller buildings.

Then why are they build taller buildings now, not earlier? Are taller buildings more profitable today than before, or they cannot afford to build taller building at the start?

(a) Ratio, new over land (b) New and land, in area

Figure 2: Areas, new projects and land purchase, annually

Among studies focused on the equilibrium behavior of REDs, most works propose links between house price and optimality conditions derived from various profit maximization framings. I argue that the determinant of the equilibrium is the credit constraint rather than optimality conditions, i.e. corner solution is the case. In other words, the supply of real estate, although large in absolute quantity, is actually insufficient comparing to the demand.

One key determinant of credit constraint is collateral value. There are empirical studies about collateral effect on corporate investment. One of the recent works is Chaney *et al* (2012,[2]), which examined whether shock on real estate value affects corporate investment of firms from a variety of industries. They find that real estate value, as proxy for collateral value, is positively correlated with corporate investment. The elasticity is about 0.06. REDs do take high leverage to finance their projects. This is why researcher usually exclude REDs alongside financial firms when investigating general corporate finance questions. The capacity to borrow, as suggested by the rich corporate finance literature, is affected by amount of collateral held by debtors. I examine whether REDs exploited their full borrowing capacity. Had they reached the boundary, amount of collateral available must affect the quantity they delivered. Then collateral value shall be both the driver and the governor of the building boom.

1.2 Previous research

Study on housing in developed economies dedicate to describing and explaining the real estate cycle, as well as examining its spillover effect. This tradition affected research on Chinese housing market. In the recent two decades, there is one strand of literature attempt to describe the building decision of households.

To implement the observed negative relationship between vacancy rate and number of new homes under construction, Chinloy (1996,[3]) proposed a model where construction is triggered only if vacancy rate hits a threshold. This model assumes an active second-hand housing market and treats building new homes as the alternative technology to buying spot home. Wheaton (1999,[4]) analyzed investment in U.S. commercial real estate employing a stock-flow model. However, Wheaton's model relies on a deterministic steady state and treats real estate investment cycle as oscillation around that steady state. Leamer (2007,[1]) showed that in the U.S., real estate cycle is a volume cycle rather than a price cycle, in both existing homes and new built homes. He attributed this fact to aversion of nominal loss on home value. He also found that monetary policy affects only the time to build but not the total amount to build.

Ding *et al.* (2017,[5]) identified cyclical behavior of real estate investment growth rate in China with a declining trend from Jan 2008 to July 2016. However, the first negative growth rate they recorded appeared in late 2015. Their findings indicate that there is still gap between existing real estate cycle literature and Chinese housing market.

There are several reasons that Chinloy (1996,[3]) and Wheaton (1999,[4]) arguments and Leamer (2007,[1]) result cannot be applied directly on the Chinese market. First, the second-hand housing market is not very active until recently. In other word, buying second-hand home is in turn the alternative technology rather than the primary choice. Second, we witness both price growth and investment growth measured in area. This fact drives us to bear a more than moderate demand growth in mind rather than a steady and low demand growth, which is a ground stone for both models.

1.3 This paper

The paper is organized as follows. Part 1 is the introduction. In part 2, I propose a Cournot competition model and derive a dualism of linearized testable equations. Part 3 describes and discusses the data and related issues. Part 4 presents and discusses the main regression result. Part 5 present robustness test results. Part 6 gives a brief conclusion and policy discussion.

2 The Model

To model the decision of REDs, I face two challenges. The first one is to determine the market structure the REDs operate on. The second one is to find a tractable representation of the REDs' source of funding.

2.1 Market Structure

Among the four market structures in the industrial organization literature, I immediately eliminate the perfect competition and monopolistic competition. The observation is: as the product is impossible to move around, in each individual city, it is impossible to have sufficiently many REDs operating simultaneously to make themselves price taker. In addition, product vary in location, which is substantial enough to be priced. On the other hand, as real estate projects usually require sizable fund, difference between funding cost faced by incumbent REDs and that faced by potential entrants may well serve as barrier to entry, alongside with government relation and technical barriers. Therefore I ruled out the competitive frameworks.

The oligopoly shell, however, is general enough to include the rare case of monopoly, as long as the competition between oligarchies is of Cournot's fashion rather than of Bertrand's. As quantity of house supplied cannot be adjusted unless allowed lags of couple of years, it is convenient to proxy the competition in housing market as quantity-in-advance.

Thus I tackle down the first challenge by choosing Cournot oligopoly to model the style of competition REDs facing.

2.2 Source of funding

There is a lot of possible sources of funding: the RED's cash holding, and a spectra of financing vehicles between equity finance and debt finance. However, digging too deep into the detail of financing plan, especially that of large projects like real estate development, would diffuse too much attention from the main subject of this section: production decision. If we include the choice of financing vehicles at the spectra of seniority into the RED's decision, dimension of decision would be tremendous.

One natural simplification is to divide the spectra by whether pledgeable asset is involved. For convenience, I perceive all sorts of external financing claim as "debt" in this paper. Given the prevalence of exiting mechanism and mezzanine financing among equity investors, the majority of which are private equity funds, it doesn't loss much to view external equity holder as debt holder of a less senior debt with higher return.

Therefore, funding sources of REDs can be characterized as follows.

The firm can collateralize current asset such as land and inventory(unsold houses)to get bank loan at price R_t. Suppose the value of collateral is W_t, and the maximum amount of bank loan is $B_t \leq \gamma W_t$. $\gamma < 1$ is the haircut rate, which is a simplification of the common practice among banks. Ideally, this haircut rate should be endogenized as in Geanakoplos(2009, [6]). However, calibrating that model and running a restricted regression here will weaken identification of collateral effect. Hence I have to make the compromise here by adopting a fixed and exogenous haircut rate.

In addition to the collateralized bank loan, the firm obtains uncollaterliazed funds E_t from external investors, at cost of paying a higher return(IRR) $D_t > R_t$. The external investors can be viewed as a collection of PE funds, trust funds and any other shadow banks.

Both kinds of debt mature in k terms. I avoid the common practice of assuming debt turnover here for three reasons. First, term of maturity is closely related to the building cycle. Second, negotiation of debt return is often accomplished before the project starts. In addition, since I am working on monthly data, assuming debt turnover would encounter too may lagged terms at a risk of colinearity. Therefore, the non-standard k-maturity setting is more proper here.

In the real world, the firm obtains revenue from selling a combination of spots and futures, but we can make some aggregation. Denoted by $S_{t-k} = P_t(Q_{t-k})q_{t-k}$. The reason that we can make such aggregation is that on the RED's perspective, selling on either way generates positive cash flow, which can in turn be invested in a new project. Then the flow of funds is:

$$B_{t-k}R^k_{t-k} + E_{t-k}D^k_{t-k} + C_t(q_t) = B_t + E_t + P_t(Q_{t-k})q_{t-k}$$

The left hand side is obtained by, as specified above:

1. collateralized debt borrowed k periods before, multiplied by gross interest rate on collateralized debt

2. plus uncolateralized debt borrowed k periods before, multiplied by gross interest rate on uncollateralized debt

3. plus cost of supplying q_t at current period

This is total expenditure at current period.

The right hand side is obtained by:

1. collateralized debt borrowed at current period

2. plus uncollateralized borrowed at current period

3. plus revenue from selling houses started building k periods before

This is sum of funding from all three sources available at current period.

We can obtain an equivalent expression by substituting the credit constraint w.r.t. collateralized debt:

$$B_{t-k}R^k_{t-k} + E_{t-k}D^k_{t-k} + C_t(q_t) \leq \gamma W_t + E_t + P_t(Q_{t-k})q_{t-k}$$

One thing hidden here is that if the credit constraint was not binding, then the firm would not need uncollateralized fund as it costs more.

Following the tradition of real estate cycle literature, I assume the firm knows perfectly the future demand, but don't know how much other firms would build. The expected gross profit for the unconstrained firm at time t is therefore future sales income less the sum of production cost and interest payment:

$$E_t[\Pi_{t+k}] = E_t[P_{t+k}(Q_t)q_t - C_t(q_t) - B_t(R_t^k - 1) - E_t(D_t^k - 1)]$$

If we were solving to maximize this program and getting an internal solution, we must have the collateral constraint not binding. Thus the amount of uncollateralized debt E_t is zero. The actual program become:

$$max_{q_t} E_t[\Pi_{t+k}] = E_t[P_{t+k}(Q_t)q_t - C_t(q_t) - B_t(R_t^k - 1)]$$

$$s.t.\ B_{t-k}R_{t-k}^k + E_{t-k}D_{t-k}^k + C_t(q_t) = B_t + P_t(Q_{t-k})q_{t-k}$$

Plug in the budget constraint for B_t will give us a program

$$\begin{aligned} max_{q_t} E_t[\Pi_{t+k}] = E_t[&P_{t+k}(Q_t)q_t - C_t(q_t)R_t^k \\ &- (B_{t-k}R_{t-k}^k + E_{t-k}D_{t-k}^k + P_t(Q_{t-k})q_{t-k}) + P_t(Q_{t-k})q_{t-k}R_t^k] \end{aligned} \quad (1)$$

But $(B_{t-k}R_{t-k}^k + E_{t-k}D_{t-k}^k + P_t(Q_{t-k})q_{t-k}) + P_t(Q_{t-k})q_{t-k}R_t^k$ is already decided in the past, thus the objective is equivalent to the following shorter version:

$$E_t[\Pi_{t+k}] = E_t[P_{t+k}(Q_t)q_t - C_t(q_t)R_t^k]$$

By making some assumptions on corresponding functional, I propose a linear version of the above model and corresponding test equations. This linear version is compiled to work with province-month data. Detail about linearization is presented in appendix. The following box summarizes model and linearized version. If the firms were unconstrained, then the first order condition(FOC)would be the test equation. However, in this industry, bank loan accounts for only 20% to 30% of total investment. Hence it is not proper to drop the uncollateralized debt term for the constrained case. If the firms are constrained, then they won't be able to supply the Cournot quantity as the FOC implies, the test equation is the flow of funds with equality holds(i.e. financing constraint is binding).

The build-in dynamic of this model is that current choice of house supply, q_t, will affect budget constraint k periods ahead. There rises the suspicion that choosing the q_t that maximizes profit k periods ahead may deviate from the optimal decision path $\{q_t\}$ that maximizes sum of discounted profit of all time. However, the higher profit the firm gains k periods ahead or $t+k$, the larger fund it can raise in period $t+k$, which means broader decision space of choosing quantity on sale at $t+2k$. With the largest possible decision space, one expects better outcome of the constrained optimization. Thus the q_t that maximizes $E_t[\Pi_{t+k}]$ must lies on at least one of the optimal decision paths.

The RED maximizes expected profit by choosing quantity

$$max_{Q_t} E_t[\Pi_{t+k}] = E_t[P_{t+k}(Q_t)q_t - (C_t(q_t))R_t^k] \tag{2}$$

subject to financing constraint

$$B_{t-k}R_{t-k}^k + E_{t-k}D_{t-k}^k + C_t(q_t) \leq \gamma W_t + E_t + P_t(Q_{t-k})q_{t-k} \tag{3}$$

with first order condition if financing constraint not binding

$$\frac{\partial \Pi_{t+k}}{\partial q_t} = \frac{\partial P_{t+k}(Q_t)}{\partial Q_t} q_t + P_{t+k}(Q_t) - \frac{\partial C_t(q_t)}{\partial q_t} R_t^k = 0 \tag{4}$$

Equations 3 and 4 are theoretical test equations, with linearized version

$$[UL]: \ d\,Q_t^i = \beta'_{u,1} g(X_{t+k}^i) + \beta'_{u,2} Q_t^i g(X_{t+k}^i) + \beta'_{u,3} R_t^k g(Y_t^i) + \epsilon_t^i \tag{5}$$

$$[CL]: \ d\,Q_t^i = \beta'_{c,1} d\,\tilde{E}_t^i + \beta'_{c,2} d\,\tilde{W}_t^i + \beta'_{c,3} Q_t^i g(Y_t^i) + \epsilon_t^i \tag{6}$$

Notation list

$E_t[.]$	expectation operator
Π_t	profit
$P_{t+k}(Q_t)$	rational expectation of inverse demand
Q_t	aggregate supply of house
q_t	supply of house from individual RED
$C_t(q_t)$	cost function
R_t	intereste rate
B_t	collateralized debt
E_t	uncollateralized debt
D_t	IRR of uncollateralized debt
γ	haircut rate on collateral
W_t	collateral
$g(.)$	growth rate
X_t^i	demand factor of province i
Y_t^i	cost factor of province i

3 The data

I employ monthly data from Jan. 2004 to May. 2016 about all 4 direct-controlled municipalities and 26 provinces, excluding Tibet due to availability. Since the data is aggregated at province level rather than collected at firm level, it is reasonable to assume that some REDs are facing tight financing constraint and the others don't. In fact, it is more likely to happen than all REDs are facing tight constraint or all REDs are not facing financing constraint. The issue here is, what fraction of REDs are facing tight constraint. For aggregate data, if most REDs are facing tight financing constraint, the aggregate supply will be more close to the supply that all REDs are facing financial constraint, rather than the supply that none of REDs is facing the constraint. On the other hand, if only a small fraction of REDs is troubled by financing capacity, the total supply will be very close to the Cournot total supply.

Therefore, if the fraction of REDs facing financing constraint is far enough from 50%, the empirical result will likely to favor one hypothesis over the other.

For the dependent variable $d(Q_t^i)$, we have in general two sorts of measurement: in 10^8 Yuan and in 10^4 squared meter. The latter is immune to inflation while the former is what will directly transform into future GDP. In addition, the area measure is not contaminated by inclusion of land price, which is a major determinant of the yuan measure. My main result takes the area measure as the dependent variable. In robustness check, I takes the yuan measure to pin down measurement issue.

Another issue is which scope to use. I choose two scopes among the four available: total investment and investment on residence (i.e. home). Choice of the former is natural. The reason I choose the latter is that it is the majority of total investment and demand for home is more predictable to REDs than, for example, demand for government office buildings. Total investment is the dependent variable in main regressions, while investment on residence is taken in robustness check.

Collateral, the hero of this essay, are basically assets with some liquidity. For a RED, the assets are in general inventory and land. So I need to obtain measure of land value and inventory value.As the data is monthly, there is a strong suspicion that the inventory value and area of inventory sold may have strong co-linearity. Therefore, I have to take one of them. As house price is volatile, the mark-to-market value of inventory and futures also subject to fluctuation, I choose the more stable measure, area of house sold as a measure for collateral.

Finding determinants of demand is a very complex, or maybe daunting issue. No matter how much variables one collect to estimate demand, one always missed something. I argue the measures I choose are potentially noisy yet comprehensive enough for the aggregate demand at province level, which includes GDP, housing fund rate and mortgage rate.

GDP rather than GNI is a more clean measure for domestic or local purchasing power for real estate, which is both a durable good and an investment good. Housing fund rate is one of the major leverage to interfere the housing market, the other being administrative guidance on mortgage policy such as down payment ratio. The implementation of the latter is a major determinant of households' financing constraint. However, the best information on that are the central government guidelines, not exactly what adopted by banks. Guidelines the banks have to satisfy are some lower bonds. In a robustness test we will explore how good the official guideline at intervening real estate investment.

One potentially important measure I omitted here is demographic structure. There are arguments suggesting that young workers are the majority of home buyers. However, one shall be aware that these arguments are only true on home demand in migration targets. In other words, if I were working with city-level data, then I shall not omit demographic structure. When working with province-level data, one issue is that intra-province migration doesn't change total demand of the province, only inter-province migration does. As household registration (hukou) system creates a barrier to inter-province migration, ignoring demographic structure doesn't hurt for this study.

Cost is actually well-measured at profession level for personnel and item level for material. Ideally, one wants to compile above measure into a province-month index on real estate development. Such ideal is impeded by lack of data on labor hours and material usage. Including some 40 variables into a panel with some 150 months is neither good practice. Yet I still have to measure material cost and personnel cost, so I grab capital assets investment price index (or capital formation price index, from now on KFPI) and minimum wage as proxies for the two kinds of cost. KFPI and minimum wages are proxies for marginal cost. As mentioned before, cost on buying land is a major part or real estate development cost. To capture this, I divide monetary value of land purchase by total area of new project in each province to obtain a proxy for land's contribution in the marginal cost.

There are not too many candidates for interest rate. Again, the ideal measure, province specific price index for loan to REDs, is not available. I choose the benchmark rate for long-term loans, the 3-to-5-years benchmark rate, and weighted average rate of general loan as proxies.

Table 1 summarize variable names and their availability. Table 2 reports summary statistics for all sorts of variables.

[table 1 about here]

[table 2 about here]

4 Empirical Result

Before I present the results, I would like to re-state the test equations here for convenience.

$$[UL]:\ dQ_t^i = \beta'_{u,1} g(X_{t+k}^i) + \beta'_{u,2} Q_t^i g(X_{t+k}^i) + \beta'_{u,3} R_t^k g(Y_t^i) + \epsilon_t^i$$

$$[CL]:\ dQ_t^i = \beta'_{c,1} d\tilde{E}_t^i + \beta'_{c,2} d\tilde{W}_t^i + \beta'_{c,3} Q_t^i g(Y_t^i) + \epsilon_t^i$$

Since [UL] and [CL], the test equation I estimated, are local linearization of the non-linear original test equations, the information we dropped through approximation comprises the error term. We identify three channels in [UL]: the demand channel $g(X_{t+k}^i), Q_t^i g(X_{t+k}^i)$, the cost channel $g(Y_t^i)$, and the interest rate channel R_t^k. There is a new channel in [CL]: the collateral channel $d\tilde{W}_t^i$, instead of the demand channel. The demand channel was shut down by design in [CL]. To understand it, one simply rethinks what does "financially constrained" mean in real estate development. It means, no matter how large the demand is in the future, the RED can only afford to fulfill (and seize profit from) a fraction of it. Then as long as the Cournot quantity implied by a certain demand schedule is larger than the constrained quantity, how large the demand is won't matter for the realized investment. On the other hand, if the demand was so low that the REDs can optimize w.r.t. that, the REDs are not financially constrained. Effect of interest rate is implicitly captured in $d\tilde{E}_t^i$, change of liquidity tightness. Treating these two test equations as two non-nested models, I employ model selection techniques to find out which one of them is more likely binding.

The linear test equations might seem to have endogeneity problems since the regressand is dQ_t^i and Q_t^i also appears in regressors. However, the discrete difference in these regressions is an approximation of the continuous differential, rather than the other way around. Therefore it is equivalent to construct it as $dQ_t^i = Q_{t+1}^i - Q_t^i$ and $dQ_t^i = Q_t^i - Q_{t-1}^i$. We can pick the first construction to ensure dQ_t^i captures information emerge immediately after Q_t^i realized and avoid endogeneity.

To estimate [UL], I need to find a proper k. From the illustrative example in introduction, we know

$$\frac{under\ construction}{finished} > k > \frac{under\ construction}{new}$$

hold if $g_{num}(t)$ and $g_{size}(t)$ is always positive whenever the underlying growth channel is activate. While the non-negative-growth-rate condition is relatively loose, we can estimate the range of proper k by simply take annual average of the two ratios. From 2004 to 2015, the means are $mean(\frac{under\ construction}{finished}) = 5.08\ yr = 61\ mon$ and $mean(\frac{under\ construction}{new}) = 3.03\ yr = 36\ mon$. Therefore I estimate model [UL] for all integer k-s in [31,65]. Then I perform Vuong's(1989,[7]) test using code posted by prof. Jeffrey Wooldridge. It turns out that all specifications are rejected by the Vuong's test except $k = 58, 60, 64$. While $k = 64$ lacks economic justification, I present here only results from specifications with $k = 58, 60$. Result from Vuong's test is summarized in table 8.

4.1 Constrained case

Equation [CL] captures collateral, liquidity and cost. The theoretical variable for collateral, W_t^i, is measured by total area of house sold(AreaSold) and total price of land purchased(Land). The first measure proxies for inventory and the second measure captures non-inventory collateral value. Liquidity is captured in theoretical variable E_t^i, amount of uncollateralized debt. This is measured by amount of self-rasied fund in real estate investment. Theoretical variable for cost, Y_t^i, takes three measures. The first one is total price of land purchased over area of new projects, which caputures maginal cost spent on land to build one more square-meter. The second is the capital formation price index, which compiles price movement of other materials and fees. Minimum wage is a proxy for labor cost.

Assuming equation [CL], we expect $\beta'_{c,1}$ being significant and $\beta'_{c,2} > 0$. Significance of $\beta'_{c,1}$ implies change in uncollateralized debt account for change in total size of project at province level, which indicates that financing constraint is very likely to bind.

The positive elasticity between first difference in new construction and collateral measures, $\beta'_{c,2}$, consolidates the argument. If the financial constraint was binding, then an increment in collateral handy will expand the borrowing capacity, which in turn enables the RED to start larger project. Magnitude of elasticity is stable across choice of control variables and whether fix effect is included.

Prediction from liquidity channel is consistent with the model. A larger $d(E_t^i)$ means REDs are able to borrow more without locking collateral.

The negative cost effect of land cost stands out. However, positive elasticity of material cost and labor cost lead to a suspicion of reverse causality. That is, decision of building more drives up these component of marginal cost.

Diagnostic statistic is not improved significantly after introducing province fix effect.

[table 3 here]

4.2 Unconstrained case with $k = 58, 60$

Theoretical variable X_t^i is measured by local future GDP, housing fund rate and average mortgage rate. The first one is a provincial measure and the last two are country level measures. Measures for marginal cost are exactly the same as above. For interest rate, I take long-term(3-5 years) benchmark rate and average loan rate.

Assuming equation [UL], we expect $\beta'_{u,1}$ to be positive and $\beta'_{u,2}$ to be negative. However, the sign for $\beta'_{u,1}$s are not stable for both k-s. The sign for $\beta'_{u,2}$ is stable yet contrast to theoretical direction in general. The combined elasticity of production to cost and interest rate, $\beta_{u,3}$, is supposed to be negative. We see significant negative sign behind those concerning capital formation price index. For the other two cost measures, although the signs of coefficients are negative, we cannot assert their negative elasticity with statistical confidence. One thing interest here is that coefficients on housing fund rate of 5+ years and 5- years are of different signs with similar magnitude in both regressions. In the horse race regressions I will report regression output using housing fund term spread.

Diagnostic statistic is improved significantly(more than doubled) after introducing province fix effect. Magnitude of elasticities changed considerably between comparable regressions.

[table 4 here]

[table 5 here]

4.3 Horse race: a reduced form test

Although Vuong test does not reject k=58 and 60, we can do a horse race to see whether they worth taken. To examine whether regression [UL] are spurious when $k = 58, 60$, I present here a reduced form model:

$$[H]:\ d\,Q_t^i = \alpha_0 + \alpha_1' d\,\tilde{W}_t^i + \alpha_2' d\,(X_t^i\, g(X_t^i))^T + \alpha_3'(Y_t^i\, R^t)^T + \epsilon_t^i \tag{7}$$

In this reduced form model, I include theoretical variables for collateral, demand, cost and interest rate. Measurement for collateral is the same as [CL]. For demand, I keep only growth rate of local future GDP, housing fund rates and their spread. Cost measures are growth rates of marginal costs. Interest rate is captured by long term interest rate only.

If [UL] was spurious, we expect α_2' to be insignificant and α_1' to be significant. Moreover, if magnitude of α_1'-s were similar to $\beta_{c,2}'$, we strengthen the argument that regression [CL] is the better specified one that explains house building.

We find both of our expectations to be the reality. Coefficient before $Land_t^i$ is similar to those in regression [CL]. The elasticity to total area sold is larger in the horse race regression than in regression [CL]. Demand channel seems to be ruled out by inclusion of collateral channel.

Negative effect of marginal land cost and interest rate is what we expect. Positive elasticity to capital formation price index is again under suspicion of reverse causality.

[table 6 here]

[table 7 here]

5 Robustness Test

Comparison of above regression outcomes mainly rely on diagnostic statistics and economic intuition behind. The following robustness checks test the validity of my result under several possible critiques.

In this current version, I report four tests according to discussions on earlier stage of this project. The first two tests focus on measurement issue. I examine whether the result still hold when using total area of new residence project and total monetary investment on new projects as measure for Q_t^i. The third one examines whether omitting regional difference in down payment policy distorts the conclusion about demand channel. The fourth one examined whether omitting second offering cause severe omitted variable bias.

5.1 Measurement issue

I report here regression [CL] using alternative measures, namely total area of residence project and total investment on housing. Result is reported in table 9 and table 10, they are compared to table 3. For total area of residence project as dependent variable, all patterns in table 3 holds. The only difference is magnitude of coefficients. Result using yuan measure seems to be more stable than that using area measure. However, unusually high R^2 draw suspicion of regressing trend on trend.

[table 9 here]

[table 10 here]

year	month	first home	second and beyond	issuer
1998		30%	30%	PBOC
2003	6	20%	¿20%	PBOC
2006	5	30%	30%	central gov.
2008	10	20%	¿20%	PBOC
2009	12	20%	40%	central gov.
2010	4	20%	50%	central gov.
2011	1	30%	60%	central gov.
2013	2	30%	¿60%	central gov.
2014	9	30%		PBOC and CBRC
2015	3	¿20%	40%	PBOC, MOHURD and CBRC
2015	8	20%	40%	MOF, PBOC, MOHURD
2016	2	25%	30%	PBOC, CBRC

PBOC: People's Bank of China
CBRC: China Banking Regulatory Commission
MOHURD: Ministry of Housing and Urban-Rural Development
MOF: Ministry of Finance

5.2 Down payment policy

Down payment is part of demand channel, I report in table 11 horse race regression including down payment ratio as demand channel control. It is comparable to random effect results in table 6 and table 7. Including down payment policy does not shift significance and magnitude of collateral variables, given down payment ratio over the second home itself is significant. Frequency of down payment policy shift is relatively low. Controlling for down payment policy is hard to be distinguished from using year fix effect.

I recorded 10 down payment ratio changes within the sample period. A common policy pack would specify two ratios: one for household buying their first homes, one for household buying a second one or beyond. The first type of purchase is characterized as "demand as residence", and the second type is characterized as "demand as investment or speculation". Down payment ratio for investment or speculative purchase is in general higher, or at least equal to, that of purchase as residence. Evolution of down payment policy is briefed above.

[table 11 here]

5.3 Second offering

Second offering is a financial vehicle that neither takes collateral nor increase debt. According to pecking order theory, equity financing is somehow the last resort to financing a project. Real estate developers usually run gigantic projects, thus the per Yuan financing cost is lower for all sorts of external financing, including equity financing. Secondary offering, either public or non-public, is in general an important way for large public firms to finance large projects.

In my dataset, fund raised from secondary offering is encapsuled in the variable "real estate investment: self-raised". You may find this variable under the anonym E in the interest rate channel reported in table 2. Although it is a control variable, the fact that it is contaminated by equity financing is a concern for validity of my main result. I need to figure out how severe this contamination is.

While equity financing activities cast by the non-public firms are not observable to me, those done by public firms are readily observable. If that was a secondary public offering, we expect to find the project name it funds in publicly available information. This is what I found for the 12 out of 18 public second offerings within the sample period. However, there are 76 non-public secondary offerings recorded for the same time period, 35 among which don't even specify how much it raised. To make matters more complicated, only 6 out of the 12 raised fund for projects within only one province. 5 out of the remaining 6 multi-province fund raising does not specify the allocation of fund, leaving one that partially specified allocation.

Therefore, although the secondary offerings from public firms were announced publicly, they didn't reveal sufficient information to match exactly a province-month panel. The best information aggregator, given one thirds of secondary offering announcements missing total amount raised, is the number of secondary offering event within some rolling time window. I take this time window to be 6 months, which matches the disclosure cycle of financial statement.

I expand regression [CL] using the measure for recent equity financing events. Result is summarized in table 12 is comparable to table 3. Adding second offering cause negligible change in magnitude of elasticities over collateral channel.

6 Concluding Remarks

By testing a dualism of hypotheses obtained from a dynamic Cournot competition model, I find that the collateral effect is the marginal determinant of house building. The mechanism is, collateral value determines the capacity of bank loan to any specific RED. Since the demand is large enough, the REDs exploit all their capacity and produce rather than exploiting only part of it and invest as implied by some interior optimal solution.

There are some policy implications in this result. Demand side policy such as down payment ratio and purchase restriction has been proven effective in shaping first moment and second moment of house price. According to my result, demand side policy will have at most marginal effect on quantity supplied. If the policy target is house price only, then conduct the demand side policy without compensatory supply side policy would be a neat choice. On the other hand, if the policy target is quantity of house only, a well-informed policy maker might like to conduct both the supply side policy and compensatory demand side policy to prevent sharp shift in real estate price.

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Appendices

A Linear Approximation

Suppose the demand schedule is linear and the coefficients are province-specific and time-variant. A natural thinking is that they depend on province-specific macro-economic fundamentals X_t^i. That is:

$$P_{t+k}^i(Q_t^i) = A(X_{t+k}^i) + B(X_{t+k}^i)Q_t^i \tag{8}$$

One thing need to mention about the demand is the time suffix. Current investment is supposed to be sold in k months later, that's why the time-varying structural parameters and price corresponding to quantity in time t are the rational expectation prediction on what happened k terms forward.

Another feature I have to explain is why the demand to a durable good like house doesn't seem to dry out, as I project them on macroeconomic fundamentals, some mostly growing variable. The short answer is: everyone is getting older. There are always people becoming adults and start to choose when and where to buy a house and save for it. As long as we don't have a rugby-shaped demographic structure, the demand won't dry out.

I assume the cost function is also linear and coefficients $C_t^i = C(Y_t^i)$ are also time-specific and province-specific:

$$C_t^i(q_t) = C(Y_t^i)q_t \tag{9}$$

where Y_t^i describes the province-time specific variable cost. Note that, since I am using province-month data, the small q-s are aggregated into big Q-s and the individual land holding into aggregate total land sold. Then by plugging in the linear functionals specified as in (8), (9), I rewrite the test equations as:

$$[U]:\ A(X_{t+k}^i) + 2B(X_{t+k}^i)Q_t^i - C(Y_t^i)R_t^k = 0$$

$$[C]:\ B_{t-k}R_{t-k}^k + E_{t-k}D_{t-k}^k + C(Y_t^i)Q_t^i - (\gamma W_t + E_t + (A(X_t^i) + B(X_t^i)Q_{t-k}^i)Q_{t-k}^i) = 0$$

Above test equations need to be further linearized. I assume that all the parameters are linear to the province-time specific characteristics, that is:

$$A(X_t^i) = a'X_t^i,\ B(X_t^i) = b'X_t^i,\ C(Y_t^i) = c'Y_t^i$$

By assuming these linear relation between time-variant parameters and province-month characteristics the test equations are reduced to:

$$[U]:\ a'X^i_{t+k} + 2b'X^i_{t+k}Q^i_t - c'Y^i_t R^k_t = 0$$

$$[C]:\ B_{t-k}R^k_{t-k} + E_{t-k}D^k_{t-k} + c'Y^i_t Q^i_t - (\gamma W_t + E_t + (a'X^i_t + b'X^i_t Q^i_{t-k})Q^i_{t-k}) = 0$$

As a side effect, the little abuse of notation B become less annoying. Yet above forms are still not very easy to test. I will test a local linear approximation of [U] and [C].

To obtain such approximation of [U], first recover $d\,Q^i_t$ from total differential, then crop the higher order terms from Taylor approximation:

$$d\,Q^i_t = \frac{R^k_t c' d\,Y^i_t - (a' + 2b'Q^i_t) d\,X^i_{t+k}}{2b'X^i_{t+k}} \approx \theta' g(X^i_{t+k}) - \mu'_1 Q^i_t g(X^i_{t+k}) - \frac{c'Y^i_t}{2b'X^i_{t+k}} \mu'_2 R^k_t g(Y^i_t)$$

where μ-s are convex weighting vectors and $g(.)$-s are growth rates.

A final step is to approximate the highly involatile ratio $\frac{c'Y^i_t}{2b'X^i_{t+k}}$ by a constant. We can break it into product of two ratios. The first one is variable cost versus macroeconomic fundamentals at time t, the second one is cumulative growth rate of k periods. That is:

$\frac{c'Y^i_t}{2b'X^i_{t+k}} = \frac{c'Y^i_t}{2b'X^i_t} \times \frac{2b'X^i_t}{2b'X^i_{t+k}}$

The first ratio is involatile across time since both the denominator and numerator expose to the same money supply. The second ratio is involatile when k is large enough($> 12 months$ in this paper) so that seasonality of monthly growth rate is mostly aggregated out. Thus the cumulative growth rate is more close to $\frac{k}{12} \times annual\ growth\ rate$.

After taking above approximation, I name the linear approximation to [U] by "[UL]" and switch the constants to the notation we have familiarity with:

$$[UL]:\ d\,Q^i_t = \beta'_{u,1} g(X^i_{t+k}) + \beta'_{u,2} Q^i_t g(X^i_{t+k}) + \beta'_{u,3} R^k_t g(Y^i_t) + \epsilon^i_t \tag{10}$$

For [C], I made simplification using accounting relationships before employ the total differential. Notice that the term $(a'X^i_t + b'X^i_t Q^i_{t-k})Q^i_{t-k}$ is nothing but the current sale income, and the term $B_{t-k}R^k_{t-k} + E_{t-k}D^k_{t-k}$ is nothing but current debt payment, I rewrite the test equation as:

$$(SaleIncome - DebtPayment)^i_t + E^i_t + \gamma W^i_t - c'Y^i_t Q^i_t = 0$$

As the current debt payment is pre-determined at time $t-k$ and the sale income comes from selling spots and futures corresponding to previous investment, they can be viewed as a constant. Then use the total-differential-then-crop trick to obtain:

$$d\,Q_t^i = \frac{d\,E_t^i + \gamma d\,W_t^i - c' Q_t^i d\,Y_t^i}{c' Y_t^i}$$

Draw a linear approximation of this equation and rename it "[CL]", then switch notation to β-s, we have:

$$[CL]:\; d\,Q_t^i = \beta'_{c,1} d\,\tilde{E}_t^i + \beta'_{c,2} d\,\tilde{W}_t^i + \beta'_{c,3} Q_t^i g(Y_t^i) + \epsilon_t^i \tag{11}$$

Tables

Table 1: Variable list

Variable Name	Variable Meaning	Freq.	Unit	Availability	Source
AreaNew	Area of new construction	Monthly	10,000m^2	2001-02: 2016-05	NBSC
AreaNewResi	Area of new construction: residence	Monthly	10,000m^2	1999-02: 2016-05	NBSC
REInv	Real estate investment	Monthly	100mln Yuan	1999-02: 2016-05	NBSC
AreaSold	Area sold	Monthly	10,000m^2	2001-02: 2016-04	NBSC
Land	Land purchase	Monthly	100mln Yuan	2002-03: 2016-04	NBSC
g(GDP)	Gross domestic product	Quarterly	100mln Yuan	1978-10: 2016-03	NBSC
HF5minus	Housing fund rate, less than 5 years	Daily	%	1999-06-10: 2015-10-24	PBOC
HF5plus	Housing fund rate, more than 5 years	Daily	%	1999-06-10: 2015-10-24	PBOC
MortAvg	Average interest rate, mortgage	Quarterly	%	2008-10: 2016-03	PBOC
Downpayment First	Down payment ratio: first home	Monthly	%	2003-06: 2016-02	Central Gov., PBOC
Downpayment Second	Down payment ratio: second and more	Monthly	%	2003-06: 2016-02	Central Gov., PBOC
REInvSelfRaisedFund	Real estate investment: self-raised fund	Monthly	100mln Yuan	1999-02: 2016-04	NBSC
LandAreaNew	Land cost over area of new construction	Monthly	10,000 Yuan per m^2	2002-03:2016-04	NBSC
KapFormPrcIndex	Capital formation price index	Quarterly	100	2003-01: 2016-03	NBSC
MinWage	Minimum wage	Annual	Yuan per hr	2003: 2015	MHRSSC
R3to5	Benchmark rate, length 3 to 5 years	Daily	%	1989-02-01: 2015-10-24	PBOC
LoanAvg	Average interest rate, general loan	Quarterly	%	2007-10: 2016-03	PBOC
SO6monthcount	# of secondary offerings in the past 6 months	Monthly	1	1998-08: 2016-05	CSMAR

PBOC: People's Bank of China

NBSC: National Bureau of Statistics of the People's Republic of China

MHRSSC: Ministry of Human Resources and Social Security of the People's Republic of China

CSMAR: a research database commonly used for Chinese financial market.

Table 2: Summary statistics

VARIABLES	N	mean	sd	min	max
AreaNew	4,029	407.9	375.7	0.0500	2,894
AreaNewResi	4,027	309.0	285.3	0.0500	2,388
REInv	4,058	156.8	164.2	0.0200	1,161
AreaSold	4,024	281.7	274.0	0.190	2,384
Land	3,972	28.43	40.50	0.01000	372.9
g(GDP)	4,320	0.150	0.0688	-0.166	0.323
HF5minus	4,470	3.872	0.520	2.750	4.770
HF5plus	4,470	4.357	0.500	3.250	5.220
MortAvg	2,700	5.843	1.008	4.340	7.620
Downpayment First	4,470	25.23	4.995	20	30
DownpaymentSecond	4,470	39.40	16.52	20	60
REInvSelfRaisedFund	4,030	81.66	96.48	0.0200	1,097
LandAreaNew	3,961	0.0735	0.122	0.000345	2.592
KapFormPrcIndex	4,410	102.6	3.767	92.60	117.4
MinWage	3,991	42.21	191.3	1.850	1,670
R3to5	4,470	6.214	0.711	4.750	7.740
LoanAvg	3,060	6.875	0.797	5.640	8.190
SO6monthCount	4,470	3.389	4.422	0	19

Table 3: constrained case

dependent variable:	$d(New\,Construction\,in\,Area)$			
	(1)	(2)	(3)	(4)
	Rand E	Rand E	Fix E	Fix E
dW_t^i				
$d(AreaSold)$	0.344***	0.349***	0.354***	0.375***
	(0.0464)	(0.0516)	(0.0479)	(0.0502)
$d(Land)$	2.045***	1.736***	2.049***	1.582***
	(0.498)	(0.441)	(0.500)	(0.431)
$d(E_t^i)$	1.571***	1.507***	1.560***	1.417***
	(0.155)	(0.150)	(0.154)	(0.144)
$Q_t^i g(Y_t^i)$	-0.0137***	-0.0137***	-0.0130***	-0.0118**
$Y_t^i = \frac{land\ cost}{area}$	(0.00436)	(0.00520)	(0.00450)	(0.00528)
$Q_t^i g(Y_t^i)$	0.576	0.663*	0.601	0.570
$Y_t^i = KFPI$	(0.374)	(0.397)	(0.367)	(0.366)
$Q_t^i g(Y_t^i)$		0.607***		1.121***
$Y_t^i = min.wage$		(0.115)		(0.210)
Constant	-11.16***	-52.85***	-11.47***	-89.69***
	(4.248)	(7.994)	(2.246)	(14.69)
Observations	3,528	2,620	3,528	2,620
Number of Provinces	30	30	30	30
R^2 overall	0.366	0.387		
R^2 within	0.365	0.402		
R^2 between	0.396	0.0274		
R^2			0.365	0.412
Wald $\chi^2(n)$	295.7	401.7		
F statistics			61.55	120.3

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

KFPI=capital formation price index

Table 4: unconstrained case, $k = 58$

dependent variable:	$d(New\,Construction\,in\,Area)$			
	(1)	(2)	(3)	(4)
	Rand E	Rand E	Fix E	Fix E
$g(X^i_{t+k})$				
$g(GDP)$	543.0***	-760.6**	-71.07	-1,836***
	(195.4)	(336.5)	(215.5)	(657.8)
$g(HF\ rate, 5-years)$	-11,131***		-11,772***	
	(3,974)		(3,664)	
$g(HF\ rate, 5+years)$	13,881***		15,024***	
	(4,921)		(4,651)	
$g(avg.mortgage\ rate)$		821.3***		1,410***
		(264.6)		(494.3)
$g(X^i_{t+k})Q^i_t$				
$g(GDP)Q^i_t$	-0.959	2.467**	3.901***	8.863***
	(0.760)	(1.226)	(0.829)	(1.579)
$g(HF\ rate, 5-years)Q^i_t$	58.33***		54.33***	
	(16.73)		(14.87)	
$g(HF\ rate, 5+years)Q^i_t$	-72.74***		-69.02***	
	(20.08)		(18.19)	
$g(avg.mortgagerate)Q^i_t$		-2.087***		-2.962***
		(0.470)		(0.990)
$RL * g(\frac{land\ cost}{area})$	-6.64e-05		4.98e-06	
	(7.22e-05)		(6.51e-05)	
$RL * g(KFPI)$	-0.00408		-0.0160***	
	(0.00377)		(0.00455)	
$RL * g(min.wage)$	-2.32e-05		0.000972	
	(0.000507)		(0.000827)	
$RAvg * g(\frac{land\ cost}{area})$		-4.94e-05		8.09e-06
		(6.72e-05)		(5.28e-05)
$RAvg * g(KFPI)$		-0.00530**		-0.0153***
		(0.00245)		(0.00365)
$RAvg * g(min.wage)$		-0.000407		-0.000299
		(0.000649)		(0.00105)
Constant	-80.63**	-19.63	-152.5***	-100.3**
	(31.63)	(25.98)	(34.72)	(42.89)
Observations	982	736	982	736
Number of Provinces	30	30	30	30
R^2 overall	0.138	0.0632		
R^2 within	0.195	0.164		
R^2 between	0.000347	0.0125		
R^2			0.261	0.203
Wald $\chi^2(n)$	55.53	64.49		
F statistics			22.01	13.10

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
RL=long-term loan rate(3 5 yrs)
RAvg=average rate of general loan
KFPI=capital formation price index

Table 5: unconstrained case, $k = 60$

dependent variable:	$d(New\,Construction\,in\,Area)$			
	(1)	(2)	(3)	(4)
	Rand E	Rand E	Fix E	Fix E
$g(X^i_{t+k})$				
$g(GDP)$	392.8	-1,017**	-114.7	-2,917***
	(243.8)	(398.8)	(268.9)	(834.0)
$g(HF\ rate, 5-years)$	-14,789***		-13,862***	
	(4,687)		(4,198)	
$g(HF\ rate, 5+years)$	18,795***		18,043***	
	(5,761)		(5,257)	
$g(avg.mortgage\ rate)$		678.6**		1,660***
		(277.3)		(551.2)
$g(X^i_{t+k})Q^i_t$				
$g(GDP)Q^i_t$	-0.587	2.655**	3.958***	9.236***
	(1.007)	(1.217)	(0.837)	(1.546)
$g(HF\ rate, 5-years)Q^i_t$	36.43**		43.74**	
	(18.56)		(17.56)	
$g(HF\ rate, 5+years)Q^i_t$	-46.90**		-56.93**	
	(22.27)		(21.37)	
$g(avg.mortgagerate)Q^i_t$		-0.860**		-1.939**
		(0.413)		(0.881)
$RL * g(\frac{land\ cost}{area})$	-3.85e-05		1.62e-05	
	(5.27e-05)		(4.95e-05)	
$RL * g(KFPI)$	-0.00345		-0.0121***	
	(0.00266)		(0.00329)	
$RL * g(min.wage)$	0.000179		0.000934*	
	(0.000307)		(0.000521)	
$RL * g(\frac{land\ cost}{area})$		-3.08e-05		8.82e-06
		(4.72e-05)		(3.73e-05)
$RAvg * g(KFPI)$		-0.00329*		-0.00976***
		(0.00180)		(0.00254)
$RAvg * g(min.wage)$		-0.000411		-3.92e-05
		(0.000450)		(0.000668)
Constant	-33.26	4.916	-126.8***	-13.99
	(31.15)	(26.53)	(37.51)	(52.90)
Observations	982	736	982	736
Number of Provinces	30	30	30	30
R^2 overall	0.0995	0.0566		
R^2 within	0.171	0.190		
R^2 between	0.000787	0.0106		
R^2			0.233	0.203
Wald $\chi^2(n)$	59.17	30.09		
F statistics			27.15	12.51

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
RL=long-term loan rate(3 5 yrs)
RAvg=average rate of general loan
KFPI=capital formation price index

Table 6: Horse race, $k = 58$

dependent variable:	$d(New\,Construction\,in\,Area)$			
	(1)	(2)	(3)	(4)
	Rand E	Rand E	Fix E	Fix E
$d(AreaSold)$	0.617***	0.618***	0.639***	0.642***
	(0.0854)	(0.0857)	(0.0872)	(0.0880)
$d(Land)$	2.057**	2.048**	1.987*	1.976*
	(0.997)	(0.992)	(0.998)	(0.992)
$g(GDP)$	153.4*	119.0	145.8	85.97
	(78.37)	(94.69)	(101.0)	(148.8)
HF rate,5-years		-95.51		-57.62
		(173.8)		(146.1)
HF rate,5+years		106.4		69.06
		(180.0)		(152.6)
HF term spread	-2.802		-36.09	
	(159.8)		(148.6)	
$g(\frac{land\ cost}{area})$	-6.610***	-6.615***	-5.931**	-5.933**
	(2.263)	(2.269)	(2.348)	(2.351)
$g(KFPI)$	178.8	209.1*	209.4*	238.6*
	(122.7)	(125.8)	(117.1)	(119.3)
$g(min.wage)$	-46.61	-46.71	57.47	58.08
	(36.04)	(35.38)	(79.10)	(79.29)
RL	-7.474*	-8.867**	-8.487**	-9.644**
	(4.176)	(4.452)	(4.134)	(4.096)
Constant	24.24	-58.79	33.17	-49.73
	(88.48)	(121.4)	(82.52)	(112.5)
Observations	1,122	1,122	1,122	1,122
Number of Provinces	30	30	30	30
R^2 overall	0.288	0.288		
R^2 within	0.292	0.292		
R^2 between	0.179	0.179		
R^2			0.293	0.294
Wald $\chi^2(n)$	149.3	204.8		
F statistics			26.96	30.49

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
KFPI=capital formation price index
RL=long-term loan rate(3 5 yrs)

Table 7: Horse race, $k = 60$

dependent variable:	$d(New\,Construction\,in\,Area)$			
	(1)	(2)	(3)	(4)
	Rand E	Rand E	Fix E	Fix E
$d(AreaSold)$	0.617***	0.618***	0.639***	0.641***
	(0.0855)	(0.0855)	(0.0871)	(0.0876)
$d(Land)$	2.058**	2.050**	1.989*	1.981*
	(0.997)	(0.993)	(0.997)	(0.992)
$g(GDP)$	163.1**	128.1	157.0	101.2
	(80.98)	(103.6)	(101.1)	(158.5)
HF rate,5-years		-180.6		-111.5
		(192.8)		(170.8)
HF rate,5+years		189.6		120.2
		(197.0)		(175.8)
HF term spread	106.3		49.00	
	(185.0)		(165.9)	
$g(\frac{land\ cost}{area})$	-6.604***	-6.611***	-5.925**	-5.929**
	(2.264)	(2.272)	(2.348)	(2.352)
$g(KFPI)$	182.6	217.9*	212.8*	244.5*
	(124.1)	(129.7)	(118.8)	(124.8)
$g(min.wage)$	-46.33	-46.48	58.45	58.77
	(35.73)	(35.19)	(78.61)	(79.02)
RL	-8.617*	-10.35**	-9.761*	-11.05**
	(4.816)	(4.683)	(4.791)	(4.650)
Constant	-31.62	-92.52	-10.40	-65.23
	(93.61)	(115.6)	(84.69)	(108.9)
Observations	1,122	1,122	1,122	1,122
Number of ProvinceCode	30	30	30	30
R^2 overall	0.288	0.288		
R^2 within	0.292	0.292		
R^2 between	0.180	0.180		
R^2			0.293	0.293
Wald $\chi^2(n)$	157.3	194.9		
F statistics			27.04	29.89

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

KFPI=capital formation price index

RL=long-term loan rate(3 5 yrs)

Table 8: Vuong's Test

	K=31	K=32	K=33	K=34	K=35
Coeff	-21,408***	-22,210***	-22,007***	-18,134***	-18,443***
	(6,005)	(5,918)	(5,997)	(5,241)	(5,419)
Observations	1,790	1,760	1,734	1,708	1,708
	K=36	K=37	K=38	K=39	K=40
Coeff	-17,923***	-18,216***	-20,028***	-19,584***	-19,622***
	(5,432)	(5,462)	(5,302)	(5,493)	(5,688)
Observations	1,708	1,678	1,648	1,618	1,588
	K=41	K=42	K=43	K=44	K=45
Coeff	-20,146***	-14,875**	-16,179***	-19,061***	-15,715***
	(5,582)	(5,728)	(5,781)	(5,626)	(5,685)
Observations	1,558	1,528	1,498	1,468	1,439
	K=46	K=47	K=48	K=49	K=50
Coeff	-12,818**	-14,425**	-14,079**	-15,554***	-17,366***
	(5,990)	(6,028)	(5,838)	(5,616)	(5,367)
Observations	1,411	1,411	1,411	1,381	1,351
	K=51	K=52	K=53	K=54	K=55
Coeff	-14,847**	-17,430***	-17,753***	-14,763**	-14,282**
	(5,680)	(5,934)	(5,883)	(6,505)	(6,089)
Observations	1,321	1,291	1,261	1,231	1,201
	K=56	K=57	K=58	K=59	K=60
Coeff	-17,061***	-15,647**	-8,764	-12,331*	-10,670
	(6,407)	(6,858)	(6,471)	(6,587)	(6,412)
Observations	1,172	1,147	1,121	1,121	1,121
	K=61	K=62	K=63	K=64	K=65
Coeff	-11,698*	-14,902**	-13,738**	-9,907	-12,343*
	(6,359)	(6,106)	(6,314)	(6,878)	(7,048)
Observations	1,091	1,061	1,031	1,001	971

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: constrained case, residence only

dependent variable:	$d(New\,Construction\,in\,Area,\,residence)$			
	(1)	(2)	(3)	(4)
	Rand E	Rand E	Fix E	Fix E
dW_t^i				
$d(AreaSold)$	0.294***	0.306***	0.303***	0.325***
	(0.0386)	(0.0398)	(0.0398)	(0.0389)
$d(Land)$	1.370***	1.135***	1.377***	1.026***
	(0.417)	(0.371)	(0.418)	(0.361)
$d(E_t^i)$	1.145***	1.092***	1.135***	1.025***
	(0.128)	(0.125)	(0.127)	(0.122)
$Q_t^i g(Y_t^i)$	-0.00995***	-0.00973**	-0.00944**	-0.00838**
$Y_t^i = \frac{land\ cost}{area}$	(0.00336)	(0.00383)	(0.00345)	(0.00387)
$Q_t^i g(Y_t^i)$	0.625**	0.728**	0.643**	0.658**
$Y_t^i = KFPI$	(0.289)	(0.296)	(0.288)	(0.279)
$Q_t^i g(Y_t^i)$		0.408***		0.790***
$Y_t^i = min.wage$		(0.0847)		(0.143)
Constant	-10.89***	-39.72***	-11.18***	-67.06***
	(3.429)	(6.510)	(1.873)	(10.16)
Observations	3,526	2,618	3,526	2,618
Number of Provinces	30	30	30	30
R^2 overall	0.352	0.369		
R^2 within	0.352	0.384		
R^2 between	0.317	0.0193		
R^2			0.352	0.394
Wald $\chi^2(n)$	218.1	272.7		
F statistics			45.18	87.56

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

KFPI=capital formation price index

Table 10: constrained case, yuan measure

dependent variable:	$d(New\,Investment)$			
	(1)	(2)	(3)	(4)
	Rand E	Rand E	Fix E	Fix E
dW_t^i				
$d(AreaSold)$	0.0916***	0.123***	0.0912***	0.124***
	(0.0132)	(0.0145)	(0.0135)	(0.0151)
$d(Land)$	1.319***	1.280***	1.316***	1.268***
	(0.181)	(0.175)	(0.184)	(0.177)
$d(E_t^i)$	0.377***	0.358***	0.377***	0.352***
	(0.0377)	(0.0331)	(0.0384)	(0.0330)
$Q_t^i g(Y_t^i)$	-5.69e-05	5.94e-05	-3.80e-05	0.000152
$Y_t^i = \frac{land\ cost}{area}$	(0.000137)	(0.000126)	(0.000139)	(0.000138)
$Q_t^i g(Y_t^i)$	0.0171	-0.00442	0.0208	-0.00417
$Y_t^i = KFPI$	(0.0373)	(0.0356)	(0.0380)	(0.0359)
$Q_t^i g(Y_t^i)$		0.0374**		0.0647***
$Y_t^i = min.wage$		(0.0149)		(0.0207)
Constant	1.273**	-2.253	1.297**	-4.204**
	(0.524)	(1.411)	(0.599)	(1.681)
Observations	3,528	2,620	3,528	2,620
Number of Provinces	30	30	30	30
R^2 overall	0.650	0.669		
R^2 within	0.647	0.667		
R^2 between	0.898	0.817		
R^2			0.647	0.667
Wald $\chi^2(n)$	207.5	243.4		
F statistics			40.83	34.76

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

KFPI=capital formation price index

Table 11: Horse race, with down payment ratio

dependent variable:	$d(New\,Construction\,in\,Area)$			
	(1)	(2)	(3)	(4)
	k=58	k=58	k=60	k=60
$d(AreaSold)$	0.623***	0.620***	0.623***	0.620***
	(0.0850)	(0.0860)	(0.0852)	(0.0863)
$d(Land)$	2.047**	2.096**	2.047**	2.141**
	(0.992)	(1.012)	(0.991)	(1.012)
$g(GDP)$	-2.634	-11.39	-7.925	14.73
	(120.7)	(121.8)	(119.6)	(119.8)
HF rate,5-years		872.7***		1,496***
		(332.6)		(516.9)
HF rate,5+years		-962.1***		-1,676***
		(364.6)		(571.2)
HF term spread	-172.9		-51.80	
	(159.3)		(201.3)	
Downpayment rate,	-0.629	3.258	0.0947	7.901**
first home	(2.186)	(3.055)	(2.232)	(4.017)
Downpayment rate,	-1.856***	-4.382***	-1.836***	-7.875***
second home	(0.559)	(1.474)	(0.563)	(2.505)
$g(\frac{land\ cost}{area})$	-6.604***	-6.569***	-6.595***	-6.471***
	(2.230)	(2.164)	(2.229)	(2.067)
$g(KFPI)$	460.7***	523.5***	448.6***	506.1***
	(167.4)	(175.2)	(164.1)	(169.0)
$g(min.wage)$	-49.65	-51.23	-48.06	-52.71
	(34.32)	(36.89)	(33.71)	(37.86)
RL	-8.149	-16.74	-11.16	-20.38
	(9.336)	(11.38)	(10.56)	(13.49)
Constant	192.8**	969.5***	134.6	1,681***
	(92.08)	(347.6)	(101.1)	(539.4)
Observations	1,122	1,122	1,122	1,122
Number of Provinces	30	30	30	30
R^2 overall	0.293	0.297	0.293	0.305
R^2 within	0.297	0.302	0.297	0.309
R^2 between	0.176	0.175	0.176	0.171
Wald $\chi^2(n)$	204.7	288.9	297.8	370.3

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
KFPI=capital formation price index
RL=long-term loan rate(3 5 yrs)

Table 12: constrained case, with second offering count

dependent variable:	$d(New\,Construction\,in\,Area)$			
	(1)	(2)	(3)	(4)
	Rand E	Rand E	Fix E	Fix E
dW_t^i				
$d(AreaSold)$	0.344***	0.345***	0.353***	0.369***
	(0.0466)	(0.0522)	(0.0481)	(0.0508)
$d(Land)$	2.042***	1.723***	2.046***	1.549***
	(0.497)	(0.437)	(0.499)	(0.424)
$d(E_t^i)$	1.572***	1.508***	1.561***	1.413***
	(0.155)	(0.150)	(0.154)	(0.143)
Count of second	0.636	2.530**	0.645	4.296***
offering, last 6 mon.	(0.638)	(1.058)	(0.639)	(1.251)
$Q_t^i g(Y_t^i)$	-0.0137***	-0.0135***	-0.0130***	-0.0114**
$Y_t^i = \frac{land\ cost}{area}$	(0.00436)	(0.00519)	(0.00450)	(0.00527)
$Q_t^i g(Y_t^i)$	0.554	0.584	0.578	0.432
$Y_t^i = KFPI$	(0.371)	(0.392)	(0.365)	(0.355)
$Q_t^i g(Y_t^i)$		0.635***		1.200***
$Y_t^i = min.wage$		(0.116)		(0.219)
Constant	-13.22***	-64.33***	-13.56***	-111.4***
	(4.577)	(9.706)	(2.765)	(16.49)
Observations	3,528	2,620	3,528	2,620
Number of Provinces	30	30	30	30
R^2 overall	0.366	0.388		
R^2 within	0.365	0.405		
R^2 between	0.396	0.0230		
R^2			0.366	0.416
Wald $\chi^2(n)$	317.8	393.4		
F statistics			55.34	95.14

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

KFPI=capital formation price index