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FINANCIAL CONDITIONS, LOCAL COMPETITION, AND LOCAL MARKET LEADERS: THE CASE OF REAL ESTATE DEVELOPERS

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Financial Conditions, Local Competition, and Local Market Leaders: The Case of Real Estate Developers[Ω]

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Abstract:

This paper studies whether (and how) corporate decisions are affected by internal factors (such as the financial conditions of own company) and external factors (such as the actions of local competitors) in an imperfectly competitive environment. We study the listed real estate developers in Beijing as a case study. Our hand-collected dataset includes transaction-level information booked indicators (such as profitability, liability, and liquidity) and un-booked financial indicators (political connections). Our multi-step empirical model shows that both the firm's financial conditions and her competitors' counterparts are essential but play different roles in the output design, pricing, and the time-on-the-market (TOM). Internal versus external factors' relative importance relates to the degrees of market concentration in a nonlinear manner. Local market leaders' existence alters the small firms' strategy and leads to higher selling prices and slower selling pace in the local market. Our findings survive various robust checks.

Keywords: corporate financial status; output market decision; internal and external driven; real estate developers; housing supply

JEL Classification: G11, R30, L10

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1. Introduction

This paper shows that the following factors matter in pricing and the competition among firms: the firm's financial condition, the financial condition of local rivals, and the existence of a price leader in the local market. It is in sharp contrast with what the paradigm of a perfectly competitive market would predict.[1] In effect, we combine the insights of the finance-IO literature and the literature of local competition. The former emphasizes the interactions of financial decisions (e.g., the leverage ratio) and the equilibrium product prices and output levels (Brander and Lewis, 1986). The latter would study the impacts of a local price leader, such as Wal-Mart (Jia, 2008; Holmes, 2011).[2]

Empirically, this paper overcomes at least two challenges. First, with the development of technologies and different internet platforms, the local market boundary is not clear. For instance, consider a geographically isolated small town, which has only one bookstore. However, residents in that small town may use Amazon or another internet platform to order books and audio items. This paper focuses on housing, which is non-tradeable. We can also identify the local competitors and obtain the corresponding information for our analysis, further explained later. Second, the debt ratio cannot capture all the financial decisions (Glazer, 1994; Maksimovic, 1988). The debt structure (such as short-term versus long-term debt) matters. Other financial instruments, such as warrants, convertible bonds, etc., can also affect the product market competition. In light of these contributions, this paper includes a wide range of financial condition variables (FCV) to capture the potentially complex relationship between firms' internal finance and product market behaviors.

Our research focuses naturally ties us to several strands of the literature. First, this paper complements the literature on spatial competition (SC), which overlaps urban economics and IO (Borla, 2012; Brekke et al., 2010; Pennerstorfer, 2017). Our empirical findings on how real estate developers compete locally would complement the SC literature, which tends to be theoretical.

Second, since this paper employs listed real estate developer data, it contributes to the urban economics literature, emphasizing the housing demand. Studies on housing supply are limited.[3] Several authors have recently shown that regulatory constraints would limit the housing supply and drive up the house prices (Green et al., 2005; Hilber and Vermeulen, 2016; Jackson, 2016; Saiz, 2010). Those studies are typically at the city level. This paper complements these studies with a firm-level analysis. In particular, we would argue that the market structure for real estate development in Beijing is oligopolistic. The decisions made by the developers, including the product design (such as the average height of a real estate development), pricing, etc., are influenced by both the financial conditions of the developers, as well as the competitors (i.e., other developers) within the same district. Hence, while all Beijing developers may face the same set of regulatory constraints, they may behave differently.

[1] Among others, see Mas-Colell et al. (1995) for a detailed analysis.

[2] Many have examined both the theoretical robustness and empirical validity of such effect (Campello, 2003; Chevalier, 1995; Fresard, 2010). Parsons and Titman (2009) surveyed the literature on the relationship between debt financing and corporate strategy and confirmed the leverage ratio's importance on corporate decisions.

[3] Among others, see Green and Malpezzi (2003), Leung et al. (2020), Leung and Ng (2019). The housing supply literature considers real estate development a real option, inspired by Titman (1985). Except for Quigg (1993), that literature seems to be mainly theoretical (Grenadier, 1996; Lee and Jou, 2010; Wang and Zhou, 2006).

We concentrate our attention on the real estate developers (REDR) in Beijing and study whether their decisions are driven by internal factors (such as the financial conditions) and external factors (such as the financial conditions of *local* competitors). Several academic merits may be worth attention. First, Beijing is China's capital city and has 21 million people, according to 2016 official statistics. Such population size is comparable to some member countries in the United Nations and some large metropolitan areas such as Los Angeles and New York. The lessons we learn from Beijing may shed light on other cities and countries. Second, as housing is non-tradeable, it mitigates the concerns of competitions from different places through the internet. In a way, comparing the importance of internal versus external factors among competing real estate developers may provide a relatively "clean" test.

Third, many REDR in Beijing is listed in the stock market. In contrast, many REDR in advanced economies are private companies, and hence, they may not disclose the vital information critical for academic research. This research takes advantage of corporate information disclosure in the stock market requirement and uses it in our empirical analysis. Notice that other firms could influence a firm's decisions when a market deviates from the perfect competition paradigm. Hence, we may *need the information about a firm and its rivals* to analyze a company's behaviors in a micro-level analysis (Leung and Tang, 2015; Wang and Zhou, 2000, 2006; Williams, 1993). Our sample of listed real estate developers enables us to observe one firm's financial conditions and rivals. Our fruitful hand-collected dataset includes information obtained from the listed mother companies, all of the "daughter companies" that we can identify, some of which are private, and the housing units' trading information. Besides, we have access to variables that reflect the "corporate financial status," including both booked indicators (profitability, liability, and liquidity) and un-booked indicator (political connections), as well as local economic conditions. Thus, the information of developers, projects, and land is efficiently matched. We then investigate these developers' principal decisions, namely, land acquisition, project development, and sales. Employing a sample of listed REDR may also enrich our understanding of how oligopolistic firms compete with financial conditions. Notice that these REDR are listed firms and hence should have better access to external funding. If the listed REDR behave as financially constrained, likely, those non-listed firms are even more so.

Fourth, real estate developers share some similarities with other corporations. For instance, real estate developers need to make decisions sequentially in the production process, in which earlier decisions ("*upstream*") may potentially create valuable discretionary "*downstream*" opportunities (Herath and Park, 2002; Miles et al., 2010). More specifically, developers take the risk and evolving cost and revenue in the locational choice and land acquisition stage. After the land acquisition, developers need to decide what to develop, how much to develop, and what prices the units would be sold (Wang and Zhou, 2000; Williams, 1991). These decisions could depend on the site's location and the developers' preference, how products are being offered, or would soon be provided by other developers locally (Dong and Sing, 2013).[4] Intuitively, given the differences in physical/social landscape, real estate projects are heterogeneous by nature, and developers might have significant market power (Salop, 1979).

[4] The location choice of developers may be similar to the choice of location for multinationals. See Baldwin (2006), Okubo et al. (2010), among others.

To mitigate the potential competitive pressure from other developers, a developer has incentives to shape a real estate development (RED) to make it even more differentiated from those produced by the competitors and to increase her market power (Gnagey, 2012; Leung et al., 2014; Somervile, 1999). Also, a developer can adjust the prices and the timing mechanism to maximize her profit. These facts highlight the necessity to control the multi-stage decision chain, from land acquisition and project development to the market transaction in a sequential manner. Our multi-step empirical model thereby mitigates several econometric issues. They include the endogeneity and non-linearity in the real estate development process and the pricing-timing process. Thus, this study may throw light on how corporates compete, given the internal factors (such as the financial status) and external factors (such as the rivals).

To our knowledge, our paper is the first to provide empirical evidence in comparing the impact of corporate internal and external financial status on both pricing and output decisions of REDR. On average, we find that both the corporate and its competitors' financial indicators are significant in the output design and marketing stages. We also find that the presence of a prominent developer would influence how other developers compete. Thus, our results suggest that incorporating financial information may be necessary to understand the local competition. Our findings are robust to changing the measurement of financial status and controlling the spatial-temporal co-movement of housing prices and time on the market. Second, since existing empirical studies on real estate markets disproportionally focus on the demand side, our paper could enhance our understanding of housing supply.

The organization of the paper is as follows. Section 2 provides background information on the case market and literature review of the real estate developer decision-making mechanism. We then describe the data and the multi-step empirical strategies used in the study. Section 4 presents the empirical results for the role of internal and external financial status in the developing decision. Section 5 presents our conclusions.

2. A Brief Review of the Literature

This section provides a review of the different strands of literature from which this paper is built. They include research on the relationship between financial conditions and corporate decisions and the housing supply studies in urban development.

There is a voluminous literature on the relationship between firms' financial conditions and their product market behaviors. Brander and Lewis (1986) articulated a two-stage duopoly game that corporate financial status could have effects on rivals in an imperfectly competitive environment. Many have examined both the theoretical robustness and empirical validity of such a result (Benoit and Krishna, 1991; Bolton and Scharfstein, 1990; Campello, 2003; Chevalier, 1995; Fresard, 2010; Matsa, 2010; Oechssler and Schuhmacher, 2004). Parsons and Titman (2009) surveyed the literature on the relationship between debt financing and corporate strategy and confirmed the leverage ratio's importance on corporate decisions. This paper complements the literature in several ways. We include several financial condition variables (FCV) in the empirical analysis and show that these FCV explain the developers' behaviors. Our multi-step procedures enable us to identify how different FCV affect different stages of real estate development.

The literature on multi-stage housing production is also a source of inspiration for this paper. The location choice, project decision, and marketing strategy are often considered critical stages in RED decisions (Miles et al., 2010; Weiss, 2002). As an echo of the famous saying, "location, location, and location," some authors estimate that the locational choice can affect over 95% of the follow-up decisions of a project and is also positively correlated with the risk rating and profitability of a project (Gregor, 2015).

The third strand of literature that is related to our work concerns the project design of RED. In principle, both the demand and supply sides would influence the housing structure design and land use patterns. Developers play a core role in the formation of scale, density, style, and structure of the project (Peiser, 1990; Weiss, 2002), though consumers and local governments affect by inducing or regulating the project (Maruani and Amit-Cohen, 2011). By investigating projects in Shanghai, Lai et al. (2008) confirm that if a developer reaches a specific scale, it can freely decide its developing strategy, which ensures developers' critical role in the process of project location choice and design.

This paper is also related to the literature on "price leadership" (Deneckere and Kovenock, 1992; Ono, 1982). In that literature, researchers have established conditions under which some firms would be disproportionally influential in setting the market prices. In this paper, we can identify the competitors in each local market ("district"). We examine whether the large developers are "price leaders" in practice.

This paper complements the previous literature on the pre-marketing stage of housing supply in several ways. First, we highlight the importance of considering financial constraints. For real estate developers (REDR), both assets (such as land) and products (such as housing units) are "collateralizable" or pledgable. Our sample focuses on listed REDR, which are expected to have better access to external funding sources. If even the listed REDR are "financially constrained," many other firms would more likely to be financially constrained. In this paper, we employ several measures of "financial constraint" and test whether the REDR in our sample is indeed constrained. Real estate development is a multi-stage process, and we have access to the actions by the REDR in different stages. Our multi-step empirical strategy can indicate whether the REDR are financially constrained and at which stage they are constrained if they are indeed constrained. Also, since we have all the listed REDR information, we can examine whether their rivals may affect the REDR and at which stage their opponents exert those influences. Moreover, as we have explained, housing is non-tradeable goods. Non-local competition can be comfortably neglected in our analysis.

This paper may also contribute to the literature on the marketing stage of housing supply, which studies the relationship between the housing price and time-on-the-market (TOM). Most studies in that literature focus on the secondary market, where buyers and sellers engage in a search-and-matching process (e.g., Allen et al., 2005; Anglin, 1997; Knight, 2002; Leung and Tse, 2017; Yavas, 1992). On the other hand, this paper focuses on the asymmetric primary market, where sellers (i.e., real estate developers) and buyers (often households) arguably have very different bargaining power (BP) may be overlooked. Intuitively, if REDR were financially distressed, they would be more willing to accept lower prices to sell faster. The capital appreciation expectations of developers may also increase TOM (Ong et al., 2000). We examine whether (and if so, to what extent) a real estate developer's financial conditions and its rivals affect the selling price and TOM. We believe this point may be relatively new because there are typically many potential sellers in the secondary market. Hence, empirical works often implicitly assume each seller as a price-taker and do not consider the sellers' strategic interactions.

Based on our discussion, here are our hypotheses.

1. The financial conditions matter. More specifically, the coefficients of the company's financial condition variables and its rivals are expected to be statistically significant.

2. Leaders matter. More specifically, we examine whether some large real estate developers' presence influences the local market prices and transaction patterns.

Moreover, if multiple factors are found statistically significant, we provide an empirical decomposition on how different factors can explain pricing behaviors.

3. Data and Empirical Design

3.1 Data Descriptions

While we provide a more detailed description of the dataset in the appendix, it is worth giving some highlights here. This paper employs data from different sources. Our macroeconomic data comes from the Beijing Statistical Yearbook (2007-2009) and includes permanent and external population, land area, population density, disposable income per capita, fixed assets, and real estate investment.[5] The nominal variables are deflated by the annual consumer price index (CPI).

Our second category of data is housing-related. The micro-level housing data are drawn from the City Housing Index Database, established by the Ministry of Construction (MOC) and the Department of Housing and Urban and Rural Construction Committee in Beijing. We focus on development projects by listed firms, as the corresponding financial information is readily available. After the usual data-cleansing procedures,[6] we obtain 59,451 residential unit transaction records from 2006 to 2008. The sample contains information on the project name, unit-selling price, selling time, and issue date of the pre-sale license, in addition to the physical attributes of the project and unit, such as project area, the total number of floors in the building, unit area, and the height of the unit. We used GIS Mapping to acquire the location and neighborhood attributes, including the distance to CBD, the nearest subway station, hospitals, and schools.

Geographically, Beijing is divided into different "rings." Roughly speaking, the higher the ring's number, the further the ring is located from the central business district (CBD). We, therefore, divide our sample into four sub-samples, namely, inside the second ring (the "core

[5] "Permanent population" refers to the population with the registered citizenship (*hokou*).
[6] We removed observations with incomplete information on one of the following categories: location, project design, and transaction details. We also removed projects that are not developed by listed (A-share) real estate firms in China.

function zone"), inside the fifth ring (the "expanded function zone"), inside the sixth ring (the "development zone") and outside the sixth ring (the "ecological zone"). Figure 1 provides a visualization of the geographical distribution of the fifteen districts. First, we aggregate them into four Functional Zones or Regions. Within our sampling period, most of the new-developed projects are located inside the fifth ring. It is probably due to the following facts: (1) the core function zone is already well developed, (2) the infrastructure and amenities in the ecological zone is under-supplied, and (3) the land leasing policy imposed by the government that may not be driven by purely economic reasons.

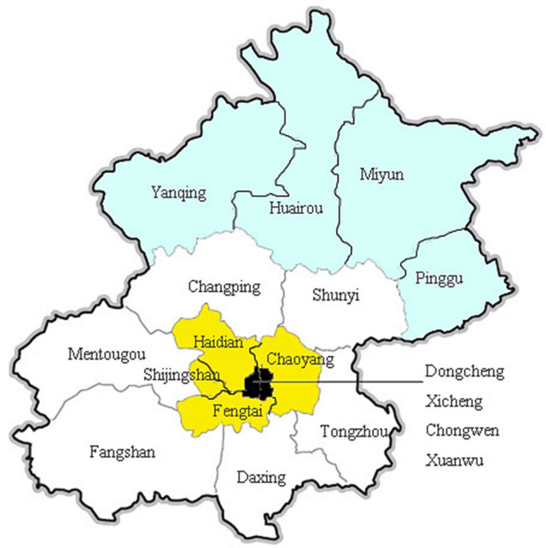


Figure 1 Distribution of Four Functional Zones in Beijing

The oligopolistic nature of the Beijing housing market is well illustrated in its distribution of sales volume. In the appendix, we show that the top 10 developers account for about one half of the total sales volume from 2006 to 2008. We naturally turn to the industrial organization literature and measure market concentration. We first calculate the Herfindahl–Hirschman Index (HHI), which is one of the most popular measures in this regard.[7] During this period, HHI reaches 0.26, which indicates that the market is highly concentrated. The market is more concentrated in the inner city as well as the outer suburban. This result is intuitive. The land cost in the inner city is very high. And in the outer sub-urban, the market demand is highly uncertain. It discourages financially weak developers from entering those markets. (We will provide a more systematic analysis on the location choices of the developers).

Furthermore, the four zones' major developers are all different, which suggests that different developers might have distinct "comparative advantages" in each zone. The comparative

[7] HHI is a widely used measure of the concentration of industry. It is beyond the scope of this paper to review the related literature. Among others, see Tremblay and Tremblay (2012) and the reference therein. The formula of HHI is simple and stated as follows:

$$H = \sum_{i=1}^{N} s_i^2$$

where s_i is the market share of firm i in the market, and N is the number of firms. Conventionally, a value of HHI below 0.01 may indicate a highly competitive industry, below 0.15 may indicate an un-concentrated industry, between 0.15 to 0.25 may indicate moderate concentration. Above 0.25 may show high concentration.

advantage might be economically (such as local knowledge in a specific area) or politically (such as the top executives being more politically connected to the local government officials).[8] More discussion and analysis related to such market concentration will be presented later.

Our third source of data is financial. The RESSET Financial Database provides us the listed developers' information, including the earnings per share, current ratio, interest cover ratio, inventory turnover ratio, debt-to-asset ratio, PE ratio, and yearly market capitalization. These indices reflect profitability, competitiveness, and the debt-paying ability of the firm.[9] The recent literature also demonstrates the potential benefits of political connectedness (Chan et al., 2012; Li et al., 2007, 2008; Lambert and Volpin, 2017). We refer them as un-booked financial status or political economy variables in this paper. We include additional information such as the firm's corporate governance information, including the governance background of the firm's board members, supervisors, and executive leaders, etc., as a proxy of the firm's political connections. Following Faccio (2006), we identify firms as politically connected if one of the firm's board members, supervisors, or executives used to have an official governmental background. They include the National People's Congress (NPC) deputy, Chinese People's Political Consultative Conference (CPPCC) member, and officials at national, provincial, city, or county levels. Thus, for each project, we can match the mother company's financial status and political connection status at the listing time. Table 1 provides a quick summary of the financial and political economy variables of the firms. Several remarks are in order. Recall that the interest cover ratio is a company's earnings before interest and taxes (EBIT), divided by the company's interest expenses for the same period. The top 10 developers have a significantly higher interest cover ratio, which is about 140. The full sample average is only about 40.

Moreover, the PE ratio of the top 10 developers is 76, compared to the full sample average, which is less than 6. We may say that the top 10 developers have some advantages in terms of finance. On the other hand, it seems that the top 10 developers are less politically connected at the national and provisional level, but more connected than the average at the city and county level.

[8] Notice that the comparative advantage might be economically (such as local knowledge in a certain zone), or politically (such as the top executives being more politically connected to the local government officials).

[9] Our choice of variables is guided by the literature and constrained by data availability. For a survey of the literature, see Shleifer and Vishny (1997), among others.

Table 1 Descriptive Statistics of Financial and Political Economy Variables of Listed Developers

Variable	Definition	Mean (Full Sample)	Std. Dev. (Full Sample)	Mean (Top 10 developers)	Std. Dev. (Top 10 developers)
	Financial Attributes (booked)				
currt	current ratio	1.600742	2.072399	1.05806	0.520694
intcvr	interest cover ratio	39.38115	260.5568	144.48	567.0533
dbastrt	debt-to-assets ratio	57.51366	32.52184	56.85389	20.84452
peratio	PE ratio	5.260944	132.6877	76.25905	60.5248
ebitda	earnings per share	2.37E+08	4.76E+08	1.62E+08	8.87E+07
	Political Economy Indicators				
npc_cppcc	dummy variable equals to 1 if the corporate management level used to have a NPC and CPPCC background [10]	0.292370	0.454855	0.169015	0.374781
official_1_2	dummy variable equals to 1 if the corporate management level used to have a national official background	0.084841	0.278648	0.020798	0.142714
official_3_4	dummy variable equals to 1 if the corporate management level used to have a provincial or ministerial official background	0.138616	0.345548	0.020798	0.142714
official_5_6	dummy variable equals to 1 if the corporate management level used to have a city-level or bureau-level official background	0.136059	0.342855	0.177759	0.382326
official_7_8	dummy variable equals to 1 if the corporate management level used to have a county-level official background	0.419111	0.493418	0.546689	0.497837
official_9_12	dummy variable equals to 1 if the corporate management level used to have a township official background	0.209261	0.406785	0.169015	0.374781
official_other	dummy variable equals to 1 if the corporate management level used to have an other official background	0.673249	0.469029	0.569864	0.495116

3.2 Multi-Step Design and Multicollinearity Solution

As we have discussed above, the decisions of Chinese real estate developers (location selection, project design, pricing, and timing) could be influenced by her financial conditions and the conditions of her rivals, among other factors. We, therefore, build a simple multi-step empirical model, which reflects such a sequential decision process.

[10] "Management level" denotes firm's board members, supervisors and executive layers. NPC denotes National People's Congress and CPPCC denotes Chinese People's Political Consultative Conference (CPPCC).

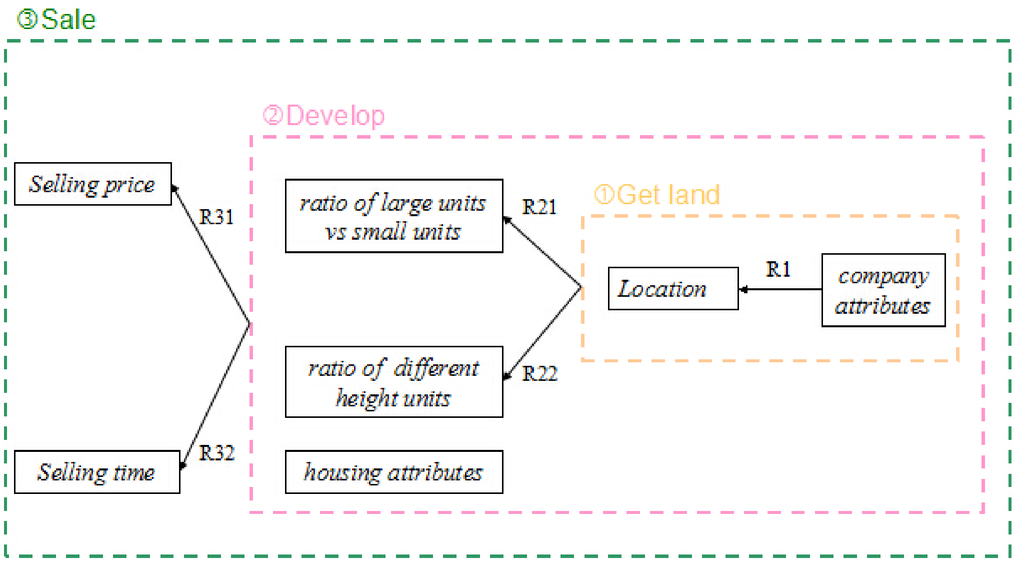


Figure 2 Multi-Step Empirical Process

Step I

In the first step, firms make location choices. As consumer demand for housing differs across locations, developers would have different willingness to pay for land slots in various regions or "zones" in Beijing. Because land prices vary across zones within Beijing, it is also possible that the financial conditions could constrain the locational choice. We, therefore, include the financial condition as a crucial empirical determinant of that decision. Implicitly, this formulation assumes that financial strength (or financial constraint) could impact land acquisition. We observe "location anchoring" of developers, which means that among 64 listed firms in our dataset, 71.88% of them choose to develop projects in only one district during our sampling period. Only two firms in our sample invest in more than two regions in Beijing. Thus, instead of diversifying their investments, most developers display strong "locational preference" and tend to "focus" on specific areas.[11] This fact may be due to government regulations, or developers' preference, or that most developers are so financially constrained that they cannot afford to develop more than one project within Beijing. In any case, we use a multiple logit model as follows.[12]

$$ln\frac{P(region_{it}=m)}{P(region_{it}=n)}=\beta_0+\beta_1 financial_{it}+\beta_2 financial_{-it}+control_{it}+\varepsilon_{it}$$

[11] Generally, location choice reflects both financial status and the inherent attribute of the land. Hence, a conditional logit model is more favored to combine the information on both sides. However, due to the phenomenon of "location anchoring," we cannot separately identify the pure effect of regional-macroeconomic variables from the firm's financial status. Therefore, we omit the macroeconomic variables in the first step. We include the macroeconomic variables in the regressions in Step 2 and Step 3 to control the impact on project design and pricing-timing mechanism.

[12] It has been suggested to us that the land heterogeneity could be embedded in the location choice. Consider instead that different developers have different projects (un-observed) in mind. Then, "given" the characteristics of land, the developer will decide whether a particular piece of land would "fit-in" those project plans, and if that piece of land does, the developer will attempt to acquire it. Hence, there might be an endogenous issue in location choice and project design. This problem has been studied with the Principal Component Analysis and Propensity Score Method by some authors. We nevertheless use the current "recursive" empirical strategy instead. The reasons are clear. First, to complement existing studies, it may be interesting to use an alternative approach to examine whether specific findings still stand.

Moreover, most land characteristics are dummy variables based on subjective classification; the synthesized index could lose robustness. It seems to us that "project design" could be changed significantly when the regulations suddenly change. And there are examples reported in the media. On the other hand, whether a piece of land with specific characteristics is available or not seems to be out of the control for most, if not all, real estate developers.

where $financial_{it}$ denotes the financial conditions of developers i in period t. $control_{it}$ refers to the year dummies of transaction. We also control the firm and year-month fixed effect, and the standard error is clustered at the project level.[13] $financial_{-i}$ denotes the weighted financial conditions of the developer's local competitors. More specifically, for each developer, $i = 1,2, \ldots$, we calculate $financial_{-it}$ using two different weighting methods. The first method is value-based weighting, $\omega_{it}^2 = V_{it}/V_t$, where V_{it} is the total value of housing units sold by developer i in period *t,* and $V_t = \sum_i V_{it}$ is the total value of transactions in period *t*. Thus, developers who sell less but more expensive units could carry a higher weight than those who trade more affordable units in the index. The second method is transaction-based weighting, $\omega_{it}^1 = N_{it}/N_t$, where N_{it} is the number of housing units sold by developer *i* in period *t,* and $N_t = \sum_i N_{it}$ is the total number of transactions in period *t*. Thus, developers that are associated with more dealings would get more weight in $financial_{-i}$.

Step II

The second step is to investigate the determinants of residential design by a structural model. As "design" is a multi-dimensional subject, and given the data availability, we can only focus on the building height and unit area as proxies of the developer's project design. However, for a specific land with a given land area, the average floor and unit area of a given project are endogenously determined due to the FAR (Floor Area Ratio) limit and Building Height Restriction.[14] We apply three-stage least square (3SLS) to estimate the simultaneous equation system. More specifically, the empirical model is shown as follows.

Stage 1

$$\begin{aligned} pro\_floor_{irt} &= \alpha_{10} + \alpha_{11} financial_{irt} + \alpha_{12} financial_{-irt} + \alpha_{13} X_{irt} + \alpha_{14} Y_{1irt} \\ &\quad + control2_{irt} + \delta_{1irt} \\ unit\_area_{irt} &= \alpha_{20} + \alpha_{21} financial_{irt} + +\alpha_{22} financial_{-irt} + \alpha_{23} X_{irt} + \alpha_{24} Y_{2irt} \\ &\quad + control2_{irt} + \delta_{2irt} \end{aligned}$$

where pro_floor_{irt} and $unit\_area_{irt}$ represents the building's total floors and the average area (squared meters) of the project developed by developer i in region r during period t. $financial_{-irt}$ is the weighted financial conditions of the developer i's local competitors in region r and period t. X_{irt} includes macroeconomic variables, which is common to all regions, and region-specific variables,[15] as well as the project's location attributes, such as the distance to CBD, the nearest subway station, hospitals, and schools. Y_{1irt} and Y_{2irt} are exclusive vectors, where Y_{1irt} denotes the project's average floor and Y_{2irt} denotes the total construction area of

[13] Notice that in each real estate development (RED) project, there are several units. Units within the same RED project share the same average building height and average area information. Yet each of them has a potentially unique selling price and selling time. Thus, the variable resid is not independent. We need to control for such clustering in the regression.

[14] According to the Regulation for the Management of Construction Land Plot Ratio issued by Housing and Urban-Rural Development of the People's Republic of China, a developer is forbidden to exceed the ceiling FAR (Floor Area Ratio) and Building Height determined by the urban planning department. Under this regulation, there are two extreme situations. Situation A: build a house with a big unit area but low building height. Situation B: build an apartment with a small unit but high building height. Thus, we could consider that the average unit area and building height being jointly decided.

[15] The macroeconomic variables include GDP, fixed assets investment, and real estate investment. The region-specific variables include the number of subway lines, population structure (permanent, external, registered, move in-out ratio), and employ status (number of labors, registered urban unemployed people). We also include household variables (disposable income per capita, labor compensation per capita, and consumption per capita).

the project. $control2_{irt}$ refers to the time dummy of the transaction as well as the district dummy of the project. After stage 1, we obtain the OLS projects of the endogenous variables $\widehat{unit\_area}_{irt}$ and $\widehat{pro\_floor}_{irt}$.

Stage 2

$$\begin{aligned} pro\_floor_{irt} &= \gamma_{10} + \gamma_{11} financial_{irt} + \gamma_{12} financial_{-irt} + \gamma_{13} X_{irt} + \gamma_{14} Y_{1irt} \\ &\quad + \gamma_{15} \widehat{unit\_area}_{irt} + control2_{irt} + \partial_{1irt} \\ unit\_area_{irt} &= \gamma_{20} + \gamma_{21} financial_{irt} + \gamma_{22} financial_{-irt} + \gamma_{23} X_{irt} + \gamma_{24} Y_{2irt} \\ &\quad + \gamma_{25} \widehat{pro\_floor}_{irt} + control2_{irt} + \partial_{2irt} \end{aligned}$$

We retain the residuals to form a consistent estimate of the covariance matrix of the disturbances.

Stage 3

We then employ GLS estimation with the covariance matrix in Stage 2 as the optimal weighting matrix and analyze the impact of $financial_i$ on project design.

Step III

The last step is to identify the empirical determinants of pricing and timing mechanism by simultaneous estimation. The time difference between listing time and selling time, namely TOM, is involved as the proxy of the selling pace of developers. It reflects the waiting cost of developers and consumers in the searching process. To study the transaction price changes ratio with the monthly extension of TOM, reflecting the difference of the marginal change rate, and reduce the influence of different variance problem, the semi-logarithm Hedonic model is applied for exploring the correlations between TOM and selling price. The endogeneity between TOM and selling price cannot be neglected, as it is a critical tradeoff experienced by the sellers. Previous studies have confirmed that prices TOM. On the other hand, housing transaction price depends not only on its physical properties and location attribute but also on TOM (see Clauretie and Daneshvary, 2009; Yavas, 1992).

To solve the endogenous problem, we estimate another simultaneous equation system as follows.

$$\begin{aligned} lunit\_price_{irt} &= \rho_{10} + \rho_{11} financial_{irt} + \rho_{12} financial_{-irt} + \rho_{13} X_{irt} + \rho_{14} W_{1irt} \\ &\quad + \rho_{15} \widehat{\partial_{1irt}} + \rho_{16} TOM_{irt} + control2_{irt} + \omega_{irt} \\ TOM_{irt} &= \rho_{20} + \rho_{21} financial_{irt} + \rho_{22} financial_{-irt} + \rho_{23} X_{irt} + \rho_{24} W_{2irt} + \rho_{25} \widehat{\partial_{2irt}} \\ &\quad + \rho_{26} lnprice_{irt} + control2_{irt} + \omega_{irt} \end{aligned}$$

where $lunit_price_{irt}$and TOM_{irt} represents the unit transaction price (per square meters) and the time on market (in days) of the unit located in the project developed by developer i in region r during period t. W_{1irt} and W_{2irt} are a pair of exclusive vectors. W_{1irt} denotes information on the unit level, which includes the floor and area of the unit. In contrast, W_{2irt} indicates information on the project level, which includes the project's average floor and total construction area of the project. To get more consistent estimates of pricing-timing mechanism and firm's financial status variables, we involve both of the estimated residual terms in step two ($\widehat{\partial_{1\iota rt}}$ and $\widehat{\partial_{2\iota rt}}$) together with other explanatory variables into the third step regression. We further employ three stage least square to estimate the structural model.

PCA Process: Financial Status Variables and Macro Variables

We have a long list of explanatory variables. Therefore, the potentially high correlations of explanatory variables in each step of our multi-step procedure cannot be ignored. In the appendix, we show that many of our variables are significantly correlated to one another. These high correlations are more frequently found among the financial status indicators and macroeconomic variables. Such multi-collinearity problem might induce distortions in our estimation or the interpretations of the results. To tackle this problem, we follow the literature to adopt the principal component analysis (PCA) (Leung et al., 2006). As a statistical procedure, PCA transforms the original correlated variables into a set of orthogonal variables called the principal components (PC).

Moreover, we can attribute to each PC the share of the total variations of the original set it causes. In the usual practice, researchers focus on the few PCA that account for most of the original data variations. Hence, PCA can effectively mitigate the multi-collinearity problem and reduce the dimensionality of the right-hand-side variables simultaneously (Huang et al., 2015; Jolliffe, 2005). In our study, we select the high-correlated variables to establish a scandalized matrix Z ($Z = [z_{ij}]_{n\times a}$, where n denotes the number of residential unit samples, while a indicates the variable size). Then, we calculate the correlation matrix R of standardized matrix Z. Solving the eigen-equation ($|\mathrm{R} - \lambda I_a| = 0$), we obtain the eigenvalue (λ) and eigenvector (b), and determine the number of principal components (m). We get the value of principal components by calculating $Comp_{iq} = Z_i^T b_q$ ($q = 1,2, \dots, m$).

PCA is applied twice in our paper. First, we extract principal components of financial condition. The calculated eigenvalues and eigenvectors of principal components process in each step are shown in Table 2a and Table 2b. In 11 raw proxy variables of booked and un-booked financial status indicators, the PCA process helps us extract five principal components. We label them as *profitability*, *liability*, *liquidity*, *PClocal*, and *PCcentral*, as each of the PC is strongly correlated to a different set of variables.

Table 2a Principal Components of Financial Variables (Eigenvalue and Covariance Proportion)

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	**2.13509**	0.574262	0.1941	0.1941
Comp2	**1.56083**	0.161999	0.1419	0.336
Comp3	**1.39883**	0.14423	0.1272	0.4632
Comp4	**1.2546**	0.217235	0.1141	0.5772
Comp5	**1.03736**	0.229915	0.0943	0.6715
Comp6	0.807449	0.034322	0.0734	0.7449
Comp7	0.773127	0.025053	0.0703	0.8152
Comp8	0.748074	0.084515	0.068	0.8832
Comp9	0.663559	0.200298	0.0603	0.9435
Comp10	0.463261	0.305437	0.0421	0.9857
Comp11	0.157824	.	0.0143	1

Table 2b Principal Components of Financial Variables (Eigenvectors)

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Unexplained
stdcurrt	0.0431	0.0418	0.2395	0.1332	**-0.8382**	0.162
stdintcvr	-0.1247	0.0048	0.3538	**0.5138**	0.1638	0.4325
stddbastrt	0.0057	0.4574	0.0722	**-0.4688**	0.0467	0.3881
stdperatio	0.0769	0.0225	**0.5281**	0.3599	0.2972	0.3424
stdebitda	0.1073	-0.1029	**0.4693**	-0.5115	0.1547	0.2977
stdnpc_cppcc	0.1164	**0.5626**	-0.2835	0.137	0.1333	0.3227
stdofficial_1_2	-0.0177	**-0.5721**	-0.3657	0.0231	0.1356	0.2816
stdofficial_3_4	**0.3935**	0.0602	-0.2794	0.2253	-0.0865	0.4831
stdofficial_5_6	**0.5327**	-0.0254	0.0965	0.0067	-0.2166	0.3314
stdofficial_7_8	**0.4514**	0.1952	-0.0541	0.1309	0.2444	0.4179
stdofficial_9_12	**0.5558**	-0.3029	0.0933	-0.1415	0.077	0.1538

Note: All variables have been standardized to eliminate the influence of dimensionality. Bold types indicate that this weight is the highest among Comp1, Comp2 and Comp3.

We test the correlation between our five financial status indicators with some integration index constructed in the existing literature. Financial dependency, which is a measurement of the demand in external finance, could be regarded as a combined measurement of scale, cashibility, solvency, and the profitability of developers (Claessens et al., 2012). Following the methodology developed by Rajan and Zingales (1998) and Claessens et al. (2012), we calculate the financial independence index as an alternate proxy explaining changes in the ex-post "performance" of real estate firms (i.e., profits, sales, and investments). Two measures of a firm's intrinsic dependence on external finance are employed in the robustness tests, namely intrinsic dependence on external finance for investment (FD_INV_i) and intrinsic dependence on external finance for working capital (FD_WK_i).[16] The data is collected from the China Stock Market Trading Database (CSMAR database), which provides the listed firm's financial status together, including capital expenditures, cash flows, inventories, etc. We merge CSMAR quarterly information with our developer database and construct the following approximations of a firm's intrinsic dependence on external finance for capital investment:

[16] There are other metrics for a firm's reliance on external finance, or the extent of the firm may be financially constrained that are used in the literature. However, we are constrained by data availability to employ those metrics.

$$FD\_INV_{it} = \frac{capital\ expenditures_i - cash\ flow_i}{capital\ expenditures_i}$$

$$FD\_WK_i = 365 * (\frac{inventories_i - account\ payables_i}{cost\ of\ goods\ sold_i} + \frac{account\ receivables_i}{total\ sales_i})$$

According to Table 2c, our five indicators of financial status show some correlations with traditional definitions. However, correlations are not exceptionally high. Notice that our financial status variables include the booked variables like profitability, liability, and liquidity and some un-booked variables like political connections. Thus, our indicators could contain more abundant information on corporate financial status than the current literature's singularized index. We use FD_INV and FD_WK as alternative measurement of financial position and compare the results with our findings in the robustness check.

Table 2c Correlation between Our Measurement and Financial Dependence Identified by Literature

Variable	FD_INV	FD_WK	HFD_WK
profitability	-0.0745	-0.2287	-0.0231
liability	-0.004	-0.018	0.026
liquidity	0.1075	-0.0449	-0.0261
pccentral	0.0143	0.3701	0.1872
pclocal	-0.0375	-0.3056	-0.055

Note: *FD_INV* denotes "intrinsic dependence on external finance for investment," while *FD_WK* denotes "intrinsic dependence on external finance for working capital." *HFD_WK* denotes the "intrinsic dependence on external finance for working capital" calculated using history information (i.e., an average of *FD_WK* in the past three years). Due to the data deficiency before 2007, we could not calculate the historical "actual firm use of external finance for investment (*FD_INV*)." As an alternative test, historical information of "actual firm use of external finance for working capital (*FD_WK*)" is used as a comparison.

Second, we extract components of local and macroeconomic information. The calculated eigenvalues and eigenvectors of the principal components process in each step are shown in Table 3a and Table 3b. In 18 raw proxy variables of geological and macroeconomic status, the PCA process helps us to extract three principal components macro-fundamental indicator (*macro*), geography indicator (*geography*), and household indicator (*micro*).

Table 3a Principal Components of Macro Variables (Eigenvalue and Covariance Proportion)

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	11.4155	8.01925	0.6008	0.6008
Comp2	3.39622	2.18151	0.1787	0.7796
Comp3	1.21471	0.265008	0.0639	0.8435
Comp4	0.949698	0.455094	0.05	0.8935
Comp5	0.494603	0.0601661	0.026	0.9195
Comp6	0.434437	0.189129	0.0229	0.9424
Comp7	0.245308	0.0468846	0.0129	0.9553
Comp8	0.198424	0.0250695	0.0104	0.9657
Comp9	0.173354	0.0489089	0.0091	0.9749
Comp10	0.124445	0.0149295	0.0065	0.9814
Comp11	0.109516	0.0207766	0.0058	0.9872
Comp12	0.0887391	0.0136461	0.0047	0.9918
Comp13	0.075093	0.0321952	0.004	0.9958
Comp14	0.0428978	0.0226082	0.0023	0.998
Comp15	0.0202896	0.0114481	0.0011	0.9991
Comp16	0.00884153	0.00347079	0.0005	0.9996
Comp17	0.00537074	0.00302876	0.0003	0.9999
Comp18	0.00234198	0.00209627	0.0001	1

Table 3b Principal Components of Macro Variables (Eigenvectors)

Variable	Comp1	Comp2	Comp3	Unexplained
d_cbd	-0.1412	**0.4355**	0.0608	0.1339
d_sub	-0.1838	**0.2678**	0.067	0.3771
d_h1	-0.1307	**0.4477**	0.1133	0.1201
d_middle	-0.1698	**0.3898**	0.1098	0.1539
d_high	-0.1422	**0.4441**	0.1314	0.0916
n_subway	**0.2667**	0.0764	-0.0826	0.1805
perma_pop	**0.2686**	0.1888	-0.2127	0.03029
exeter_pop	**0.2538**	0.2203	-0.2277	0.06634
registered_pop	**0.2819**	0.1251	-0.1468	0.03981
move_in_out	**0.2133**	0.0718	-0.063	0.4718
no_employed	**0.2795**	0.1357	-0.0549	0.06444
no_unemployed	**0.2613**	0.0391	-0.1024	0.2236
gdp	**0.2853**	0.1351	0.0463	0.02904
fix_investment	**0.2787**	0.123	-0.0721	0.07835
real_estate_investment	**0.2711**	0.089	-0.0796	0.1481
personal_disposable_income	0.1988	-0.0301	**0.7015**	0.06304
personal_consumption	0.2504	-0.1186	**0.4232**	0.07422
personal_income_employed	0.2577	0.045	**0.349**	0.1309

Note: All variables have been standardized to eliminate the influence of dimensionality. Bold types indicate that this weight is the highest among Comp1, Comp2 and Comp3.

Following the correlation test after the PCA process, all the high correlations are successfully eliminated (see Appendix). Indeed, since PCA is easily affected by the relative scaling of the original variables, we also employ the Kaiser-Meyer-Olkin (KMO) test to measure of sampling adequacy and the applicability of the PCA process in each step. We pass the test, and the details are omitted due to limited space.

4 Empirical Results

This section presents the empirical results. The presentation follows the natural order: results from the pre-marketing stage first (i.e., the location choice and project design), followed by results from the marketing stage (i.e., pricing and timing decisions). Then we present a diagnosis of the drivers in the marketing stage. We will also provide several robustness checks.

4.1 Pre-Marketing Stage

In this sub-section, we present the results in both the location sorting and the project design. Table 4a shows the impact of the developer's financial status on project location choice.

Table 4a Regression of Developer's Financial Status and Location Selection

	(1) Region 2/ Region 1	(2) Region 3/ Region 1	(3) Region 4/ Region 1	(4) Region 3/ Region 2	(5) Region 4/ Region 2	(6) Region 4/ Region 3
Value-based weighting						
profitability	0.913***	-0.145	0.571	-1.057***	-0.341	0.716
	(0.187)	(0.217)	(0.475)	(0.136)	(0.440)	(0.446)
liability	-0.0330	0.558***	1.538**	0.591***	1.571**	0.980
	(0.156)	(0.178)	(0.644)	(0.134)	(0.630)	(0.627)
liquidity	-1.650***	-0.105	-0.0492	1.545***	1.601***	0.0560
	(0.239)	(0.266)	(0.433)	(0.148)	(0.372)	(0.351)
pccentral	0.706***	-0.798***	-0.985**	-1.504***	-1.691***	-0.187
	(0.128)	(0.148)	(0.406)	(0.106)	(0.389)	(0.396)
pclocal	-0.769***	-0.650***	0.209	0.119***	0.978***	0.860***
	(0.0800)	(0.0860)	(0.311)	(0.0409)	(0.302)	(0.303)
profitability$_{-i}$	-0.376**	0.637***	0.595	1.013***	0.971**	-0.0419
	(0.183)	(0.212)	(0.457)	(0.133)	(0.422)	(0.427)
liability$_{-i}$	-0.504***	-1.113***	-2.321***	-0.609***	-1.817***	-1.208**
	(0.151)	(0.173)	(0.626)	(0.131)	(0.612)	(0.609)
liquidity$_{-i}$	0.236	-0.909***	-1.173***	-1.145***	-1.409***	-0.264
	(0.234)	(0.261)	(0.393)	(0.145)	(0.326)	(0.303)
pccentral$_{-i}$	-1.065***	-0.525***	-2.069***	0.541***	-1.004***	-1.544***
	(0.125)	(0.146)	(0.383)	(0.105)	(0.365)	(0.373)
pclocal$_{-i}$	0.396***	0.391***	0.354	-0.00433	-0.0413	-0.0369
	(0.0793)	(0.0852)	(0.296)	(0.0407)	(0.286)	(0.287)
Transaction-based weighting						
profitability	0.925***	-0.135	0.566	-1.060***	-0.359	0.701
	(0.189)	(0.218)	(0.484)	(0.135)	(0.448)	(0.453)
liability	-0.0604	0.553***	1.489**	0.614***	1.550**	0.936
	(0.160)	(0.183)	(0.656)	(0.137)	(0.641)	(0.637)
liquidity	-1.627***	-0.0586	-0.0206	1.568***	1.606***	0.0380
	(0.241)	(0.269)	(0.440)	(0.150)	(0.378)	(0.358)
pccentral	0.728***	-0.790***	-0.951**	-1.519***	-1.679***	-0.161
	(0.129)	(0.151)	(0.409)	(0.109)	(0.392)	(0.399)
pclocal	-0.766***	-0.646***	0.195	0.120***	0.961***	0.840***
	(0.0806)	(0.0865)	(0.315)	(0.0410)	(0.305)	(0.306)
profitability$_{-i}$	-0.387**	0.628***	0.601	1.015***	0.988**	-0.0268
	(0.185)	(0.214)	(0.465)	(0.133)	(0.430)	(0.435)
liability$_{-i}$	-0.478***	-1.109***	-2.274***	-0.631***	-1.796***	-1.165*
	(0.155)	(0.178)	(0.638)	(0.134)	(0.624)	(0.620)
liquidity$_{-i}$	0.213	-0.955***	-1.203***	-1.168***	-1.415***	-0.248
	(0.236)	(0.263)	(0.399)	(0.146)	(0.333)	(0.310)
pccentral$_{-i}$	-1.087***	-0.532***	-2.103***	0.555***	-1.015***	-1.571***
	(0.127)	(0.148)	(0.386)	(0.107)	(0.300)	(0.305)
pclocal$_{-i}$	0.393***	0.387***	0.368	-0.00575	-0.350	-0.210
	(0.0799)	(0.0858)	(0.299)	(0.0409)	(0.338)	(0.339)
Obs	55170	55170	55170	55170	55170	55170

Note: This table presents the impact of a firm's financial status on the probability project's location choice (across Region 1, Region 2, Region 3 and Region 4 defined in Table 3), controlling for *year fixed effect* and *project's cluster effects* on 55170 transaction records. Standard errors are in parentheses: *p<0.10, **p<0.05, *** p<0.01.

We find developers with higher profitability locate their projects within ring 5, as there is a tradeoff between land price and housing demand. Real estate development in the inner city is expensive, as both the land price and demolition compensation are high. On the other hand, commuting time in suburban areas, such as in ring 6, is long, and public facilities such as hospitals and schools tend to be under-supplied. The housing demand in those areas is uncertain. Our empirical results indicate that developers with high profitability prefer inner-city locations, leaving the risky development to less profitable competitors.

Developers with higher liquidity values, i.e., better debt-paying ability, prefer projects located inside ring 2. This result is also intuitive. First, the land price within ring 2 is exceptionally high. Moreover, unexpected liquidity needs, for instance, from other projects, may emerge in the development process. Thus, other things being equal, developers with better financial strength and capital turnover ability would locate in this area. We also find that developers with higher liability will show a higher possibility to choose the land locating outside ring 5 and ring 6. As we have explained, the development projects in sub-urban areas are riskier as the housing demand may be more volatile. With limited liability, real estate developers with more debt may find themselves optimal to choose risky projects.[17]

Regarding un-booked financial status (political connections on both central and local levels), we find that developers with more robust relationships with the central government will be more likely to develop projects in inner-city zones. In contrast, developers with tighter local political connections will be more likely to develop projects in outer city zones, primarily suburban areas. In other words, developers with lower liquidity, higher liability, and higher central political connections favor areas located inside ring 2 and ring 5. In contrast, sites located in suburban areas are more favored by developers with more debt burden and higher local political connections. Our results are robust to changing the value-based weighting to transaction-based weighting.

It is noteworthy that, developer's location choice may influence developers' financial status. We then replace the indicators with historical information of financial and political connection status back to two years before the listing time as a robustness check.[18] Table 4b shows that the results are similar, which suggests some degree of robustness of our results.

[17] For instance, see Vereshchagina and Hopenhayn (2009) for related analysis.

[18] Unlike western countries, the timing of land development is considerably shorter in China. Based on the residential land parcel transaction data from the Beijing Municipal Bureau of Land and Resources, the average duration from land acquisition to housing presale is around 10 months, while the duration form land acquisition to construction completion is still less than 20 months from 2003 to 2015 (Yang and Wu, 2018). Thus, the current project's land acquisition process is less likely to interfere with the developer's financial information two years ago.

Table 4b Regression of Developer's Financial Status and Location Selection (Historical Information)

	(1) Region 2/ Region 1	(2) Region 3/ Region 1	(3) Region 4/ Region 1	(4) Region 3/ Region 2	(5) Region 4/ Region 2	(6) Region 4/ Region 3
Value-based weighting						
history_profitability	0.484***	-0.110	0.703***	-0.594***	0.219	0.813***
	(0.113)	(0.117)	(0.180)	(0.0372)	(0.154)	(0.154)
history_liability	-0.297	-0.914***	-2.228***	-0.616***	-1.931***	-1.314***
	(0.209)	(0.213)	(0.342)	(0.0581)	(0.278)	(0.276)
history_liquidity	0.824***	1.102***	1.564***	0.278***	0.739***	0.461**
	(0.117)	(0.119)	(0.212)	(0.0260)	(0.181)	(0.181)
history_pccentral	-0.142	-1.362***	-2.781***	-1.220***	-2.639***	-1.419***
	(0.145)	(0.166)	(0.347)	(0.104)	(0.329)	(0.324)
history_pclocal	-0.768***	-0.500***	-1.352***	0.268***	-0.584**	-0.852***
	(0.0917)	(0.0993)	(0.277)	(0.0455)	(0.266)	(0.267)
history_profitability$_{-i}$	-0.182	-0.0220	2.140***	0.160***	2.321***	2.162***
	(0.114)	(0.119)	(0.178)	(0.0393)	(0.153)	(0.153)
history_liability$_{-i}$	1.911***	2.945***	2.283***	1.034***	0.371	-0.663**
	(0.213)	(0.217)	(0.334)	(0.0603)	(0.266)	(0.264)
history_liquidity$_{-i}$	0.238*	0.102	-1.284***	-0.136***	-1.523***	-1.387***
	(0.127)	(0.130)	(0.252)	(0.0342)	(0.223)	(0.223)
history_pccentral$_{-i}$	-0.417***	-0.487***	-0.247	-0.0699	0.170	0.240
	(0.143)	(0.164)	(0.332)	(0.103)	(0.314)	(0.309)
history_pclocal$_{-i}$	0.443***	0.234**	1.136***	-0.209***	0.693***	0.902***
	(0.0915)	(0.0991)	(0.274)	(0.0456)	(0.263)	(0.264)
Transaction-based weighting						
history_profitability	0.485***	-0.107	0.693***	-0.592***	0.207	0.800***
	(0.113)	(0.117)	(0.181)	(0.0373)	(0.155)	(0.155)
history_liability	-0.314	-0.931***	-2.219***	-0.617***	-1.905***	-1.288***
	(0.210)	(0.214)	(0.343)	(0.0582)	(0.278)	(0.276)
history_liquidity	0.823***	1.102***	1.579***	0.278***	0.755***	0.477***
	(0.117)	(0.119)	(0.211)	(0.0260)	(0.180)	(0.180)
history_pccentral	-0.136	-1.356***	-2.776***	-1.220***	-2.640***	-1.421***
	(0.146)	(0.167)	(0.350)	(0.104)	(0.332)	(0.327)
history_pclocal	-0.770***	-0.502***	-1.357***	0.267***	-0.587**	-0.854***
	(0.0924)	(0.1000)	(0.280)	(0.0456)	(0.268)	(0.270)
history_profitability$_{-i}$	-0.182	-0.0244	2.154***	0.158***	2.336***	2.178***
	(0.114)	(0.119)	(0.179)	(0.0393)	(0.154)	(0.154)
history_liability$_{-i}$	1.931***	2.967***	2.275***	1.035***	0.343	-0.692***
	(0.214)	(0.218)	(0.335)	(0.0605)	(0.267)	(0.265)
history_liquidity$_{-i}$	0.239*	0.103	-1.303***	-0.136***	-1.543***	-1.406***
	(0.127)	(0.130)	(0.252)	(0.0343)	(0.222)	(0.222)
history_pccentral$_{-i}$	-0.423***	-0.493***	-0.253	-0.0705	0.170	0.241
	(0.144)	(0.165)	(0.336)	(0.103)	(0.317)	(0.312)
history_pclocal$_{-i}$	0.445***	0.237**	1.142***	-0.208***	0.697***	0.905***
	(0.0922)	(0.0998)	(0.277)	(0.0457)	(0.265)	(0.267)
Obs	49618	49618	49618	49618	49618	49618

Note: This table presents the impact of firm's financial status on the probability project's location choice, *controlled for year fixed effect and project's cluster effects* on 49618 transaction record (we lose some observations due to limitations in historical information). Standard errors are in parentheses: *p<0.10, **p<0.05, *** p<0.01.

Recall that the second stage of real estate development concerns the project design. Here we present the results relating to the project design and the financial conditions of the developers. Our econometric approach considers that the simultaneous choices on the unit area and project height are endogenous. Table 5 exhibits the crucial determinates of project dual decision in building height and unit area design. Column (1) and (3) exhibit the result using simultaneous estimation under two weighting systems. We find that after controlling for the simultaneity issues, the coefficients of profitability and liability are significantly positive in both regressions. *Companies with higher financial solvency and profitability tend to build larger and high-rise residential units.* Companies with a smaller scale, lower financial solvency, and profitability are more inclined to produce small-sized and medium-rise residential units. These findings are consistent with *the conjecture that larger and high-rise units are more profitable, but may also be riskier, as fewer people would be able to afford them.* Thus, developers need to have "precautionary saving" to build those units and be profitable. Further, there is a significant negative interaction between the average unit area and building height, consistent with the construction constraints above-mentioned.

Table 5 Regression of Developer's Financial Status and Project Design

	value -based weighting		transaction-based weighting	
	(1)	(2)	(3)	(4)
	lunit_area	*lpro_floor*	*lunit_area*	*lpro_floor*
lpro_floor	-0.246***		-0.246***	
	(0.00803)		(0.00803)	
lunit_area		-5.613***		-5.614***
		(0.435)		(0.435)
profitability	0.193***	1.085***	0.193***	1.093***
	(0.0164)	(0.127)	(0.0164)	(0.128)
liability	0.0427***	0.249***	0.0427***	0.260***
	(0.0165)	(0.0942)	(0.0165)	(0.0964)
liquidity	-0.0247	-0.162*	-0.0247	-0.157*
	(0.0160)	(0.0908)	(0.0160)	(0.0915)
pccentral	0.0733***	0.453***	0.0733***	0.461***
	(0.0145)	(0.0913)	(0.0145)	(0.0927)
pclocal	0.0147**	0.0880**	0.0147**	0.0912**
	(0.00667)	(0.0386)	(0.00667)	(0.0388)
$profitability_{-i}$	-0.132***	-0.753***	-0.132***	-0.761***
	(0.0160)	(0.110)	(0.0160)	(0.111)
$liability_{-i}$	-0.0312*	-0.164*	-0.0312*	-0.175*
	(0.0160)	(0.0902)	(0.0160)	(0.0924)
$liquidity_{-i}$	0.00107	0.0278	0.00107	0.0224
	(0.0154)	(0.0865)	(0.0154)	(0.0873)
$pccentral_{-i}$	-0.0514***	-0.300***	-0.0514***	-0.308***
	(0.0142)	(0.0833)	(0.0142)	(0.0847)
$pclocal_{-i}$	0.0102	0.0557	0.0102	0.0526
	(0.00662)	(0.0372)	(0.00662)	(0.0373)
geography	0.0385***	0.186***	0.0385***	0.186***
	(0.00184)	(0.0127)	(0.00184)	(0.0127)
macro	-0.00239	-0.0113	-0.00239	-0.0114
	(0.00234)	(0.0132)	(0.00234)	(0.0132)
micro	-0.0495***	-0.181***	-0.0495***	-0.181***
	(0.00608)	(0.0309)	(0.00608)	(0.0309)
Obs	55170	55170	55170	55170

Note: This table presents the impact of a firm's financial status on the project's design (building height and unit area), *controlled for region fixed effect, year fixed effect and project's cluster effects* on 55170 transaction records. Standard errors are in parentheses: *p<0.10, **p<0.05, *** p<0.01.

4.2 Marketing Stage

At the marketing stage, the housing units are completed. The developers now decide at what price and at what pace the units be sold. As a preview of the results, we find strong evidence that liquidity demand influences the simultaneous decision of price of sale and TOM, consistent with previous sections' results. Table 6a exhibits the results on the price, and Table 6b displays the results on the TOM. Our results confirm the expected tradeoff between the two variables.

Table 6a Regression of Developer's Financial Status and the effect of TOM on prices

	(1) 3 Stage Least Squares	(2) TOM Quintile (≤0.25)	(3) TOM Quintile (0.25 to 0.5)	(4) TOM Quintile (0.5 to 0.75)	(5) TOM Quintile (>0.75)
Value-based weighting					
TOM	-0.000726	0.160***	-0.142***	-0.140***	0.0140***
	(0.000784)	(0.0315)	(0.0405)	(0.0198)	(0.00233)
$\widehat{\partial_\iota}$	-0.308***	-0.581***	-0.424***	-0.208***	-0.108***
	(0.00723)	(0.0161)	(0.0117)	(0.0169)	(0.0189)
profitability	0.0307**	-0.326***	-0.0989**	0.105***	0.0246
	(0.0123)	(0.0589)	(0.0386)	(0.0366)	(0.0273)
liability	0.0234*	-0.191***	-0.133**	0.00142	-0.0341
	(0.0124)	(0.0445)	(0.0528)	(0.0424)	(0.0251)
liquidity	0.0536***	-0.00850	-0.0410**	0.0954**	0.147***
	(0.0113)	(0.0545)	(0.0200)	(0.0400)	(0.0503)
pccentral	0.00579	-0.0197	0.0990***	-0.0349	-0.0547*
	(0.0102)	(0.0317)	(0.0220)	(0.0324)	(0.0282)
pclocal	-0.00236	-0.00789	0.0317***	0.0687***	-0.100***
	(0.00481)	(0.0101)	(0.00918)	(0.0100)	(0.0148)
$profitability_{-i}$	-0.00957	0.296***	0.137***	-0.0999***	0.0196
	(0.0121)	(0.0583)	(0.0381)	(0.0358)	(0.0265)
$liability_{-i}$	-0.0298**	0.147***	0.162***	0.000697	0.0395
	(0.0121)	(0.0431)	(0.0518)	(0.0413)	(0.0243)
$liquidity_{-i}$	-0.0552***	0.0288	0.0498**	-0.0891**	-0.228***
	(0.0108)	(0.0537)	(0.0194)	(0.0388)	(0.0476)
$pccentral_{-i}$	-0.0298***	-0.00759	-0.155***	0.0494	0.0628**
	(0.00999)	(0.0314)	(0.0218)	(0.0338)	(0.0275)
$pclocal_{-i}$	0.00264	0.00578	-0.0350***	-0.0602***	0.120***
	(0.00484)	(0.00988)	(0.00973)	(0.0103)	(0.0143)

Transaction-based weighting					
TOM	-0.000721	0.160***	-0.142***	-0.140***	0.0140***
	(0.000784)	(0.0315)	(0.0405)	(0.0198)	(0.00233)
$\widehat{\partial_\iota}$	-0.308***	-0.581***	-0.424***	-0.208***	-0.108***
	(0.00723)	(0.0161)	(0.0117)	(0.0169)	(0.0189)
profitability	0.0309**	-0.326***	-0.100***	0.103***	0.0225
	(0.0124)	(0.0592)	(0.0387)	(0.0368)	(0.0278)
liability	0.0243*	-0.189***	-0.135**	0.000271	-0.0394
	(0.0127)	(0.0456)	(0.0530)	(0.0427)	(0.0257)
liquidity	0.0537***	-0.00943	-0.0417**	0.0929**	0.159***
	(0.0114)	(0.0546)	(0.0200)	(0.0403)	(0.0516)
pccentral	0.00507	-0.0201	0.0999***	-0.0360	-0.0631**
	(0.0103)	(0.0319)	(0.0220)	(0.0326)	(0.0291)
pclocal	-0.00281	-0.00827	0.0317***	0.0682***	-0.104***
	(0.00483)	(0.0101)	(0.00918)	(0.0101)	(0.0149)
$profitability_{-i}$	-0.00973	0.297***	0.139***	-0.0975***	0.0218
	(0.0122)	(0.0586)	(0.0382)	(0.0360)	(0.0271)
$liability_{-i}$	-0.0306**	0.145***	0.165***	0.00179	0.0449*
	(0.0123)	(0.0442)	(0.0519)	(0.0416)	(0.0249)
$liquidity_{-i}$	-0.0553***	0.0297	0.0505***	-0.0868**	-0.240***
	(0.0109)	(0.0539)	(0.0195)	(0.0391)	(0.0489)
$pccentral_{-i}$	-0.0291***	-0.00723	-0.156***	0.0506	0.0711**
	(0.0101)	(0.0316)	(0.0218)	(0.0340)	(0.0283)
$pclocal_{-i}$	0.00310	0.00616	-0.0350***	-0.0597***	0.124***
	(0.00486)	(0.00989)	(0.00974)	(0.0104)	(0.0145)
Obs	55170	14117	13677	13582	13794

Note: This table presents the impact of a firm's financial status on the pricing-timing mechanism. The dependent variable is *lunit_price*, *controlled for region fixed effect, year fixed effect and project's cluster effects* on 55170 transaction records. Column (1) exhibits the simultaneous regression results in the cohort of the shortest duration of sales (lowest 25% *TOM*). Column (2) exhibits the simultaneous regression results in the cohort of the sub-shortest duration of sales (*TOM* located in the interval 25%-50%). Column (3) exhibits the simultaneous regression results in the cohort of the sub-longest duration of sales (*TOM* located in the interval 50%-75%). Column (4) exhibits the simultaneous regression results in the cohort of the longest duration of sales (highest 25% *TOM*). Standard errors are in parentheses: *p<0.10, **p<0.05, *** p<0.01.

Table 6b Regression of Developer's Financial Status and the effect of price on TOM

	(1) 3 Stage Least Squares	(2) Price Quintile (≤0.25)	(3) Price Quintile (0.25 to 0.5)	(4) Price Quintile (0.5 to 0.75)	(5) Price Quintile (>0.75)
Value-based weighting					
lunit_price	8.311***	0.112***	0.398***	0.139	4.314***
	(0.285)	(0.0358)	(0.0459)	(0.182)	(0.505)
$\widehat{\partial_\iota}$	1.068***	0.0149	0.00969	0.417***	0.0678
	(0.0806)	(0.0114)	(0.00927)	(0.0407)	(0.177)
profitability	0.777***	0.283***	-0.379***	0.104	-0.812*
	(0.275)	(0.0935)	(0.0681)	(0.166)	(0.419)
liability	-1.202***	0.113	-0.377***	-0.249	0.525
	(0.278)	(0.0704)	(0.0979)	(0.191)	(0.386)
liquidity	1.238***	0.154*	-0.136***	0.806***	-1.087
	(0.251)	(0.0861)	(0.0370)	(0.172)	(0.773)
pccentral	0.837***	-0.00538	0.203***	-0.910***	0.943**
	(0.227)	(0.0505)	(0.0389)	(0.122)	(0.433)
pclocal	0.692***	-0.0507***	0.120***	0.00387	-0.806***
	(0.107)	(0.0157)	(0.0158)	(0.0471)	(0.230)
profitability$_{-i}$	-1.292***	-0.342***	0.361***	-0.138	1.200***
	(0.269)	(0.0921)	(0.0673)	(0.162)	(0.406)
liability$_{-i}$	1.217***	-0.134**	0.353***	0.227	-0.713*
	(0.270)	(0.0682)	(0.0960)	(0.186)	(0.373)
liquidity$_{-i}$	-1.092***	-0.0729	0.123***	-0.751***	0.0567
	(0.241)	(0.0853)	(0.0361)	(0.168)	(0.737)
pccentral$_{-i}$	0.271	-0.0235	-0.180***	1.037***	-0.497
	(0.223)	(0.0501)	(0.0385)	(0.119)	(0.423)
pclocal$_{-i}$	-1.240***	-0.00354	-0.139***	0.0759	0.288
	(0.107)	(0.0158)	(0.0162)	(0.0475)	(0.229)
Transaction-based weighting					
lunit_price	8.329***	0.112***	0.398***	0.137	4.326***
	(0.286)	(0.0358)	(0.0459)	(0.182)	(0.505)
$\widehat{\partial_\iota}$	1.064***	0.0149	0.00967	0.417***	0.0645
	(0.0806)	(0.0114)	(0.00927)	(0.0407)	(0.177)
profitability	0.784***	0.285***	-0.379***	0.103	-0.826*
	(0.278)	(0.0940)	(0.0683)	(0.167)	(0.428)
liability	-1.203***	0.112	-0.376***	-0.245	0.580
	(0.284)	(0.0722)	(0.0982)	(0.192)	(0.395)
liquidity	1.243***	0.153*	-0.135***	0.813***	-1.163
	(0.253)	(0.0863)	(0.0371)	(0.173)	(0.794)
pccentral	0.881***	-0.00421	0.202***	-0.917***	1.046**
	(0.230)	(0.0508)	(0.0389)	(0.122)	(0.447)
pclocal	0.717***	-0.0508***	0.120***	0.00357	-0.785***
	(0.108)	(0.0157)	(0.0159)	(0.0472)	(0.233)
profitability$_{-i}$	-1.300***	-0.344***	0.361***	-0.136	1.214***
	(0.272)	(0.0926)	(0.0674)	(0.163)	(0.415)
liability$_{-i}$	1.219***	-0.133*	0.352***	0.224	-0.770**
	(0.276)	(0.0699)	(0.0963)	(0.187)	(0.381)
liquidity$_{-i}$	-1.097***	-0.0725	0.122***	-0.758***	0.135

	(0.244)	(0.0855)	(0.0362)	(0.169)	(0.758)
pccentral$_{-i}$	0.228	-0.0246	-0.179***	1.044***	-0.600
	(0.226)	(0.0504)	(0.0385)	(0.120)	(0.437)
pclocal$_{-i}$	-1.266***	-0.00348	-0.139***	0.0761	0.266
	(0.107)	(0.0158)	(0.0162)	(0.0475)	(0.233)
Obs	55170	13450	14009	13817	13894

Note: This table presents the impact of a firm's financial status on the pricing-timing mechanism. The dependent variable is *TOM*, *controlled for region fixed effect, year fixed effect and project's cluster effects* on 55170 transaction records. Column (1) exhibits the simultaneous regression results in the cohort of the lowest transaction price (lowest 25% *unit_price*). Column (2) exhibits the simultaneous regression results in the cohort of the sub-lowest transaction price (*unit_price* located in the interval 25%-50%). Column (3) exhibits the simultaneous regression results in the cohort of the sub-highest transaction price (*unit_price* located in the interval 50%-75%). Column (4) exhibits the simultaneous regression results in the cohort of the highest transaction price (highest 25% *unit_price*). Standard errors are in parentheses: *p<0.10, **p<0.05, *** p<0.01.

Combining with our previous results, we also find developers with stronger connections central and local government wait a long time on the market. Notice that political connections might signal for Soft Budget Constraint or implicit guarantee. In other words, firms with stronger political relationships might have an extra resource when needed (Faccio, 2006). Therefore, these developers could have more bargaining power and the ability to wait longer. As a mirror image, we find that when the developers with better politically-connected competitors reduce their transaction price and TOM. Since their rivals might have more information on the future policy changes and better resources, developers find it optimal to adopt a "quick sale with discounted price" strategy.

Some casual observations suggest that the relationship between TOM and price might be nonlinear. For instance, financially constrained households are forced to purchase relatively cheap housing units and may not discount much along the time dimension. The "middle class" who can choose housing units of different sizes may be more sensitive to the tradeoff between TOM and price. For affluent households, a budget constraint may be less binding. Instead, they might be more selective regarding characteristics, including the location, the architectural design, even the neighbors, or their peers' perception. These are the considerations from the demand side. On the supply side, recall that the top 10 developers are financially more "adequate" than an average developer. Thus far, all the results presented have also confirmed that the corporate's financial conditions would significantly affect her behavior. Putting these observations together, it may be reasonable to conjecture that the relationship between TOM and price is indeed nonlinear.

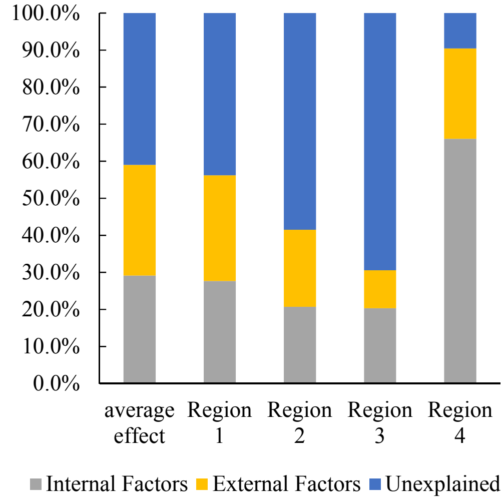
To formally examine this hypothesis, we divide the TOM and transaction price of the unit into for quintiles, respectively (Quintile (≤0.25), Quintile (0.25 to 0.5), Quintile (0.5 to 0.75), and Quintile (>0.75)). According to the comparisons of the different cohort, we find while transaction price, in general, has a positive impact on TOM, TOM has a U-shape impact on the transaction price. This empirical result may be related to the "Fishing Strategy" and "Negative Herding" effect discussed in the literature. Sellers can either sell the house immediately with certainty at the current market price, or fish for a better price by waiting for high-price bidders. This fishing strategy will induce high transaction price co-existence with long TOM (Stein, 1995; Leung and Tse, 2017). Also, potential buyers may regard TOM as a sign of unobserved information like housing quality (Taylor, 1999). Since longer TOM could induce buyer's suspicion of a flaw in the house, the seller may have an incentive to post an inordinately low initial price to make an early sale and avoid consumer "herding." Our results show that the negative herding effect is associated with the initial transaction in line with existing literature, while the fishing effect is reflected in longer waiting times. Similarly, the impact on price on TOM is much weaker at the highest Quintile, suggesting at the high-end market, factors other than price may be more critical in determining the Time-On-the-Market of housing units.

4.3 Empirical Determinants of the Developers' behavior at the Marketing Stage

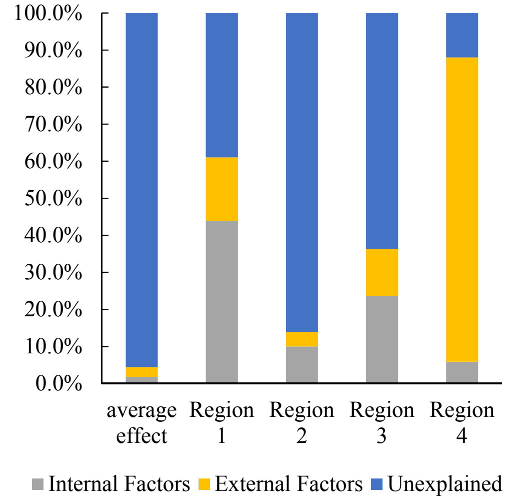
We begin with the observation that, in an oligopolistic market, firms would respond to internal factors (such as liability, liquidity, and political connection) and external factors (such as the pricing behaviors of rival firms). Developers who have higher liquidity levels and stronger political relationships with the local government can afford a slower pace of sales and sell their property at higher transaction prices. Developers who have the limited risk-bearing capacity and faces inventory financing constraints and debt service obligations may be forced to sell at lower prices to accelerate the sales, which is often specified as the liquidity constraint effect (Chevalier and Scharfstein, 1995; White, 1992). To investigate such possibility, in this section, we first compare the different driven forces of internal and external financial status by calculating the marginal effect of latent variables, i.e., internal financial status and external financial status. Figure 3 provides a visualization.

On average, we find that our empirical framework can explain about 60% of the developers' pricing behavior, in which internal and external factors have roughly equal contributions. However, our previous quantile regressions suggest that different variables' explanatory power may vary across different price quantiles. Figure 3(a) confirms the same idea. In particular, our model's explanatory power declines in regions 2 and 3, where external factors seem to be less critical. On the other hand, our model explains almost 90% of the pricing behaviors in region 4, where amenities tend to be under-provided, and internal factors contribute nearly 70%.

Simultaneously, Figure 3(b) shows that our model explains less than 10% of TOM across developers on average. As in the case of the transaction price, heterogeneity seems to be the key to this unsatisfactory result. It is clear that our model again explains almost 90% of the variations of TOM across developers within region 4. This time, however, it is the external factors which make up nearly all the contributions. The model's performance in explaining TOM in region 1 is about 60%, which is comparable to the performance in explaining transaction prices in the same area. Our econometric model cannot explain the prices in regions 2 and 3; our model also fails to account for the TOM in those regions.



(a)



(b)

Figure 3 Decomposition of Internal and External Effects in Pricing and Timing

Note: Figure (a) and (b) present the comparison of decomposition of internal and external effects (using value-based weighting system). The dependent variable in (a) is unit selling price, while the dependent variable in (b) is TOM. We apply *three stage least square* to estimate the simultaneous regression, *controlled for region fixed effect, year fixed effect and project's cluster effects* on 55170 transaction records. The results are almost the same using transaction-based weighting system.

Given the dramatic difference in our model performance among different regions, we then turn to the *more disaggregate geographical classification* and investigate whether the "mode of local competitions" varies across regions (regions with and without top 10 developers). Since the *location choice is not random*, we modify our empirical model in this section. More specifically, we first calculate the probability of having at least one of the top 10 developers in a given district. In the second stage, we re-estimate the pricing and TOM equations, taking the residual term from the first stage as a proxy for some top 10 developers' location preference, and again employ three-stage least square to estimate the structural model. Table 7a shows the distribution of real estate development projects across the 15 districts in Beijing during our sampling period. Notice that *the top 10 real estate developers have never been involved in some districts,* namely, districts 1, 4, 6, 9, 10, 12. We can, therefore, propose the following test procedures.

Table 7a Distribution of real estate projects across the 15 districts in Beijing

District No	District Name	Non-big10	Big10	Total
1	Changping	5	0	5
2	Chaoyang	31	5	36
3	Chongwen	1	4	5
4	Daxing	3	0	3
5	Dongcheng	1	1	2
6	Fangshan	2	0	2
7	Fengtai	8	2	10
8	Haidian	12	2	14
9	Huairou	2	0	2
10	Miyun	1	0	1
11	Shijingshan	0	1	1
12	Shunyi	5	0	5
13	Tongzhou	5	1	6
14	Xicheng	1	2	3
15	Xuanwu	1	3	4
Total		78	21	99

More formally, in the first stage, we recognize that the location choice is not random and we estimate the following model,

$$Prob(top10 = 1|W_i) = \Phi({W_i}^T\gamma)$$

$$\widehat{Prob}_{top10} = \Phi({W_i}^T\gamma)$$

$$resid(Prob_{top10}) = top10 - \widehat{Prob}_{top10}$$

where dummy variable $top10$ denotes whether there is a project developed by the top 10 developer in a given district. W_i is a vector of explanatory variables that might affect the top 10 developers' location choice, including the geographic, macro, and micro factors of the district, and year fixed-effects. γ is a vector of unknown parameters estimated by maximum likelihood. Φ is the cumulative distribution function of the standard normal distribution. $\widehat{Prob}_{top10}$ is the estimated probability of having a top 10 developer in a given district while

$resid(Prob_{big10})$ is the residual of estimation, reflecting some idiosyncratic location preference or not included in our dataset.

In the second stage, we re-estimate the pricing and TOM equations, taking the residual term from the first stage, as a proxy for the top 10 developers' location preference.

$$lunit\_price_{irt} = \rho_{10} + \rho_{11} financial_{irt} + \rho_{12} financial_{-irt} + \rho_{13} X_{irt} + \rho_{14} W_{1irt} + \rho_{15}\widehat{\partial_{1irt}} + resid(Prob_{big10}) + \rho_{16} TOM_{irt} + control2_{irt} + \omega_{irt}$$

$$TOM_{irt} = \rho_{20} + \rho_{21} financial_{irt} + \rho_{22} financial_{-irt} + \rho_{23} X_{irt} + \rho_{24} W_{2irt} + \rho_{25}\widehat{\partial_{2irt}} + resid(Prob_{big10}) + \rho_{26} lnprice_{irt} + control2_{irt} + \omega_{irt}$$

where W_{1i} and W_{2i} are a pair of exclusive vectors. W_{1i} denotes information on the unit level, including the unit's floor and area. In contrast, W_{2i} conveys information on the project level, consisting of the project's average floor and total construction area. To get more consistent estimates of pricing-timing mechanism and firm's financial status variables, we involve both the estimated residual term in step two ($\widehat{\partial_{1\iota rt}}$ and $\widehat{\partial_{2\iota rt}}$) and other explanatory variables into the third step regression. We again employ a three-stage least square to estimate the structural model.

Table 7b reports the results. Several observations are in order. First, the slopes are much steeper in districts without the top 10 developers. For instance, the coefficient of TOM on log(unit price) is around -0.002 in districts that involve some real estate projects by the top 10 developers. In contrast, the counterpart in districts without any project by the top 10 developers is around -0.035.

Similarly, the coefficient of log(unit price) on Tom is around 5 in districts that involve some real estate projects by the top 10 developers. In contrast, the counterpart in districts without any project by the top 10 developers is around 30. Second, the project design preference matters. Recall that in stage two, we estimate the project design against financial and geographical variables. Hence, the residuals terms ($\widehat{\partial_{1\iota rt}}$ and $\widehat{\partial_{2\iota rt}}$) can be interpreted as indicators of the developers' project design, which are not captured by our observed variables. Notice that the coefficients of these second-stage residual terms in the log(unit price) and TOM equations are -0.399 and 1.207 in districts with the top 10 developers, respectively. In comparison, the counterparts in districts without any of the top 10 developers are -0.794 and 2.362. All of these coefficients are 1% significant.

Third, the top 10 developers' presence does not only change the sensitivities of the house price and TOM to each other, to the project design but also directly impact the house price and TOM. Recall that the variable resid($Prob_{top10}$) can be interpreted as the top 10 developers' location preference. In districts with the top 10 developers' presence, the coefficients of that location preference variable in the house price and TOM equations are -0.272 and -0.725, respectively. In districts without these prominent developers' involvement, the corresponding coefficients become -0.364 and -17.39, respectively. Thus, in districts without the top 10 developers, other things being equal, houses would be sold at lower prices and faster. Notice that we use the 3-stage least square method to mitigate the endogeneity. We, therefore, may not be able to provide the usual adjusted R^2. Fortunately, we can still produce an estimate about how much our model explains the variations of the house price and TOM across districts.

Table 7b Pricing and TOM influenced by financial conditions and local competition

	Districts with big10		Districts without big10	
	lunit_price	***TOM***	***lunit_price***	***TOM***
	(1)	(2)	(3)	(4)
TOM	-0.00254***		-0.0351***	
	(0.000856)		(0.00393)	
lunit_price		5.483***		28.57***
		(0.289)		(1.735)
$\widehat{\partial_i}$	-0.399***	1.207***	-0.229***	1.894***
	(0.00903)	(0.0905)	(0.0139)	(0.175)
$resid(Prob_{top10})$	-0.272***	0.725	-0.364***	-17.39***
	(0.0337)	(0.747)	(0.0609)	(0.704)
profitability	0.144***	-1.057***	0.443***	-28.72***
	(0.0131)	(0.292)	(0.0941)	(3.078)
liability	-0.0153	0.408	0.189*	-20.66***
	(0.0130)	(0.286)	(0.101)	(3.151)
liquidity	0.0127	2.406***	-0.588***	21.11***
	(0.0120)	(0.261)	(0.0913)	(3.193)
pccentral	0.104***	-1.303***	-0.219***	18.79***
	(0.0110)	(0.244)	(0.0469)	(1.520)
pclocal	0.0363***	0.310***	-0.0830**	0.0192
	(0.00510)	(0.113)	(0.0336)	(1.040)
$profitability_{-i}$	-0.0932***	0.0107	-0.221**	16.33***
	(0.0127)	(0.282)	(0.0869)	(2.740)
$liability_{-i}$	0.00802	-0.114	-0.150	16.61***
	(0.0125)	(0.277)	(0.0958)	(2.975)
$liquidity_{-i}$	-0.0324***	-2.031***	0.248***	-6.311**
	(0.0114)	(0.250)	(0.0873)	(2.793)
$pccentral_{-i}$	-0.0741***	1.178***	0.0978**	-12.86***
	(0.0106)	(0.236)	(0.0440)	(1.353)
$pclocal_{-i}$	-0.00296	-1.279***	-0.00532	5.220***
	(0.00514)	(0.112)	(0.0341)	(1.029)
region effect	*controlled*	*controlled*	*controlled*	*controlled*
year effect	*controlled*	*controlled*	*controlled*	*controlled*
project's cluster	*controlled*	*controlled*	*controlled*	*controlled*
N	12370	12370	37250	37250

Note: This table presents the compassion between districts with top 10 developers and districts without top 10 developers, focusing on the impact of a firm's financial status on the pricing-timing mechanism. The dependent variable in columns (1) and (3) is *lunit_price*, while the dependent variable in columns (2) and (4) is *TOM*, *controlled for region fixed effect, year fixed effect and project's cluster effects*. All the rival variables, such as $profitability_{-i}$, $liability_{-i}$, etc., are value-weighted. Standard errors are in parentheses: *p<0.10, **p<0.05, *** p<0.01.

Figure 4 demonstrates some intuitive results. Therefore, in districts without the top 10 developers' participation, competition is among relatively small developers. We find that internal factors majorly drive the pricing strategy while external factors drive timing strategy. However, in districts with "market leader(s)," i.e., involving at least one of the top 10 developers, the contributions of internal and external factors are approximately the same in pricing. Notice also that the explanatory power on our model's pricing is comparable in districts with top 10 developers (about 50%) and districts without (about 40%).

On the other hand, the explanatory power on TOM is very different. In districts without top

10 developers, our model can explain more than 80% of the variations and attribute mostly to the external factors, suggesting that the developers may compete intensively to sell their units. In districts that involve at least one of the top 10 developers, our model can explain less than 20% of TOM variations across real estate projects. The presence of "market leaders" may lead firms to adopt much more complicated strategies that can be captured by our empirical framework. While a full account would be left to future research, we consider this sharp contrast between local markets with and without "leaders" a potential important stylized fact for real estate economics and industrial organization research.

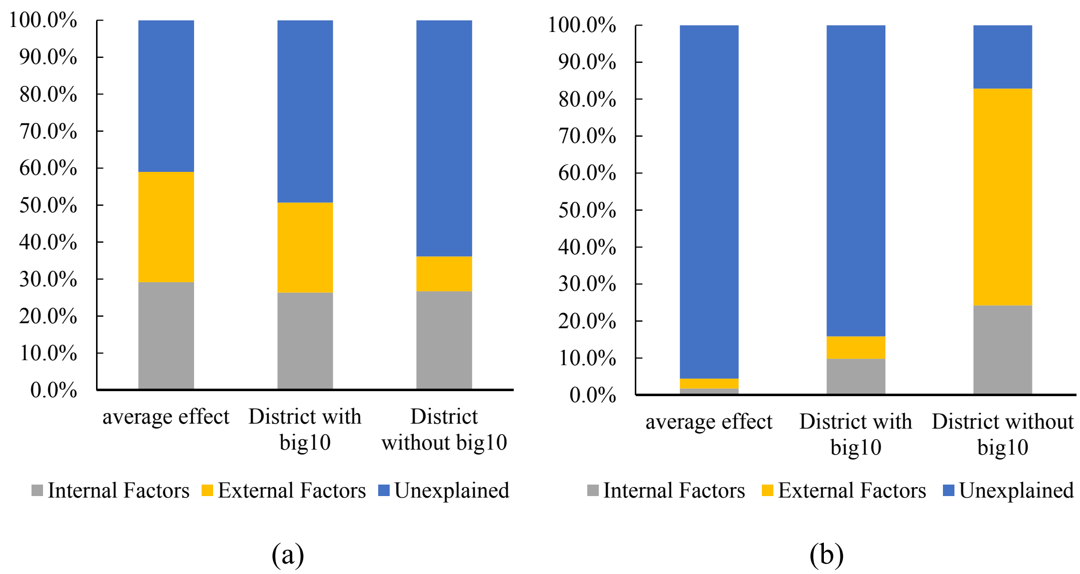


Figure 4 Decomposition of Internal and External Effects in Pricing and Timing (with and without Big 10)

Figure (a) and (b) present the comparison of the decomposition of internal and external effects (using a value-based weighting system). The dependent variable in (a) is the unit selling price, while the dependent variable in (b) is TOM. We apply three-stage least square to estimate the simultaneous regression, *controlled for region fixed effect, year fixed effect, and project's cluster effects* on 55170 transaction records. The results are almost the same using a transaction-based weighting system, and hence not presented here.

4.4 Robustness Check: Spillover Effects

Thus far, our analysis presumes that when a developer considers her actions, she will take her rivals' financial conditions in consideration (section 3.2). Implicitly, we have assumed that those financial condition variables (FCV) would dictate opponents' actions. In practice, the actions taken by a developer might be influenced by some other factors, including some idiosyncratic shocks that we, as researchers, cannot observe. In those situations, including the FCV alone may not be enough. There may be additional state variables that are important to the actions taken by other developers. The literature contains a discussion on the spillover effect of other developers' behaviors under asymmetric information, such as aggressive pricing and fishing strategy (for instance, see Pesaran et al., 2004). Thus, in this section, we include proxies for *other developers' pricing variables and timing variables* at period *t* into our structural pricing-timing model and re-estimate.

More specifically, for each developer, $i = 1,2, \ldots$ we construct two variables, which are the weighted average of the unit prices $lunit\_price_{-irt}$ and timing strategies TOM_{-irt} of developers other than developer i in region r at time t. Hence, for different developers, the variables $lunit\_price_{-irt}$ and TOM_{-irt} are different. Limited by the data availability, we consider using these weighted average variables operational and a "constrained optimal" empirical strategy.[19] Since theory per sec does not give us clear guidance about how to construct these indices, we also use value-based weighting and transaction-based weighting methods for calculating $lunit\_price_{-irt}$ and TOM_{-irt}. Based on the empirical model in step III, we further involve the spillover effect variables ($lunit\_price_{-irt}$ and TOM_{-irt}) into a structural model. We apply three-stage least square to estimate the simultaneous regression.

$$lunit\_price_{irt} = \beta_{10} + \beta_{11} financial_{irt} + \beta_{12} X_{irt} + \beta_{13} W_{1irt} + \beta_{14} \widehat{\partial_{1irt}} + \beta_{15} TOM_{irt} + \beta_{16} lunit\_price_{-irt} + \beta_{17} TOM_{-irt} + control2_{irt} + \tau_{irt}$$

$$TOM_{irt} = \beta_{20} + \beta_{21} financial_{irt} + \beta_{22} X_{irt} + \beta_{23} W_{2irt} + \beta_{24} \widehat{\partial_{2irt}} + \beta_{25} lnprice_{irt} + \beta_{26} lunit\_price_{-irt} + \beta_{27} TOM_{-irt} + control2_{irt} + \tau_{irt}$$

As mentioned above, W_{1i} and W_{2i} are a pair of exclusive vectors, while $\widehat{\partial_{1irt}}$ and $\widehat{\partial_{2irt}}$ are estimated residual term in step II. Three stages least square is adopted to estimate the simultaneous regression.

According to Table 8, our principal conclusions do not change, and the formerly identified interactions between *lunit_price* and TOM are robust. Meanwhile, the negative coefficient of *lunit_price-i* on TOM indicates that the booming regional market where other developers are taking a high-pricing strategy will accelerate the target developer's selling pace. This result is consistent with the conventional wisdom that housing units produced by different developers are substitutes, and when other developers are posting high prices, the consumers switch to the target developer and hence accelerate the selling pace. We also find a significant positive effect of TOM_{-irt} on developers' pricing mechanism. If other developers extend the time-on-market to get higher transaction prices, the target developer will also raise its market price. This result is also consistent with the textbooks' pricing strategies because when the competitors charge high prices, the target developer can also increase its price, perhaps to a smaller extent, without worrying that customers would be lost to its competitors.[20] The statically significance of the variables $lunit\_price_{-irt}$ and TOM_{-irt} we obtain, when we already include the FCV of other developers.

[19] An alternative that has been suggested to us is to write down an oligopoly game and estimate empirically. Since we only have three years of data and a limited amount of explanatory variables, such "ideal" strategy may not be feasible with the current data set.

[20] Among others, see Tirole (1988), Tremblay and Tremblay (2012) and the reference therein.

Table 8 Spillover Effect and Pricing-Timing Mechanism

	value-based weighting		transaction-based weighting	
	(1)	(2)	(3)	(4)
	lunit_price	*TOM*	*lunit_price*	*TOM*
TOM	0.00893***		0.00872***	
	(0.00118)		(0.00118)	
lunit_price		5.059***		5.062***
		(0.229)		(0.230)
$lunit\_price_{-i}$	0.118***	-1.656***	0.121***	-1.665***
	(0.00247)	(0.0455)	(0.00248)	(0.0465)
TOM_{-i}	-0.0144***	0.954***	-0.0141***	0.955***
	(0.00119)	(0.00594)	(0.00119)	(0.00594)
$\widehat{\partial_{\iota}}$	-0.310***	0.755***	-0.310***	0.754***
	(0.00706)	(0.0623)	(0.00705)	(0.0623)
profitability	0.0187	0.181	0.0195	0.182
	(0.0123)	(0.217)	(0.0124)	(0.218)
liability	0.00589	0.309	0.00585	0.298
	(0.0125)	(0.218)	(0.0127)	(0.223)
liquidity	0.0216*	0.970***	0.0215*	0.985***
	(0.0113)	(0.197)	(0.0114)	(0.199)
pccentral	0.0130	0.922***	0.0116	0.940***
	(0.0103)	(0.179)	(0.0104)	(0.181)
pclocal	-0.00164	0.184**	-0.00268	0.194**
	(0.00481)	(0.0843)	(0.00481)	(0.0846)
$profitability_{-i}$	-0.00525	-0.168	-0.00616	-0.168
	(0.0121)	(0.212)	(0.0122)	(0.214)
$liability_{-i}$	-0.00858	-0.318	-0.00854	-0.308
	(0.0121)	(0.212)	(0.0124)	(0.217)
$liquidity_{-i}$	-0.0227**	-0.796***	-0.0224**	-0.811***
	(0.0109)	(0.190)	(0.0109)	(0.191)
$pccentral_{-i}$	-0.0355***	-0.605***	-0.0342***	-0.623***
	(0.0101)	(0.176)	(0.0102)	(0.179)
$pclocal_{-i}$	0.00263	-0.386***	0.00366	-0.395***
	(0.00481)	(0.0843)	(0.00482)	(0.0847)
Obs	55170	55170	55170	55170

This table presents the impact of the spillover effect on the pricing-timing mechanism. We apply three-stage least square to estimate the simultaneous regression. The dependent variable in column (1) and (3) is *lunit_price*. In contrast, the dependent variable in columns (2) and (4) is TOM, *controlled for region fixed effect, year fixed effect, and project's cluster effects* on 55170 transaction records. Standard errors are in parentheses: *p<0.10, **p<0.05, *** p<0.01.

Meanwhile, we find a robust correlation between FCV and their marketing strategies after controlling for "direct" spillover effect (i.e., $lunit\_price_{-irt}$ and TOM_{-irt}). Higher internal liquidity levels and political connections could raise the transaction price and postpone the transaction pace. In contrast, higher profitability, liquidity, and political connection level of their competitors will reduce the transaction price and accelerate the transaction pace.

Now, we conduct another robustness check on the measurement of the financial conditions of the developers. In the previous sections, we construct our financial condition variables (FCV) by adopting the principal component (PCA) method. There are other alternatives in the literature. In this section, we replace our PCA-based measures with more standard metrics and check whether our results would be changed. Following the methodology developed by Rajan and Zingales (1998) and Claessens et al. (2012), we calculate the financial independence index, namely intrinsic dependence on external finance for investment (*FD_INVi*) and inherent dependence on external funding for working capital (*FD_WKi*). For the interest of space, we present only a summary here and the details in the appendix. Consistent with our former findings, there is a significantly negative correlation between financial dependence and the probability to locate their project between ring 2 and ring 5; developers with lower financial dependence will build more extensive and high-rise residential units. Meanwhile, controlling for the financial dependence of real estate firms, the correlation between the selling price and TOM is also robust for the whole sample, quantile, and spillover effect regressions.

Table 9 exhibits the summary of explanatory power comparison in the internal and external financial dependence index. Intuitively, we find a higher unexplained share using the financial dependence variable compared to our indicating system. Thus, our approach of using a more comprehensive measurement of financial status, including booked indicators of profitability, liability, and liquidity, as well as the un-booked indicators like political connection, may provide a better understanding of the competitions among the real estate developers compared with the standard measures suggested by existing literature. On average, we also find the results using financial dependence variables are consistent with our previous findings. Overall, external variables dominate internal variables in explaining the pricing-timing mechanism of developers. However, when focusing on the regional heterogeneity, the conclusion slightly deviates from our findings. Concerning pricing strategy, the deviation majorly comes from the sub-urban regions. While regarding the timing strategy, the departure majorly comes from the inner-city regions. Part of the reason could be developers' spatial distribution with different non-booked financial status (political connections on both central and local levels). As we discovered before, developers with a more profound association with the central government will be more likely to develop inner-city zones.

In contrast, developers with higher local political connections will be more likely to develop projects in outer city zones. According to our former results, developers with stronger political relationships with the local government tend to sell their property at higher transaction prices and wait a long time on the market. Since the traditional financial status measurement does not capture these political economy variables, their estimated impacts could be different from ours.

Table 9 Decomposition of Internal and External Effects
(when alternative measures of financial condition variables are used)

	Average	Region 1	Region 2	Region 3	Region 4
financial dependence (FD_INV)					
pricing regressions					
Internal Factors	3.9%	2.9%	4.8%	9.1%	0.0%
External Factors	52.0%	45.1%	35.9%	10.8%	90.6%
Unexplained	44.0%	52.0%	59.2%	80.0%	9.5%
timing regressions					
Internal Factors	0.5%	1.9%	3.6%	8.2%	11.0%
External Factors	0.5%	45.4%	11.1%	9.3%	77.1%
Unexplained	99.0%	52.7%	85.4%	82.5%	11.9%
financial dependence (FD_WK)					
pricing regressions					
Internal Factors	10.7%	0.0%	10.9%	0.4%	22.6%
External Factors	41.9%	48.2%	17.6%	17.2%	67.9%
Unexplained	47.4%	51.8%	71.5%	82.5%	9.4%
timing regressions					
Internal Factors	0.2%	2.2%	4.4%	0.6%	65.9%
External Factors	1.1%	43.4%	4.9%	17.4%	22.0%
Unexplained	98.8%	54.5%	90.7%	82.1%	12.1%

Note: This table presents the comparison of decomposition of internal and external effects (using value-based weighting system). We apply *three-stage least square* to estimate the simultaneous regression, *controlled for region fixed effect, year fixed effect and project's cluster effects* on 55170 transaction records. Due to the limitation of the database, we lose the information of *FD_INV* before 2007, which narrows down the valid sample size into 25330. Similarly, due to the limitation of the database, we lose the information of *FD_WK* in some real estate firms, which narrows down the valid sample size into 55049. The results is almost the same using transaction-based weighting system.

Also, we use the information on a firm's history during each year between 2006 and 2008. We define individual firms' actual use of external finance for working capital and investment (actual firm use of external finance for investment and actual firm use of external finance for working capital) in a similar way as above. The result is consistent with our former findings and not shown here.

5 Conclusion

This paper provides a systemic examination of the relative importance of internal versus external factors in corporate decision-making, using the listed real estate developers in Beijing as a "case study." Based on the micro-level data we compile; this paper builds a multi-step empirical framework that mimics the developers' decision-making process and controls several endogenous issues. In general, we find robust evidence that the company's financial conditions and that of the rival companies are essential empirical determinants but play different roles in location, design, pricing-timing decisions of development. We also identify the location pattern of developers. Developers with higher liability are more likely to develop in suburban areas, while developers with higher liquidity tend to choose to build in the inner city more likely; such spatial heterogeneity in the driven force hints the tradeoff between risk consideration in cost and demand. Regarding project design, we confirm that companies with higher financial solvency in terms of liquidity and liability and better profitability, tend to build larger, high-rise residential units. In contrast, companies with lower financial capacity and profitability are more inclined to construct small, medium-rise residential units.

Concerning pricing-timing decisions, there is strong evidence that liquidity demand influences the simultaneous choice of selling price and TOM, while the interactions between TOM and transaction price are non-linear: TOM has a U-shaped effect on the transaction price, while transaction price has a positive impact on TOM. We further provide evidence on the behavioral interactions between different developer clusters. The booming regional market where other developers use high-pricing strategies accelerates the selling pace of the target developer; meanwhile, if other developers extend their time on the market to get higher transaction prices, the target developer will also raise his selling price.

Our findings also suggest that the degree of competition may be location-dependent. The *relative importance of internal* (i.e., the financial conditions of the own company) *versus external factors* (i.e., the rival firms) *varies* along city center to suburban areas, as the *degree of market concentration also varies across markets*. Also, since the top ten developers are much larger than the other developers, our district-level analysis reveals that the existence of those large developers as "market leaders" would significantly affect small developers' strategy and further shape the local market situation. Other things being equal, in districts without any participation of the top ten developers, competing firms tend to respond more vital to one another's actions. In contrast, *the presence of at least one of those large developers would lead to higher selling prices and a slower selling pace*. These results hold even when the endogeneity of location choice and product design are taken into considerations. Hence, our results are consistent with the notion that the existence of some "market leader" would significantly change the strategies of relatively small firms in the local market and have a significant "general equilibrium effect." Therefore, our results provide support to both theories that emphasize the interactions between corporate financial decisions and product market competition and models that highlight the importance of "market leader." Our results sustain a series of robustness checks.

There are many possibilities for future research. First, one can go beyond Beijing's city and compare the situation in other cities and even countries. Second, this study only covers a short period so that future research can extend to this dimension. In particular, a comparison of developer behavior under different policy regimes would be interesting to pursue. Besides, since our paper shows that not only her financial conditions would affect the firm's practice, but the financial conditions of her rivals also matter. Hence, any policy attempt to "relax the financial constraints" of firms may have non-trivial implications on the market structure and future output and prices. More research efforts may be needed along these lines.

Reference

Akerlof, G. A. (1970). The market for "lemons": Quality uncertainty and the market mechanism. *Quarterly Journal of Economics*, 488-500.

Allen, M. T., Faircloth, S., & Rutherford, R. C. (2005). The impact of range pricing on marketing time and transaction price: a better mousetrap for the existing home market? *Journal of Real Estate Finance and Economics*,*31*(1), 71-82.

Anglin, P. M., Rutherford, R., & Springer, T. M. (2003). The trade-off between the selling price of residential properties and time-on-the-market: The impact of price setting. *Journal of Real Estate Finance and Economics*, *26*(1), 95-111.

Baerwald, T. J. (1981). The site selection process of suburban residential builders. *Urban Geography*, *2*(4), 339-357.

Baldwin, R. E., & Okubo, T. (2006). Heterogeneous firms, agglomeration and economic geography: spatial selection and sorting. *Journal of Economic Geography*, *6*(3), 323-346.

Balmer, M., Axhausen, K., & Nagel, K. (2006). Agent-based demand-modeling framework for large-scale microsimulations. *Transportation Research Record: Journal of the Transportation Research Board*, 125-134.

Benoit, J. P., & Krishna, V. (1991). Entry deterrence and dynamic competition: the role of capacity reconsidered. *International Journal of Industrial Organization*, 9(4), 477-495.

Bolton, P., & Scharfstein, D. S. (1990). A theory of predation based on agency problems in financial contracting. *American Economic Review*, 93-106.

Bond, E. and Syropoulos, C. (2012). Economic integration and the sustainability of multimarket collusion, *Economic Letters*, 117, 42-44.

Borla, S. (2012). Spatial competition and merging incentives when firms produce complements, *Regional Science and Urban Economics*, 42, 221-229.

Brander, J. A., & Lewis, T. R. (1986). Oligopoly and financial structure: The limited liability effect. *American Economic Review*, 956-970.

Brekke, K., Siciliani, L. and Straume, O. (2010). Price and quality in spatial competition, *Regional Science and Urban Economics*, 40, 471-480.

Campello, M. (2003). Capital structure and product markets interactions: evidence from business cycles, *Journal of Financial Economics*, 68, 353-378.

Campello, M. (2006). Debt financing: Does it boost or hurt firm performance in product markets? *Journal of Financial Economics*, 82(1), 135-172.

Chan, K. S., Dang, V. Q. and Yan, I. K. (2012). Chinese firms political connection, ownership, and financing constraints, Economics Letters, 115(2), 164-167.

Chevalier, J. A. (1995). Do LBO Supermarkets Charge More? An Empirical Analysis of the Effects of LBOs on Supermarket Pricing, *Journal of Finance*, 50(4), 1095-1112.

Chevalier, J. A., & Scharfstein, D. S. (1995). Liquidity constraints and the cyclical behavior of markups. *American Economic Review*, 85(2), 390-396.

Chivakul, M., Lam, R., Liu, X., Maliszewski, W. and Schipke, A. (2015). Understanding residential real estate in China, IMF working paper.

Claessens, S., Tong, H., and Wei, S. J. (2012). From the financial crisis to the real economy: Using firm-level data to identify transmission channels. *Journal of International Economics*, *88*(2), 375-387.

Delbono, F. and Lambertini, L. (2014). Cartel size and collusive stability with non-capitalistic players, *Economics Letters*, 125, 156-159.

Deneckere, R. J. & Kovenock, D. (1992). Price Leadership. *Review of Economic Studies*, 59(1), 143-162.

Deng, Y., Girardin, E. & Joyeux, R. (2015). Fundamentals and the volatility of real estate prices in China: a sequential modelling strategy. HKIMR working paper 22/2015.

Dong, Z., & Sing, T. F. (2014). Developer Heterogeneity and Competitive Land Bidding. *Journal of Real Estate Finance and Economics*, 48(3), 441-466.

Echambadi, R., Campbell, B., & Agarwal, R. (2006). Encouraging best practice in quantitative management research: An incomplete list of opportunities. *Journal of Management Studies*, *43*(8), 1801-1820.

Faccio, M. (2006). Politically Connected Firms. *American Economic Review, 96*(1), 369-386.

Fang, H., Gu, Q., Xiong, W., & Zhou, L. A. (2016). Demystifying the Chinese housing boom. *NBER Macroeconomics Annual*, *30*(1), 105-166.

Forgey, F. A., Rutherford, R. C., & Springer, T. M. (1996). Search and Liquidity in Single□Family Housing. *Real Estate Economics*, *24*(3), 273-292.

Fortune Magazine (2015). China's slowing economy: The worst has yet to come. (January) http://fortune.com/2015/01/21/china-economy-growth-slowdown/

Fresard, L. (2010). Financial strength and product market behavior: The real effects of corporate cash holdings. *Journal of Finance*, 65(3), 1097-1122.

Friedman, J. (1981). A conditional logit model of the role of local public services in residential choice. *Urban Studies*, *18*(3), 347-358.

Genesove, D. & Mayer, C. (2001). Loss Aversion And Seller Behavior: Evidence From The Housing Market, *Quarterly Journal of Economics*, 116(4), 1233-1260.

Glazer, J. (1994). The Strategic Effects of Long-Term Debt in Imperfect Competition, *Journal of Economic Theory*, 62(2), 428-443.

Glower, M., Haurin, D. R., & Hendershott, P. H. (1998). Selling time and selling price: The influence of seller motivation. *Real Estate Economics*, *26*(4), 719-740.

Gnagey, M. (2012). Heterogeneous Developers, Spatial Interactions, and Land Development Outcomes under Uncertainty. In *2012 Annual Meeting, August 12-14, 2012, Seattle, Washington* (No. 124932). Agricultural and Applied Economics Association.

Green, R. & Malpezzi, S. (2003). A Primer on US housing markets and housing policy, Washington, D.C.: Urban Institute.

Green, R., Malpezzi, S. & Mayo, S. (2005). Metropolitan-Specific Estimates of the Price Elasticity of Supply of Housing, and Their Sources, *American Economic Review*, 95(2), 334-339.

Grenadier, S. R. (1996). The Strategic Exercise of Options: Development Cascades and Overbuilding in Real Estate Markets, *Journal of Finance*, vol. 51(5), 1653-79.

Gregor, B. (2015). *Land use scenario developer: Practical land use model using a stochastic microsimulation framework*. Transportation Research Record, Washington, DC.: Transportation Research Board.

Gu, G., Michael, L., & Cheng, Y. (2015). Housing supply and its relationships with land supply. *International Journal of Housing Markets and Analysis*, *8*(3), 375-395.

Harrington, J. (2017). The deterrence of collusion by a structural remedy, *Economic Letters*, 160, 78-81.

Head, K., & Mayer, T. (2004). Market potential and the location of Japanese investment in the European Union. *Review of Economics and Statistics*, *86*(4), 959-972.

Hilber, C. & Vermeulen, W. (2016). The Impact of Supply Constraints on House Prices in England, *Economic Journal*, 126(591), 358-405.

Holmes, T. (2011). The diffusion of Wal-Mart and economies of density, Econometrica, 79(1), 253-302.

Huang, D. J., Leung, C. K., & Qu, B. (2015). Do bank loans and local amenities explain Chinese urban house prices?. *China Economic Review*, 34, 19-38.

Jackson, K. (2016). Do land use regulations stifle residential development? Evidence from California cities, *Journal of Urban Economics*, 91, 45-56.

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305-360.

Jia, P. (2008). What Happens When Wal-Mart Comes to Town: An Empirical Analysis of the Discount Retailing Industry, Econometrica, 76(6), 1263-1316.

Jolliffe, I., (2005). Principal Component Analysis. New York: Springer.

Jud, G. D., Winkler, D. T., & Kissling, G. E. (1995). Price spreads and residential housing market liquidity. *Journal of Real Estate Finance and Economics*, *11*(3), 251-260.

Knight, J. R. (2002). Listing price, time on market, and ultimate selling price: Causes and effects of listing price changes. *Real Estate Economics*, *30*(2), 213-237.

Lai, S. K., Ding, C., Tsai, P. C., Lan, I. C., Xue, M., Chiu, C. P., & Wang, L. G. (2008). A game-theoretic approach to urban land development in China. *Environment and Planning. B, Planning & Design*, *35*(5), 847.

Lai, R. N., Wang, K., & Zhou, Y. (2004). Sale before completion of development: pricing and strategy. *Real Estate Economics*, *32*(2), 329-357.

Lambert, T. and Volpin, P. (2017). Endogenous political institutions and financial development, forthcoming in Handbook of Finance and Development, ed. By T. Beck and R. Levine (Edward Elgar Publishing).

Lee, T. and J. B. Jou (2010). Urban Spatial Development: a Real Options Approach, *Journal of Real Estate Finance and Economics*, 40(2), 161-187.

Leung, C. K. Y., Leong, Y. C. F., & Wong, S. K. (2006). Housing price dispersion: an empirical investigation. *Journal of Real Estate Finance and Economics*, *32*(3), 357-385.

Leung, C. K. Y., Ma, W. Y. & Zhang, J. (2014). The Market Valuation of Interior Design and Developers strategies: a simple Theory and some Evidence, *International Real Estate Review,* 17(1), 63-107.

Leung, C. K. Y., Ng, C. Y. J. (2019). Macroeconomic Aspects of Housing. In Hamilton, J.H., Dixit, A., Edwards, S., Judd, K. (eds) Oxford Research Encyclopedia of Economics and Finance, Oxford University Press.

Leung, C. K. Y., Ng, J. C. Y & Tang, E. C. H., (2020). What do we know about Housing Supply? The case of Hong Kong, *Economic and Political Studies*, 8(1), 6-20.

Leung, C. K. Y. & Tang, E. C. H., (2015). Availability, affordability and volatility: the case of Hong Kong housing market, *International Real Estate Review,* 18 (3), 383-428.

Leung, C. K. Y. & Wang, W. (2007), Chinese Housing Market through the lens of DiPasquale-Wheaton model: a graphical attempt, *International Real Estate Review*, 10(2), 131-165.

Leung, C. K. Y. and Tse, C. Y. (2017), Flipping in the housing market, *Journal of Economic Dynamics and Control*, 76, 232-263.

Li, H., Liu, P. W., Zhang, J. and Ma, N. (2007), Economic Returns to Communist Party Membership: Evidence From Urban Chinese Twins, *Economic Journal*, 117(523), 1504-1520.

Li, H., Meng, L. Wang, Q. and Zhou, L. A. (2008), Political connections, financing and firm performance: Evidence from Chinese private firms, *Journal of Development Economics*, 87(2), 283-299.

Maksimovic, V., (1988), Capital Structure in Repeated Oligopolies, *RAND Journal of Economics*, 19(3), 389-407.

Maruani, T., & Amit-Cohen, I. (2011). Characteristics of developers and their relations to open space conservation. *Land Use Policy*, *28*(4), 887-897.

Mas-Colell, Andreu; Michael Whinston and Jerry Green (1995), *Microeconomic Theory*, New York: Oxford University Press.

Matsa, D. (2010). Capital Structure as a Strategic Variable: Evidence from Collective Bargaining, *Journal of Finance*, 65(3), 1197-1232.

McFadden, D. (1978). Modelling the choice of residential location, mimeo.

Mi, Xingang. (2015). Top 10 Chinese universities for graduate salaries, http://www.china.org.cn/top10/2015-

05/13/content_35550719.htm
Miles, M., Berens, G., Eppli, M. J., and Weiss, M. (2007). Real Estate Development: Principles and Process. 4^{th} Ed., Washington, D. C.: Urban Land Institute.
Myers, S. C. (1977). Determinants of corporate borrowing. *Journal of Financial Economics*, *5*(2), 147-175.
Oechssler, J. & Schuhmacher, F. (2004). The limited liability effect in experimental duopoly markets, *International Journal of Industrial Organization*, 22, 163-184.
Okubo, T., Picard, P. M., & Thisse, J. F. (2010). The spatial selection of heterogeneous firms. *Journal of International Economics*, *82*(2), 230-237.
Ong, S. E., & Koh, Y. C. (2000). Time on-market and price trade-offs in high-rise housing sub-markets. *Urban Studies*, *37*(11), 2057-2071.
Ono, Y. (1982). Price Leadership: A Theoretical Analysis. *Economica*, 49(193), 11-20.
Quigg, L. (1993). Empirical testing of real option□pricing models. *Journal of Finance*, *48*(2), 621-640.
Parsons, C., & Titman, S. (2009). Empirical capital structure: A review. *Foundations and Trends in Finance*, 3(1), 1-93.
Peiser, R. (1990). Who plans America? Planners or developers? *Journal of the American Planning Association*, *56*(4), 496-503.
Pennerstorfer, D. (2017). Can competition keep the restrooms clean? Price, quality and spatial competition, *Regional Science and Urban Economics,* 64, 117-136.
Pesaran, M. H., Schuermann, T., & Weiner, S. M. (2004). Modeling regional interdependencies using a global error-correcting macroeconometric model. *Journal of Business & Economic Statistics, 22*(2), 129-162.
Rajan, R., Zingales, L., 1998. Financial dependence and growth. *American Economic Review*, 88 (3), 559–586.
Saiz, A. 2010. The Geographic Determinants of Housing Supply, *Quarterly Journal of Economics*, 125(3), 1253-1296.
Salop, S. C. (1979). Monopolistic competition with outside goods. *Bell Journal of Economics*, 141-156.
Shleifer, A., Vishny, R. (1997). A Survey of Corporate Governance. *Journal of Finance,* 52, 737-783.
Somerville, C. T. (1999). The industrial organization of housing supply: market activity, land supply and the size of homebuilder firms. *Real Estate Economics*, *27*(4), 669-694.
Song, R. and Wang, L. (2017). Collusion in a differentiated duopoly with network externalities. Economics Letters, 152, 23-26.
Stein, J. C. (1995). Prices and trading volume in the housing market: A model with down-payment effects. *The Quarterly Journal of Economics*, *110*(2), 379-406.
Taylor, C. R. (1999). Time-on-the-market as a sign of quality. *Review of Economic Studies*, *66*(3), 555-578.
Tirole, T. (1988). The Theory of Industrial Organization, Cambridge: MIT Press.
Titman, S. (1985). Urban Land Prices under Uncertainty, *American Economic Review*, 75(3), 505-14.
Tremblay, V., & Tremblay, C. H. (2012). New Perspectives on Industrial Organization, New York: Springer.
Wang, K. and Y. Zhou (2000). Overbuilding: A Game-theoretic Approach, *Real Estate Economics*, 28(3), 493-522.
Wang, K. and Y. Zhou (2006). Equilibrium Real Options Exercise Strategies with Multiple Players: The Case of Real Estate Markets, *Real Estate Economics*, 34(1), 1-49.
Weiss, M. A. (2002). *The Rise of the Community Builders: The American real estate industry and urban land planning*. Beard Books.
Whited, T. M. (1992). Debt, liquidity constraints, and corporate investment: Evidence from panel data. *Journal of Finance*, *47*(4), 1425-1460.
Williams, J. T. (1991). Real estate development as an option. *Journal of Real Estate Finance and Economics*, *4*(2), 191-208.
Williams, J. T. (1993). Equilibrium and options on real assets, *Review of Financial Studies,* 6 (4), 825-850.

Wu, J., Deng, Y., & Liu, H. (2014). House price index construction in the nascent housing market: The case of China. *Journal of Real Estate Finance and Economics*, *48*(3), 522-545.

Wu, J., Gyourko, J., & Deng, Y. (2012). Evaluating conditions in major Chinese housing markets. *Regional Science and Urban Economics*, 42, 531-543.

Wu, J., Gyourko, J., & Deng, Y. (2016). Evaluating the risk of Chinese housing markets: what we know and what we need to know. *China Economic Review*, 39, 91-114.

Yavaş, A. (1992). A simple search and bargaining model of real estate markets. *Real Estate Economics*, *20*(4), 533-548.

Appendix

This appendix has several sections.

Appendix A provides additional information about the variables, such as different correlation tables.

Appendix B provides a summary of the major governmental interventions in the Chinese housing market.

Appendix C provides the results of the robustness check using financial dependence indicators.

Appendix D outlines our decomposition procedures.

Appendix E provides more details about the Beijing housing market.

Appendix A. Additional information of the variables

Table A1 Correlations before Principle Component Analysis

	lyrmc	*currt*	*intcvr*	*invtrtrrat*	*dbastrt*	*peratio*	*d_cbd*	*d_sub*	*d_h1*	*d_middle*	*d_high*	*n_subway*	*perma_pop*	*exeter_pop*
lyrmc	1													
curt	-0.0338	1												
intcvr	-0.1149	0.0341	1											
invtrtrrat	-0.0324	-0.0475	0.0482	1										
dbastrt	0.0228	-0.0348	-0.0823	0.003	1									
peratio	0.1378	0.044	0.2269	-0.0353	-0.0687	1								
d_cbd	-0.0063	-0.0321	-0.1199	-0.1832	-0.134	0.0061	1							
d_sub	-0.0074	0.0025	-0.0643	-0.0815	-0.0371	0.0501	0.8419	1						
d_h1	0.0173	0.0124	-0.0927	-0.1397	-0.0306	0.0242	0.8772	0.9345	1					
d_middle	-0.003	-0.0061	-0.092	-0.1162	-0.0954	0.006	0.9164	0.9131	0.9291	1				
d_high	0.0122	-0.0042	-0.0966	-0.1419	-0.1073	0.0173	0.9282	0.9027	0.9307	0.9794	1			
n_subway	-0.0074	0.0412	0.073	-0.1754	0.2182	-0.0145	-0.5141	-0.5249	-0.4108	-0.4881	-0.4596	1		
perma_pop	0.031	0.0821	0.0269	-0.2835	0.2321	-0.034	-0.4825	-0.5497	-0.4581	-0.5478	-0.5118	0.9097	1	
exeter_pop	0.0104	0.0803	0.0191	-0.2902	0.2159	-0.0413	-0.4632	-0.5442	-0.4407	-0.524	-0.4816	0.9278	0.9935	1
registered_pop	0.0383	0.0981	0.0397	-0.2484	0.2474	-0.034	-0.4926	-0.5509	-0.4758	-0.5646	-0.5346	0.8563	0.9826	0.9631
move_in_out	-0.0329	0.135	0.0123	-0.1651	0.1932	-0.0675	-0.3276	-0.4423	-0.395	-0.4659	-0.4301	0.5155	0.7412	0.7101
no_employed	0.0813	0.0926	0.0498	-0.252	0.2386	-0.0356	-0.4639	-0.5288	-0.4547	-0.5526	-0.5111	0.8126	0.9561	0.9354
no_unemployed	0.0928	0.0437	0.0565	-0.1497	0.2144	0.0116	-0.486	-0.5027	-0.431	-0.5089	-0.485	0.8459	0.83	0.8239
gdp	0.0745	0.1036	0.0595	-0.2189	0.2316	-0.0272	-0.4403	-0.4954	-0.4025	-0.496	-0.454	0.8765	0.9431	0.9384
fix_investment	0.0435	0.0276	0.051	-0.2143	0.2152	-0.0112	-0.4838	-0.4783	-0.3716	-0.4639	-0.4332	0.9738	0.907	0.9198
real_estate_investment	0.0046	0.0266	0.0474	-0.2369	0.1967	-0.0278	-0.4972	-0.556	-0.4613	-0.5397	-0.4974	0.9281	0.9143	0.9237
personal_disposable_income	0.1749	0.1098	0.0215	-0.0092	0.1116	0.0038	-0.3216	-0.3808	-0.3556	-0.3931	-0.3454	0.4377	0.5323	0.5328
personal_consumption	0.1233	0.0665	0.0939	-0.1091	0.2208	-0.0056	-0.4314	-0.4244	-0.3395	-0.4354	-0.3934	0.8202	0.7963	0.8029
personal_income_employed	0.1032	0.0207	0.0713	0.0772	0.1535	0.0026	-0.6006	-0.6434	-0.5935	-0.6554	-0.618	0.712	0.7043	0.7043

Table A1 Correlations before Principle Component Analysis (continued)

	registered_pop	*move_in_out*	*no_employed*	*no_unemployed*	*gdp*	*fix_investment*	*real_estate_investment*	*personal_disposable_income*	*personal_consumption*	*personal_income_employed*
registered_pop	1									
move_in_out	0.8331	1								
no_employed	0.981	0.8221	1							
no_unemployed	0.781	0.406	0.7681	1						
gdp	0.9517	0.7488	0.9722	0.7922	1					
fix_investment	0.8448	0.481	0.8131	0.8271	0.8692	1				
real_estate_investment	0.8653	0.5678	0.8417	0.8021	0.8672	0.9454	1			
personal_disposable_income	0.5693	0.4878	0.6734	0.4582	0.7181	0.463	0.482	1		
personal_consumption	0.7943	0.5402	0.8472	0.7609	0.921	0.8222	0.7991	0.7686	1	
personal_income_employed	0.7038	0.491	0.751	0.6905	0.7942	0.7103	0.7164	0.8414	0.8075	1

Table A2 Correlations after Principle Component Analysis

	lyrmc	*currt*	*intcvr*	*invtrtrrat*	*dbastrt*	*peratio*	*geography*	*macro*	*micro*
lyrmc	1								
currt	-0.0338	1							
intcvr	-0.1149	0.0341	1						
invtrtrrat	-0.0324	-0.0475	0.0482	1					
dbastrt	0.0228	-0.0348	-0.0823	0.003	1				
peratio	0.1378	0.044	0.2269	-0.0353	-0.0687	1			
geography	0.0484	0.0648	0.0746	-0.1659	0.2118	-0.0252	1		
macro	-0.0206	0.0771	-0.0769	-0.5066	0.0336	-0.0058	0	1	
micro	0.1932	0.0307	-0.0001	0.1816	-0.0007	0.0382	0	0	1

In the paper, we use the principal components. Here we present additional results to justify this approach.

Table A3 shows that the booked and non-booked financial variables are significantly correlated.

Table A3 Pearson Correlation between booked and non-booked financial variables

	currt	*intcvr*	*dbastrt*	*peratio*	*ebitda*	*npc_cppcc*	*official_1_2*	*official_3_4*	*official_5_6*	*official_7_8*	*official_9_12*
currt	1										
intcvr	0.0341*	1									
dbastrt	-0.0347*	-0.0823*	1								
peratio	0.0440*	0.2269*	-0.0687*	1							
ebitda	0.0083	-0.0322*	0.1178*	0.0739*	1						
npc_cppcc	-0.0171*	-0.0453*	0.2259*	-0.0280*	-0.1778*	1					
official_1_2	-0.0391*	-0.0248*	0.0568*	0.2199*	0.7005*	0.0290*	1				
official_3_4	-0.1177*	-0.0580*	-0.2460*	-0.1554*	-0.1375*	-0.1951*	-0.0198*	1			
official_5_6	0.0118	-0.0490*	-0.0747*	-0.0535*	-0.0795*	0.2090*	-0.0777*	0.0240*	1		
official_7_8	0.0964*	-0.0588*	0.0363*	0.0374*	-0.009	-0.0405*	-0.2278*	-0.1489*	0.3074*	1	
official_9_12	-0.0469*	-0.0706*	-0.0156*	0.0873*	0.0059	0.2616*	-0.0697*	-0.1261*	0.2476*	0.3173*	1

Table A4 shows that we can find most of the booked and non-booked financial variables have Variance Inflation Factors (VIF) significantly higher than 5, indicating a higher probability of causing multicollinearity problems, which cannot be mitigated by directly dropping several proxies.

Table A4 Variance Inflation Factors with and without PCA

Variable	value-based weighting				transaction-based weighting			
	lunit_price		*TOM*		*lunit_price*		TOM	
	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
TOM	1.28	0.782766			1.28	0.784155		
lunit_price			2.13	0.47002			2.13	0.469969
$\widehat{\partial_\iota}$	5.49	0.182246	1.12	0.891292	5.48	0.182538	1.12	0.895263
currt	85.15	0.011744	85.12	0.011748	87.14	0.011475	87.11	0.011479
intcvr	168.05	0.00595	168.02	0.005952	169.24	0.005909	169.21	0.00591
dbastrt	38.96	0.025669	38.96	0.025665	42.6	0.023475	42.61	0.02347
peratio	117.01	0.008546	116.35	0.008595	120.64	0.008289	119.96	0.008336
ebitda	5.01	0.19968	4.86	0.20579	856.87	0.001167	856.57	0.001167
npc_cppcc	4.59	0.217948	4.75	0.210314	4.58	0.218289	4.74	0.21075
official_1_2	377.05	0.002652	376.88	0.002653	569.88	0.001755	569.8	0.001755
official_3_4	379.92	0.002632	380.76	0.002626	403.33	0.002479	404.23	0.002474
official_5_6	21.59	0.046323	21.71	0.046053	21.81	0.045846	21.94	0.045583
official_7_8	20.35	0.049129	20.43	0.048949	20.48	0.048834	20.56	0.048648
official_9_12	38.64	0.025877	38.7	0.025839	39.46	0.02534	39.52	0.025305
vcurrt	84.93	0.011775	84.93	0.011775	86.92	0.011505	86.92	0.011505
vintcvr	167.74	0.005962	167.73	0.005962	168.93	0.00592	168.92	0.00592
vdbastrt	37.95	0.026351	37.94	0.026354	41.58	0.02405	41.58	0.024049
vperatio	115.04	0.008693	114.7	0.008718	118.64	0.008429	118.28	0.008454
vebitda	2.39	0.417975	2.39	0.417958	842.78	0.001187	842.82	0.001186
vnpc_cppcc	4.91	0.203706	4.93	0.202752	4.86	0.205692	4.88	0.204781
vofficial_1_2	365.83	0.002733	365.73	0.002734	554.43	0.001804	554.35	0.001804
vofficial_3_4	377.26	0.002651	378.02	0.002645	400.79	0.002495	401.58	0.00249
vofficial_5_6	22.02	0.045412	22.11	0.045235	22.24	0.044957	22.33	0.044782
vofficial_7_8	21.32	0.04691	21.53	0.046446	21.43	0.046656	21.65	0.046182
vofficial_9_12	38.8	0.025772	38.81	0.025766	39.62	0.025237	39.63	0.025234
unit_floor	1.15	0.868081	1.65	0.607614	1.15	0.868125	1.64	0.608718
unit_area	6.37	0.15708	1.43	0.698185	6.36	0.15712	1.43	0.698119

Appendix B. Major government intervention in the Chinese housing market (2005– 2014)

This table provides a summary of the major government intervention that have significant effects on housing market in China during our sampling period.

Date	Policy or Agent	Basic Contents
2006.5.29	The General Office of the State Council: "Opinions on Adjusting Housing Supply Structure to Stabilize Housing Prices"(GOSC[2006]No.37)	The so-called "Guo Liu Tiao" aims to curb over-rapid housing prices through supply adjustment. During the 11th 5-Year- Plan period, the weight of houses with in-suite floor space of under 90 m2 must be over 70% of the total development and construction area. As for transfer within 5 years of house purchase, business tax will be levied based on the total sales income; the proportion of the first installment of a personal house mortgage shall not be lower than 30%. The first installment shall account for 20% for self-residing house purchased with insuite floor space less than 90 m2.
2006.7	The Chinese Ministry of Housing and Urban- Rural Development: "Several Opinions about Implementing of New Constructed Housing Ratio" MHURD[2006]No.165	It regulated that units with floor area less than 90 square meters must cove 70% of the total floor area in all newly registered or constructed projects.
2006.7	Notice of State Taxation Bureau on Levying Income Tax on Transferring Used House	When levying personal income tax on house transfer, the actual transaction price shall be the transfer income. When the house transaction price, declared by the taxpayer, is lower than the market price, without a proper reason, the levying institution shall have the right to verify his transfer income.
2007. 9	People's Bank of China and China Banking Regulatory Commission: Notice of Strengthening the Management of Commercial Property Credit Loans (CBRC [2007] No. 359).	Tighten credit to the property sector: raise the minimum down-payment ratio to 40% and the minimum mortgage rate to 110% of the benchmark rate for second mortgages. Minimum down-payment ratio and mortgage rates are higher for third mortgage loans.
2007.11	National Development and Reform Commission (NDRC), Ministry of Finance	Cross "Ordinary Residential Property Development" from the list of industries opening to foreign investment. Restrict foreign investment in second-hand house transactions.
2008.10	People's Bank of China: Notice of Extending the Downward Movement of Interest Rates for Loans to Residential Premises of a Commercial Nature for Individuals in Support of First Time Purchase of Ordinary Residential Premises by Residents (PBOC [2008] No. 137).	Reduce the down payment requirements from 30% to 20% and to adjust the lower limit of the lending rate for residential properties to 70% of the benchmark lending rate.
2008.12	The General Office of the State Council: several option on healthy development of real estate market (GOSC [2008] No.131)	Extend preferential policies for first-home purchases to second-home purchases. Shorten the holding period to enjoy business tax exemption from 5 years to 2 years.
2009.5	The General Office of the State Council: "A Notification on the Adjustment of Capital Proportion of Fixed Assets Investment Project"	Reduced the minimum capital requirement for the first time since 2004.

	(GOSC [2009] No. 27)	
2010.1	State Council: The Circular on Promoting the Stable and Healthy Development of the Real Estate Market (SC [2010] No. 4).	The minimum down payment of mortgage loan for additional residential property shall be 40% of the property value.
2010.4	Ministry of Housing and Urban and Rural Development, Ministry of Finance, People's Bank of China and China Banking Regulatory Commission: Notice of Issues Relating to Standardizing Different Residential Mortgage Loan Policies. (MOHUR and MF [2010] No. 179)	The minimum down payment for the first purchase of residents will be increased to 30% and all commercial banks shall suspend granting loans to customers purchasing a third or subsequent residents. For those who purchase a second residential property, the down payment shall not be less than 50% of the value and the interest rate shall not be less than 1.1 times of benchmark interest rate.
2010.9	Ministry of Land and Resources, Ministry of Housing and Urban-Rural Development ML and MOHUR [2010] No. 151.	Prohibiting developers from bidding for new plots of land if they have land that has been purchased for property development and yet left idled for a year. Restrict land supply to high-end housing and make it available only if land supply for low-end housing has been fully met
2010. 9	Ministry of Housing and Urban-rural Construction (MOHUR and PBOC [2010]No. 275)	Impose home purchase restriction rules, limiting the number of houses that individuals or households are allowed to purchase.
2010.11	Ministry of Land and Resources, State Administration of Foreign Exchange (MOHUR [2010] No. 186)	Limit foreign individuals' purchase of residential property for own use to one. Allow overseas institutions to purchase non-residential property only in the city where it is registered.
2010.12	Ministry of Land and Resources (MLS [2010] No. 204)	Require local governments to report unusual land transactions (i.e. land-transaction deals closed either with a price 50% higher than the auction starting price).
2011.1	The General Office of the State Council (GOSC [2011] No. 1)	Require local governments to set price control targets for new housing units (targets will be released within the first quarter of 2011). Collect business tax, currently at 5.5%, based on the home purchase price, rather than on the difference between the cost base and selling price, for all secondhand homes sold less than five years after purchase. Raise down-payment for mortgages on second home to at least 60%.
2011.5	National Development and Reform Commission: "A Notification on the issue of "Regulation of Selling Commercial Housing with Definite Price" (NDRC[2011] No.548)	Listed price is required to be announced for the public. No further extra cost is required by the developer.
2012.2-5	People's Bank of China	During this period, deposit reserve rate of financial institutions decreased twice and each time is decreased by 0.5%.
2012.6	People's Bank of China	The benchmark one year deposit and lending interest rate decreased by 0.25%. The interest rate provident funds is adjusted from 0.50% to 0.4% in the current year.
2014.9	The people's bank of China, the China banking regulatory commission, "the notice on further do a good job of housing financial services to establish"	For the first housing consumer, the minimum down payment is adjusted to 30%, the interest rate of loan was limited to 0.7 times of benchmark rate. For those who have one set of housing, and have paid loan is equally cheated as the first buy in mortgage. MBS and REITS are encouraged.
2014.11	The people's bank of China, the China banking regulatory commission	The benchmark one – year lending interest rate was deceased by 0.4%, and deposit rate was decreased by 0.25%. The financial institutions deposit rate floating range limit by 1.1 times of the benchmark deposit rate from the previous 1.2 times.

Appendix C. Results of the robustness check using financial dependence indicators

Table C1 Developer's Financial Dependence and Location Selection (Robustness Check)

	(1) Region 2/ Region 1	(2) Region 3/ Region 1	(3) Region 4/ Region 1	(4) Region 3/ Region 2	(5) Region 4/ Region 2	(6) Region 4/ Region 3
Value-based weighting						
FD_INV	0.00225***	0.00204***	0.000349	-0.000214***	-0.00190**	-0.00169**
	(0.000187)	(0.000187)	(0.000836)	(0.0000338)	(0.000829)	(0.000829)
FD_INV_{-i}	-0.0119***	-0.0116***	0.0164***	0.000293***	0.0282***	0.0280***
	(0.000657)	(0.000657)	(0.00300)	(0.0000862)	(0.00297)	(0.00297)
year effect	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*
project's cluster	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*
Obs	25330	25330	25330	25330	25330	25330
FD_WK	0.0476***	0.0448***	0.0273*	-0.00283***	-0.0203	-0.0175
	(0.00523)	(0.00526)	(0.0142)	(0.000728)	(0.0133)	(0.0133)
FD_WK_{-i}	0.0293***	0.0179***	-0.00707	-0.0113***	-0.0363***	-0.0250*
	(0.00374)	(0.00380)	(0.0134)	(0.000816)	(0.0129)	(0.0129)
year effect	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*
project's cluster	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*
Obs	55049	55049	55049	55049	55049	55049
Transaction-based weighting						
FD_INV	0.00225***	0.00204***	0.000357	-0.000214***	-0.00189**	-0.00168**
	(0.000187)	(0.000186)	(0.000835)	(0.0000338)	(0.000828)	(0.000828)
FD_INV_{-i}	-0.0119***	-0.0116***	0.0164***	0.000293***	0.0283***	0.0280***
	(0.000656)	(0.000656)	(0.00300)	(0.0000862)	(0.00296)	(0.00296)
year effect	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*
project's cluster	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*
Obs	25330	25330	25330	25330	25330	25330
FD_WK	0.0476***	0.0448***	0.0273*	-0.00283***	-0.0203	-0.0175
	(0.00523)	(0.00526)	(0.0142)	(0.000728)	(0.0133)	(0.0133)
FD_WK_{-i}	0.0293***	0.0179***	-0.00706	-0.0113***	-0.0363***	-0.0250*
	(0.00374)	(0.00380)	(0.0134)	(0.000816)	(0.0129)	(0.0129)
year effect	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*
project's cluster	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*	*controlled*
Obs	55049	55049	55049	55049	55049	55049

Note: This table presents the impact of firm's financial dependence index on the probability project's location choice, controlled for year fixed effect and project's cluster effects on 55170 transaction records. Due to the limitation of the database, we lose the information of *FD_INV* before 2007, which narrows down the valid sample size into 25330. Meanwhile, due to the limitation of the database, we lose the information of *FD_WK* in some real estate firms, which narrows down the valid sample size into 55049. Standard errors are in parentheses: *p<0.10, **p<0.05, *** p<0.01.

Table C2 Developer's Financial Dependence and Project Design (Robustness Check)

	(1)	(2)	(3)	(4)
	lunit_area	*lpro_floor*	*lunit_area*	*lpro_floor*
Value-based weighting				
lpro_floor	-0.178***		-0.257***	
	(0.0127)		(0.00822)	
lunit_area		-2.757***		-4.227***
		(0.147)		(0.265)
FD_INV	-0.0000344***	-0.000101***		
	(0.00000549)	(0.0000160)		
FD_INV-i	0.0000331**	0.000103***		
	(0.0000137)	(0.0000383)		
FD_WK			-0.000636***	-0.00269***
			(0.000102)	(0.000472)
FD_WK-i			-0.00181***	-0.00749***
			(0.000123)	(0.000622)
geography	0.0161***	-0.000101***	0.0423***	0.171***
	(0.00266)	(0.0000160)	(0.00196)	(0.00901)
macro	-0.00662*	0.000103***	-0.0112***	-0.0476***
	(0.00365)	(0.0000383)	(0.00239)	(0.0112)
micro	0.0302***	0.0786***	-0.0137**	-0.0375
	(0.00895)	(0.00680)	(0.00616)	(0.0268)
region effect	*controlled*	*controlled*	*controlled*	*controlled*
year effect	*controlled*	*controlled*	*controlled*	*controlled*
project's cluster	*controlled*	*controlled*	*controlled*	*controlled*
Obs	25330	25330	55049	55049
Transaction-based weighting				
lpro_floor	-0.178***		-0.257***	
	(0.0127)		(0.00822)	
lunit_area		-2.757***		-4.227***
		(0.147)		(0.265)
FD_INV	-0.0000344***	-0.000101***		
	(0.00000549)	(0.0000160)		
FD_INV-i	0.0000331**	0.000103***		
	(0.0000137)	(0.0000383)		
FD_WK			-0.000636***	-0.00269***
			(0.000102)	(0.000472)
FD_WK-i			-0.00181***	-0.00749***
			(0.000123)	(0.000622)
geography	0.0161***	0.0786***	0.0423***	0.171***
	(0.00266)	(0.00680)	(0.00196)	(0.00901)
macro	-0.00662*	-0.00939	-0.0112***	-0.0476***
	(0.00365)	(0.0107)	(0.00239)	(0.0112)
micro	0.0302***	-0.0123	-0.0137**	-0.0375
	(0.00895)	(0.0265)	(0.00616)	(0.0268)
region effect	*controlled*	*controlled*	*controlled*	*controlled*
year effect	*controlled*	*controlled*	*controlled*	*controlled*
project's cluster	*controlled*	*controlled*	*controlled*	*controlled*
Obs	25330	25330	55049	55049

Note: This table presents the impact of firm's financial dependence index on the project's design (building height and unit area), controlled for region fixed effect, year fixed effect and project's cluster effects on 55170 transaction records. Due to the limitation of the database, we lose the information of *FD_INV* before 2007, which narrows down the valid sample size into 25330. Meanwhile, due to the limitation of the database, we lose the information of *FD_WK* in some real estate firms, which narrows down the valid sample size into 55049. We use 3 Stage Least Squares to estimate the above results. Standard errors are in parentheses: *p<0.10, **p<0.05, *** p<0.01.

Table C3 Developer's Financial Dependence and Pricing-Timing Mechanism (Robustness Check)

	(1) 3 Stage Least Squares	(2) TOM Quintile (≤0.25)	(3) TOM Quintile (0.25 to 0.5)	(4) TOM Quintile (0.5 to 0.75)	(5) TOM Quintile (>0.75)	(6) Price Quintile (≤0.25)	(7) Price Quintile (0.25 to 0.5)	(8) Price Quintile (0.5 to 0.75)	(9) Price Quintile (>0.75)
lunit_price									
Value-based weighting									
TOM	0.0377***	-0.119***	-0.504***	0.329***	0.0213**	-0.0644***	-0.00213***	0.00656***	-0.000353
	(0.00367)	(0.0202)	(0.0402)	(0.0701)	(0.00909)	(0.00356)	(0.000622)	(0.00127)	(0.00190)
$\widehat{\partial}_\iota$	-0.342***	-0.387***	-0.418***	-0.307***	-0.178***	0.135***	-0.0363***	-0.0970***	-0.108***
	(0.0134)	(0.0158)	(0.0154)	(0.0445)	(0.0271)	(0.0516)	(0.00358)	(0.00646)	(0.0113)
FD_INV	0.00000121	0.000155***	0.0000810***	0.0000227**	-0.0000954***	-0.0000257***	0.00000404***	0.0000295***	-0.00000386
	(0.00000443)	(0.0000201)	(0.00000849)	(0.00000949)	(0.0000112)	(0.00000715)	(0.00000146)	(0.00000857)	(0.00000786)
FD_INV_{-i}	-0.00000978	-0.00126***	-0.000144***	-0.0000353	0.000158***	0.0000650***	-0.00000559	-0.0000825***	-0.000138***
	(0.0000110)	(0.0000332)	(0.0000212)	(0.0000228)	(0.0000327)	(0.0000176)	(0.00000356)	(0.00000890)	(0.0000210)
Transaction-based weighting									
TOM	0.0376***	-0.119***	-0.504***	0.329***	0.0213**	-0.0644***	-0.00213***	0.00654***	-0.000402
	(0.00366)	(0.0202)	(0.0402)	(0.0700)	(0.00907)	(0.00356)	(0.000622)	(0.00127)	(0.00190)
$\widehat{\partial}_\iota$	-0.342***	-0.388***	-0.418***	-0.307***	-0.178***	0.135***	-0.0363***	-0.0969***	-0.107***
	(0.0134)	(0.0158)	(0.0154)	(0.0444)	(0.0271)	(0.0515)	(0.00358)	(0.00646)	(0.0113)
FD_INV	0.00000125	0.000156***	0.0000810***	0.0000227**	-0.0000951***	-0.0000257***	0.00000404***	0.0000294***	-0.00000338
	(0.00000442)	(0.0000201)	(0.00000849)	(0.00000947)	(0.0000112)	(0.00000715)	(0.00000146)	(0.00000857)	(0.00000786)
FD_INV_{-i}	-0.00000982	-0.00126***	-0.000144***	-0.0000353	0.000157***	0.0000649***	-0.00000560	-0.0000824***	-0.000139***
	(0.0000110)	(0.0000332)	(0.0000212)	(0.0000228)	(0.0000326)	(0.0000176)	(0.00000356)	(0.00000890)	(0.0000211)
TOM									
Value-based weighting									
lunit_price	1.207***	-0.00597	0.534***	-0.876***	1.526	12.63***	62.23***	10.28**	1.477
	(0.409)	(0.0634)	(0.0535)	(0.313)	(1.295)	(4.284)	(10.31)	(4.042)	(1.533)
$\widehat{\partial}_\iota$	1.276***	0.124***	0.0177	0.254***	-0.155	3.005***	1.795***	2.707***	-1.132***
	(0.0948)	(0.0146)	(0.0112)	(0.0655)	(0.284)	(0.730)	(0.180)	(0.186)	(0.302)
FD_INV	0.0000380	0.000471***	0.00000392	-0.0000485*	0.000403*	-0.000466***	0.00118***	-0.00348***	-0.000726**
	(0.0000716)	(0.0000401)	(0.0000125)	(0.0000260)	(0.000238)	(0.000138)	(0.000126)	(0.000310)	(0.000298)
FD_INV_{-i}	0.00000484	-0.000365***	0.0000334	0.0000971	-0.00223***	0.000760**	-0.00307***	0.00411***	-0.0000905
	(0.000178)	(0.000111)	(0.0000313)	(0.0000648)	(0.000508)	(0.000348)	(0.000300)	(0.000395)	(0.000852)
Transaction-based weighting									
lunit_price	1.204***	-0.00589	0.534***	-0.879***	1.550	12.64***	62.22***	10.23**	1.476
	(0.409)	(0.0634)	(0.0535)	(0.314)	(1.300)	(4.293)	(10.31)	(4.040)	(1.535)
$\widehat{\partial}_\iota$	1.276***	0.124***	0.0177	0.254***	-0.155	3.008***	1.795***	2.704***	-1.131***
	(0.0948)	(0.0146)	(0.0112)	(0.0655)	(0.284)	(0.729)	(0.180)	(0.186)	(0.302)
FD_INV	0.0000390	0.000471***	0.00000392	-0.0000485*	0.000405*	-0.000465***	0.00118***	-0.00348***	-0.000720**
	(0.0000716)	(0.0000401)	(0.0000124)	(0.0000260)	(0.000238)	(0.000138)	(0.000126)	(0.000310)	(0.000298)

FD_INV-i	0.00000274	-0.000365***	0.0000334	0.0000972	-0.00223***	0.000758**	-0.00307***	0.00410***	-0.000106
	(0.000178)	(0.000111)	(0.0000313)	(0.0000648)	(0.000508)	(0.000348)	(0.000300)	(0.000394)	(0.000853)

Note: This table presents the impact of firm's financial dependence index (*FD_INV*) on the pricing-timing mechanism estimated by 3 stage least squares. The dependent variable in the upper section is *lunit_price*, while the dependent variable in the upper section is *TOM* controlled for region fixed effect, year fixed effect and project's cluster effects on 55170 transaction records. Due to the limitation of the database, we lose the information of *FD_INV* before 2007, which narrows down the valid sample size into 25330. Column (1) exhibits the simultaneous regression results of whole sample. Column (2) exhibits the simultaneous regression results in the cohort of the shortest duration of sales (lowest 25% *TOM*). Column (3) exhibits the simultaneous regression results in the cohort of the sub-shortest duration of sales (*TOM* located in the interval 25%-50%). Column (4) exhibits the simultaneous regression results in the cohort of the sub-longest duration of sales (*TOM* located in the interval 50%-75%). Column (5) exhibits the simultaneous regression results in the cohort of the longest duration of sales (highest 25% *TOM*). Column (6) exhibits the simultaneous regression results in the cohort of the lowest transaction price (lowest 25% *unit_price*). Column (7) exhibits the simultaneous regression results in the cohort of the sub-lowest transaction price (*unit_price* located in the interval 25%-50%). Column (8) exhibits the simultaneous regression results in the cohort of the sub-highest transaction price (*unit_price* located in the interval 50%-75%). Column (9) exhibits the simultaneous regression results in the cohort of the highest transaction price (highest 25% *unit_price*). Standard errors are in parentheses: *p<0.10, **p<0.05, *** p<0.01.

Table C4 Developer's Financial Dependence and Pricing-Timing Mechanism (Robustness Check)

	(1) 3 Stage Least Squares	(2) TOM Quintile (≤0.25)	(3) TOM Quintile (0.25 to 0.5)	(4) TOM Quintile (0.5 to 0.75)	(5) TOM Quintile (>0.75)	(6) Price Quintile (≤0.25)	(7) Price Quintile (0.25 to 0.5)	(8) Price Quintile (0.5 to 0.75)	(9) Price Quintile (>0.75)
lunit_price									
Value-based weighting									
TOM	0.00830***	-0.173***	-0.420***	-0.195***	0.0556***	0.0437***	-0.00466***	0.000299	-0.00529***
	(0.00173)	(0.0514)	(0.0457)	(0.0230)	(0.00532)	(0.00397)	(0.000919)	(0.00159)	(0.00171)
$\hat{\partial}_{\iota}$	-0.223***	-0.615***	-0.383***	-0.108***	0.00608	0.274***	-0.0304***	-0.0621***	-0.102***
	(0.00646)	(0.0156)	(0.0111)	(0.0157)	(0.0181)	(0.0219)	(0.00247)	(0.00408)	(0.00826)
FD_WK	-0.000404***	-0.00126***	-0.00175***	-0.00301***	0.000261*	0.00158***	-0.000201***	-0.000397***	0.0000489
	(0.0000688)	(0.000147)	(0.000254)	(0.000256)	(0.000148)	(0.000201)	(0.0000383)	(0.0000601)	(0.000103)
FD_WK_{-i}	-0.0000695	0.00140***	0.00209***	0.00148***	-0.00339***	-0.00523***	0.000392***	0.000370***	-0.000665***
	(0.0000823)	(0.000179)	(0.000268)	(0.000264)	(0.000265)	(0.000463)	(0.0000466)	(0.0000640)	(0.0000895)
Transaction-based weighting									
TOM	0.00845***	-0.173***	-0.420***	-0.195***	0.0561***	0.0439***	-0.00467***	0.000281	-0.00519***
	(0.00173)	(0.0515)	(0.0457)	(0.0230)	(0.00535)	(0.00398)	(0.000920)	(0.00159)	(0.00171)
$\hat{\partial}_{\iota}$	-0.224***	-0.616***	-0.383***	-0.108***	0.00625	0.275***	-0.0304***	-0.0621***	-0.102***
	(0.00647)	(0.0156)	(0.0111)	(0.0157)	(0.0182)	(0.0220)	(0.00247)	(0.00409)	(0.00826)
FD_WK	-0.000403***	-0.00126***	-0.00175***	-0.00302***	0.000265*	0.00159***	-0.000201***	-0.000397***	0.0000442
	(0.0000689)	(0.000147)	(0.000254)	(0.000257)	(0.000148)	(0.000201)	(0.0000384)	(0.0000602)	(0.000103)
FD_WK_{-i}	-0.0000749	0.00140***	0.00209***	0.00148***	-0.00342***	-0.00524***	0.000392***	0.000368***	-0.000670***
	(0.0000824)	(0.000179)	(0.000268)	(0.000265)	(0.000266)	(0.000464)	(0.0000466)	(0.0000641)	(0.0000895)
TOM									
Value-based weighting									
lunit_price	3.806***	0.153***	0.342***	0.404**	4.870***	59.85***	36.60***	51.55***	3.364***
	(0.252)	(0.0338)	(0.0396)	(0.180)	(0.662)	(2.371)	(3.969)	(7.246)	(0.938)
$\hat{\partial}_{\iota}$	1.074***	-0.0392***	-0.0158*	0.331***	-0.925***	-0.960***	1.307***	2.417***	-0.209
	(0.0626)	(0.0107)	(0.00823)	(0.0380)	(0.221)	(0.315)	(0.103)	(0.202)	(0.176)
FD_WK	-0.00259**	-0.000222	-0.000672*	-0.00370***	-0.00509**	-0.0573***	-0.0104***	0.000677	0.0412***
	(0.00124)	(0.000236)	(0.000383)	(0.000960)	(0.00198)	(0.00537)	(0.00272)	(0.00442)	(0.00241)
FD_WK_{-i}	0.0112***	0.000886***	0.0000242	-0.00355***	0.0459***	0.113***	-0.00821**	-0.0319***	0.0191***
	(0.00148)	(0.000269)	(0.000405)	(0.00107)	(0.00297)	(0.00668)	(0.00366)	(0.00415)	(0.00301)
Transaction-based weighting									
lunit_price	3.816***	0.153***	0.342***	0.404**	4.840***	59.49***	36.62***	51.79***	3.376***
	(0.251)	(0.0338)	(0.0396)	(0.180)	(0.658)	(2.352)	(3.968)	(7.274)	(0.937)
$\hat{\partial}_{\iota}$	1.073***	-0.0392***	-0.0158*	0.331***	-0.926***	-0.991***	1.307***	2.423***	-0.210
	(0.0626)	(0.0107)	(0.00823)	(0.0380)	(0.221)	(0.315)	(0.103)	(0.203)	(0.176)
FD_WK	-0.00258**	-0.000223	-0.000672*	-0.00370***	-0.00510**	-0.0573***	-0.0104***	0.000763	0.0412***
	(0.00124)	(0.000236)	(0.000383)	(0.000960)	(0.00198)	(0.00535)	(0.00272)	(0.00443)	(0.00241)

FD_WK_{-i}	0.0112***	0.000887***	0.0000244	-0.00355***	0.0460***	0.112***	-0.00820**	-0.0319***	0.0192***
	(0.00148)	(0.000269)	(0.000405)	(0.00107)	(0.00297)	(0.00666)	(0.00366)	(0.00416)	(0.00301)

Note: This table presents the impact of a firm's financial dependence index (*FD_WK*) on the pricing-timing mechanism estimated by 3 stage least squares. The dependent variable in the upper section is *lunit_price*, while the dependent variable in the upper section is *TOM* controlled for region fixed effect, year fixed effect and project's cluster effects on 55170 transaction records. Due to the limitation of the database, we lose the information of *FD_WK* in some real estate firms, which narrows down the valid sample size into 55049. Column (1) exhibits the simultaneous regression results of whole sample. Column (2) exhibits the simultaneous regression results in the cohort of the shortest duration of sales (lowest 25% *TOM*). Column (3) exhibits the simultaneous regression results in the cohort of the sub-shortest duration of sales (*TOM* located in the interval 25%-50%). Column (4) exhibits the simultaneous regression results in the cohort of the sub-longest duration of sales (*TOM* located in the interval 50%-75%). Column (5) exhibits the simultaneous regression results in the cohort of the longest duration of sales (highest 25% *TOM*). Column (6) exhibits the simultaneous regression results in the cohort of the lowest transaction price (lowest 25% *unit_price*). Column (7) exhibits the simultaneous regression results in the cohort of the sub-lowest transaction price (*unit_price* located in the interval 25%-50%). Column (8) exhibits the simultaneous regression results in the cohort of the sub-highest transaction price (*unit_price* located in the interval 50%-75%). Column (9) exhibits the simultaneous regression results in the cohort of the highest transaction price (highest 25% *unit_price*). Standard errors are in parentheses: *p<0.10, **p<0.05, *** p<0.01.

Table C5 Spillover Effect and Pricing-Timing Mechanism (Robustness Test)

	Value-based weighting		Transaction-based weighting	
	(1)	(2)	(3)	(4)
Value-based weighting				
lunit_price				
TOM	0.0382***	0.0161***	0.0380***	0.0159***
	(0.00341)	(0.00174)	(0.00340)	(0.00174)
$lunit\_price_{-i}$	0.149***	0.136***	0.150***	0.140***
	(0.00568)	(0.00265)	(0.00568)	(0.00266)
TOM_{-i}	-0.0502***	-0.0216***	-0.0500***	-0.0213***
	(0.00346)	(0.00167)	(0.00345)	(0.00167)
$\widehat{\partial_\iota}$	-0.314***	-0.217***	-0.314***	-0.216***
	(0.0134)	(0.00663)	(0.0134)	(0.00662)
FD_INV	0.00000725		0.00000728	
	(0.00000445)		(0.00000445)	
FD_INV_{-i}	-0.0000189*		-0.0000189*	
	(0.0000103)		(0.0000103)	
FD_WK		-0.00110***		-0.00111***
		(0.0000698)		(0.0000696)
FD_WK_{-i}		0.000635***		0.000642***
		(0.0000857)		(0.0000855)
TOM				
lunit_price	1.271***	4.283***	1.267***	4.274***
	(0.435)	(0.260)	(0.436)	(0.261)
$lunit\_price_{-i}$	-1.485***	-1.504***	-1.485***	-1.506***
	(0.0759)	(0.0492)	(0.0770)	(0.0505)
TOM_{-i}	1.023***	0.970***	1.024***	0.971***
	(0.00998)	(0.00558)	(0.00998)	(0.00558)
$\widehat{\partial_\iota}$	1.240***	0.946***	1.239***	0.947***
	(0.0964)	(0.0629)	(0.0963)	(0.0629)
FD_INV	0.0000856		0.0000865	

	(0.0000699)		(0.0000699)	
FD_INV $_{-i}$	-0.0000769		-0.0000784	
	(0.000162)		(0.000162)	
FD_WK		-0.00368***		-0.00370***
		(0.00123)		(0.00123)
FD_WK $_{-i}$		0.00974***		0.00971***
		(0.00147)		(0.00147)
project features	*controlled*	*controlled*	*controlled*	*controlled*
macro	*controlled*	*controlled*	*controlled*	*controlled*
region effect	*controlled*	*controlled*	*controlled*	*controlled*
year effect	*controlled*	*controlled*	*controlled*	*controlled*
project's cluster	*controlled*	*controlled*	*controlled*	*controlled*
Obs	25330	55049	25330	55049
R-Square	0.722	0.722	0.678	0.684

Note: This table presents the impact of the spillover effect on the pricing-timing mechanism. Financial independence index is controlled in the regression. We apply three stage least square to estimate the simultaneous regression. The dependent variable in column (1) and (3) is *lunit_price* while the dependent variable in column (2) and (4) is TOM, controlled for region fixed effect, year fixed effect and project's cluster effects on 55170 transaction records. Due to the limitation of the database, we lose the information of *FD_INV* before 2007, which narrows down the valid sample size into 25330. Column (1) exhibits the simultaneous regression results of whole sample. Due to the limitation of the database, we lose the information of *FD_WK* in some real estate firms, which narrows down the valid sample size into 55049. Standard errors are in parentheses: *p<0.10, **p<0.05, *** p<0.01.

Appendix D. Decomposition of developer decisions into internal factors, external factors and unexplained components

The procedure here follows Gyourko (2009). It is based on pseudo R-square calculated in three-stage least squares (3sls) regressions.

1) Run the regression including internal, external and control variables on the RHS. Calculate the pseudo R square (R0).
2) Calculate the unexplained share (unexp%):
   unexp%=1-R0
3) Run the regression including internal and control variables on the RHS. Calculate the pseudo R square (R1).
4) Run the regression including external and control variables on the RHS. Calculate the pseudo R square (R2).
5) Calculate internal share (int%):
   $\text{int\%}=\text{R0}\frac{\text{R0}-\text{R2}}{(\text{R0}-\text{R1})+(\text{R0}-\text{R2})}$
6) Calculate external share (ext%):
   $\text{ext\%}=\text{R0}\frac{\text{R0}-\text{R1}}{(\text{R0}-\text{R1})+(\text{R0}-\text{R2})}$

In this way, unexp%+ int%+ ext%≡1

Notice that this procedure naturally removes the explanatory share of “other control variables” such as area of the housing units, height of housing units, year of completion, etc.

Appendix E. More details of the Beijing housing market.

This appendix provides more details about the Beijing housing market. As we explain in the text, this study employs data from different sources. Our macroeconomic data comes from the Beijing Statistical Yearbook (2007-2009) and includes permanent and external population,[21] land area, population density, disposable income per capita, fixed assets and real estate investment. They are deflated by the annual consumer price index (CPI). Table E1 provides descriptive statistics.

Table E1 Descriptive Statistics of Macroeconomic and Urban Variables

Variable	Definition	Mean	Std. Dev.
	Macroeconomic Attributes		
n_subway	number of subway line	24.0083	19.71746
perma_pop	permanent population	205.5841	105.459
exeter_pop	external population	63.72992	35.2254
registered_pop	registered population	127.9793	61.84703
move_in_out	census register population to move in	14334.71	12260.54
no_employed	number of labor	647797.3	367426.7
no_unemployed	registered urban unemployed people	10787.6	6116.678
gdp	Gross Domestic Product (RMB)	1.13E+07	7631436
fix_investment	fixed assets investment(10,000 RMB)	624.8064	446.7557
real_estate_investment	real estate investment(10,000 RMB)	5.552781	1.038193
personal_disposable_income	disposable income per capita (RMB)	21655.75	2631.232
personal_consumption	consumption per capita (RMB)	15274.05	2221.829
personal_income_employed	labor compensation per capita(10,000 RMB)	4.591129	1.164765
	Project and Unit Attributes		
pro_area	project area(m2)	71249.45	47230.78
pro_floor	total floors of the building	16.12491	7.719355
unit_area	housing area(m2)	123.2227	60.60121
unit_floor	floors of the housing (m2)	8.476661	6.113568
tprice	total sold revenue	1510306	1532998
TOM	time difference between listing time and selling time	5.759752	6.64339
d_cbd	distance to CBD(m)	15679.81	10037.39
d_sub	distance to the nearest subway station(m)	5498.367	6716.824
d_h1	distance to the nearest Third Level 1st Class hospital(m)	7809.088	7692.845
d_pri	distance to the nearest primary school(m)	8022.387	6979.566
d_middle	distance to the nearest middle school(m)	8093.282	7621.499

Our second category of data is housing-related. The micro-level housing data are drawn from the City Housing Index Database, which was established by the Ministry of Construction (MOC) and the Department of Housing and Urban and Rural Construction Committee in Beijing. We focus on development projects by listed firms, as the corresponding financial information is readily available. After the usual data-cleansing procedures,[22] we obtain 59,451 residential unit transaction records from 2006 to 2008. The sample contains information on the project name, unit-selling price, selling time and issue date of the pre-sale license, in addition to the physical attributes of the project and unit, such as project area, the total number of floors in the building, unit area, and the height of the unit. We used GIS Mapping to acquire the location and neighborhood attributes, including the distance to CBD, the nearest subway station,

[21] "Permanent population" refers to the population with the registered citizenship (*hokou*).

[22] We removed observations with incomplete information on one of the following categories: location, project design, and transaction details. We also removed projects that are not developed by listed (A-share) real estate firms in China.

hospitals, and schools.

Tables E2 describes the distribution of residential structure design in Beijing from 2006 to 2008. We find mid-rise (>6 floors, ≤30 floors) and middle units (>60 m^2, ≤120 m^2) appear with the highest frequency. The distribution of housing stock is influenced by both time-varying market demand, urban planning requirement, as well as the so-called "90/70 policy" enacted by the joint declaration of Chinese MOC and other eight ministries and commissions.[23]

Table E2 Statistics of project floor and unit area

Variable	Definition	Freq.	Percent	Cumulative percentage
pro_floor				
1	low-rise (≤6 floors)	7,655	12.88	12.88
2	mid-rise (>6 floors, ≤30 floors)	49,122	82.63	95.50
3	super high-rise (>30 floors)	2,674	4.50	100.00
unit_area				
1	small units (≤60 m^2)	5,263	8.85	8.85
2	middle units (>60 m^2, ≤120 m^2)	28,049	47.18	56.03
3	large units (>120 m^2)	26,139	43.97	100.00

Since this paper focuses on Beijing, it may be instructive to provide more background information of the city. Geographically, Beijing is divided into different "rings." Roughly speaking, the higher the number of the ring, the further the ring is located from the central business district (CBD). We therefore divide our sample into four sub-samples, namely, inside the second ring (the "core function zone''), inside the fifth ring (the "expanded function zone"), inside the sixth ring (the "development zone") and outside the sixth ring (the "ecological zone"). Figure E1 provides a visualization of the geographical distribution of the fifteen districts. We first aggregate them into four Functional Zones or Regions. Table E3 compares the macroeconomic status of the four regions and shows the percentage of units sold in each area in Beijing. During our sampling period, most of the new-developed projects are located inside the fifth ring, and few projects are located inside the 2nd ring or outside the 6th ring. It is probably due to the following facts: (1) the core function zone is already well developed, (2) the infrastructure and amenities in the ecological zone is under-supplied, and (3) the land leasing policy imposed by the government that may not be driven by purely economic reasons.

[23] In May 2006, Chinese MOC and other eight ministries and commissions issued an opinion about the adjustment of residential supply structure and price, which mandatory require that the new residential project whose construction area is below 90 square meters, has to account for more than 70 percent of the whole project. Officially, the intention is to promote housing supply and stabilize housing price, although there may be un-intended consequences, as usual for government policies. For more analysis of the 90/70 policy, see Leung and Wang (2007), among others.

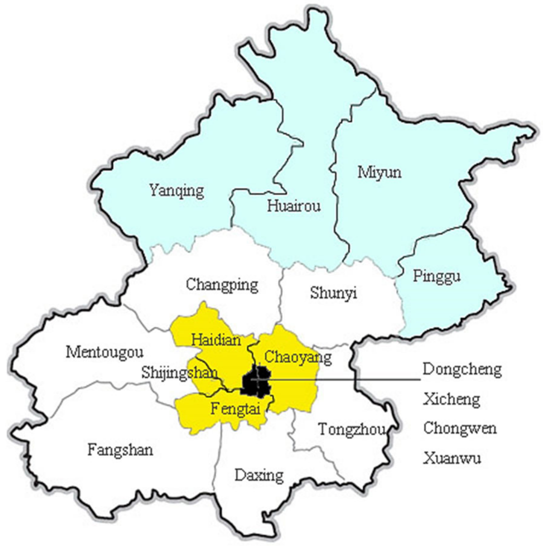


Figure E1 Distribution of Four Functional Zones in Beijing

Table E3 Definition and Statistics of the Four Functional Zones in Beijing

Region	Region 1	Region 2	Region 3	Region 4
Definition of Functional Zones	inside 2nd ring (core function zone)	inside 5th ring (expanded function zone)	inside 6th ring (development zone)	outside 6th ring (ecological zone)
Corresponding Districts	Dongcheng, Xicheng, Chongwen, Xuanwu	Chaoyang, Fengtai, Haidian, Shijingshan	Changping, Daxing, Fangshan, Shunyi, Tongzhou, Mentougou	Huairou, Miyun, Yanqing, Pinggu
Panel A: Projects Distribution in Four Functional Zones				
Freq.	4294	37333	17128	696
Percent	7.22	62.8	28.81	1.17
Cumulative percentage	7.22	70.2	98.83	100
Panel B: Mean Value of Macroeconomic Variables in Four Functional Zones				
personal_disposable_income (RMB)	22163.82	22661.88	19492.32	17793.34
personal_consumption (RMB)	16527.92	16441.54	12562.55	11643.07
pop_density (10 thousand/km2)	2.05	0.65	0.08	0.02
working_ratio (%)	38.05	52.44	39.83	25.06
dependency_ratio (%)	39.07	71.55	61.46	46.85
Panel C: Mean Difference of Macroeconomic Variables in Four Functional Zones (Compared with Region 1, t-test)				
personal_disposable_income (RMB)	-	-498.066***	2671.503***	4370.477***
personal_consumption (RMB)	-	86.385***	3965.376***	4884.854***
pop_density (10 thousand/km2)	-	1.408***	1.974***	2.038***
working_ratio (%)	-	-0.144***	-0.018***	0.130***
dependency_ratio (%)	-	-32.479***	-22.385***	-7.778***

The oligopolistic nature of the Beijing housing market is well illustrated in its distribution of sales volume. Figure E2 shows that the top 10 developers account for about one half of the total sales volume from 2006 to 2008. We naturally turn to the industrial organization literature and measure market concentration. We first calculate the Herfindahl–Hirschman Index (HHI), which is one of the most popular measures in this regard.[24] During this period, HHI reaches 0.26, which indicates that the market is highly concentrated. A concrete example to illustrate the idea: if the ratio of market volume share of the biggest developer (Beijing Urban Construction) to the second-biggest developer (Beijing Capital Development) is 1.5, then the ratio of market volume share of the biggest developer (Beijing Urban Construction) to the tenth biggest developer (Oceanwide Construction Group Co., Ltd) quickly increases to 2.6. As an alternative index, we also calculate the market share of different developers in the four "zones" mentioned above using absolute market concentration (CR_n) as a metric[25] and discover a U-shaped, non-linear relationship for the market share of the top 10 developers (CR_{10} equals to

[24] HHI is a widely used measure of the concentration of industry. It is beyond the scope of this paper to review the related literature. Among others, see Tremblay and Tremblay (2012) and the reference therein. The formula of HHI is simple and stated as follows:

$$H = \sum_{i=1}^{N} s_i^2$$

where s_i is the market share of firm i in the market, and N is the number of firms. Conventionally, a value of HHI below 0.01 may indicate a highly competitive industry, below 0.15 may indicate an un-concentrated industry, between 0.15 to 0.25 may indicate moderate concentration, and above 0.25 may indicate high concentration.

[25] The concentration ratio is the percentage of the market share held by the largest n firms in an industry,

$$\mathrm{CR_n} = \sum_{i=1}^{m} \mathrm{S_i}$$

where $\mathrm{S_i}$ is the market share and $\mathrm{CR_n}$ defines the $\mathrm{n^{th}}$ firm. High concentration ratio in an industry could indicate a relatively low level of competition among firms in that industry (Kambhampati, 1996).

88.7%, 69.6%, 89.0%, and 100% respectively, as shown in Table E4). The market is more concentrated in the inner city as well as the outer sub-urban. This result is intuitive. The land cost in the inner city is very high. And in the outer sub-urban, the market demand is highly uncertain. It discourages financially weak developers from entering those markets. (We will provide a more systematic analysis on the location choices of the developers). Furthermore, the major developers in the four zones are all different, which seems to suggest that different developers might have distinct "comparative advantages" in each zone. Notice that the comparative advantage might be economically (such as local knowledge in a specific area), or politically (such as the top executives being more politically connected to the local government officials).[26] More discussion and analysis related to such market concentration will be presented later.

[26] Notice that the comparative advantage might be economically (such as local knowledge in a certain zone), or politically (such as the top executives being more politically connected to the local government officials).

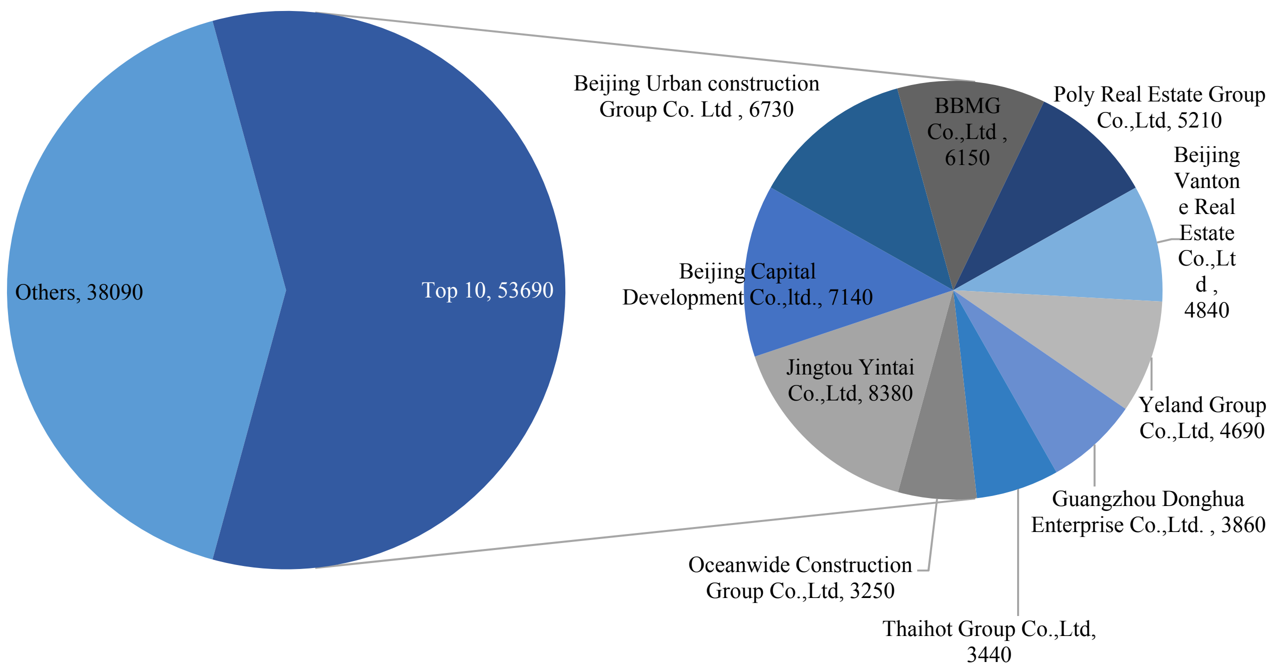


Figure E2 Sale Volume during 2006-2008

Table E4 Distribution of Sale Volume of Top 10 in Four Functional Zones in Beijing

	Region 1	Region 2	Region 3	Region 4
1	Citychamp Dartong Co.,Ltd. (27.5%)	Metro Land Co.,Ltd. (12.5%)	Poly Real Estate Group Co.,Ltd. (27.4%)	Beijing Vantone Real Estate Co.,Ltd (63.6%)
2	Shanghai New World Co.,Ltd. (20.4%)	Beijing Capital Development Co.,Ltd (10.4%)	CAC Group (20.4%)	Beijing Homyear Capital Holdings Co.,Ltd (35.6%)
3	Shenhua Group Co.,Ltd. (10.2%)	Beijing Urban Construction Investment & Development Co.,Ltd. (10.0%)	Lawton Development (8.5%)	Tsinghua Tongfang Co.,Ltd. (0.8%)
4	China Sports Industry Group Co.,Ltd (5.2%)	Bbmg Co.,Ltd. (9.0%)	Dongzhao Changtai Group (6.8%)	
5	Metallurgical Corporation Of China Co.,Ltd. (5.0%)	Yeland Group Co.,Ltd (7.2%)	Pearl River Investment	
6	China Railway Construction Corporation Co.,Ltd. (4.5%)	Guangzhou Donghua Enterprise Co.,Ltd. (5.9%)	Gemdale Co., Ltd.	
7	Metro Land Co.,Ltd. (4.1%)	Oceanwide Construction Group Co., Ltd. (5.0%)	China Vanke Co., Ltd.	
8	Guoxing Rongda Real Estate Co.,Ltd. (4.0%)	Beijing North Star Company Limited (3.2%)	Financial Street Holdings Co.,Ltd.	
9	Rongfeng Holding Group Co.,Ltd. (3.9%)	Yangguang Co.,Ltd (3.0%)	Hubei Golden Ring Co.,Ltd. (2.8%)	
10	Beijing Urban Construction Investment & Development Co.,Ltd (3.8%)	China Sports Industry Group Co.,Ltd (2.8%)	Beijing Sanyuan Foods Co.,Ltd. (2.7%)	

Our third source of data is financial. The RESSET Financial Database provides us the information of the listed developers, including the earnings per share, current ratio, interest cover ratio, inventory turnover ratio, debt-to-asset ratio, PE ratio, and yearly market capitalization. These indices reflect profitability, competitiveness, and the debt-paying ability of the firm.[27] Since the recent literature also demonstrates the potential benefits of political connectedness,[28] which is also referred as un-booked financial status or political economy variables in this paper, we also include additional information such as the firm's corporate governance information including the governance background of firm's board members, supervisors and executive leaders, etc., as a proxy of the firm's political connections. Following Faccio (2006), we identify firm as politically connected if one of the firm's board members, supervisors, or executives used to have official governmental background including the National People's Congress (NPC) deputy, Chinese People's Political Consultative Conference (CPPCC) member, and officials at national, provincial, city or county level. Thus, for each project, we can match the financial status and political connection status of the mother company at the listing time. Table E5 provides a quick summary of the financial and political economy variables of the firms. Several remarks are in order. Recall that the interest cover ratio is a company's earnings before interest and taxes (EBIT), divided by the company's interest expenses for the same period. The top 10 developers have significantly higher interest cover ratio, which is about 140 on average, than the full sample, which is only about 40, suggesting that the interest burden is in fact "lighter" for the big developers.

Moreover, the PE ratio of the top 10 developers is 76, compared to the full sample average, which is less than 6. We may say that the top 10 developers have some advantages in terms of finance. On the other hand, it seems that the top 10 developers are less politically connected at the national and provisional level, but more connected than the average at the city and county level.

Table E5 Descriptive Statistics of Financial and Political Economy Variables of Listed Developers

Variable	Definition	Mean (Full Sample)	Std. Dev. (Full Sample)	Mean (Top 10 developers)	Std. Dev. (Top 10 developers)
	Financial Attributes (booked)				
currt	current ratio	1.600742	2.072399	1.05806	0.520694
intcvr	interest cover ratio	39.38115	260.5568	144.48	567.0533
dbastrt	debt-to-assets ratio	57.51366	32.52184	56.85389	20.84452
peratio	PE ratio	5.260944	132.6877	76.25905	60.5248
ebitda	earnings per share	2.37E+08	4.76E+08	1.62E+08	8.87E+07
	Political Economy Indicators				
npc_cppcc	dummy variable equals to 1 if the corporate management level used to have a NPC and CPPCC background [29]	0.292370	0.454855	0.169015	0.374781
official_1_2	dummy variable equals to 1 if the corporate management level used to have a national official background	0.084841	0.278648	0.020798	0.142714
official_3_4	dummy variable equals to 1 if the corporate management level used to have a provincial or ministerial official background	0.138616	0.345548	0.020798	0.142714

[27] Our choice of variables is guided by the literature and constrained by data availability. For a survey of the literature, see Shleifer and Vishny (1997), among others.
[28] For a review of that literature, see Lambert and Volpin (2017), among others. For the case of China, see Chan et al. (2012), Li et al. (2007, 2008), among others.
[29] "Management level" denotes firm's board members, supervisors and executive layers. NPC denotes National People's Congress and CPPCC denotes Chinese People's Political Consultative Conference (CPPCC).

official_5_6	dummy variable equals to 1 if the corporate management level used to have a city-level or bureau-level official background	0.136059	0.342855	0.177759	0.382326
official_7_8	dummy variable equals to 1 if the corporate management level used to have a county-level official background	0.419111	0.493418	0.546689	0.497837
official_9_12	dummy variable equals to 1 if the corporate management level used to have a township official background	0.209261	0.406785	0.169015	0.374781
official_other	dummy variable equals to 1 if the corporate management level used to have an other official background	0.673249	0.469029	0.569864	0.495116