The Role of Market Competition in Fiscal Policy Transmission

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March 28, 2019

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Abstract

We propose and test market power as a transmission mechanism for fiscal policy. We show that following a targeted fiscal stimulus, the more competitive the market is, the more sectoral output responds, and the less sectoral prices and markups respond. We present a model where this is due to imperfect market competition with endogenous markups. Targeted fiscal stimulus reduces the aggregate demand elasticity in the targeted sector. In response, markups increase less the more competitive the market is. We offer new empirical evidence consistent with this mechanism in the context of a large-scale fiscal stimulus in China in 2009-2010.

JEL: E22, G21, G23, G31, H54, L13, R31
Keywords: Fiscal stimulus, market competition, endogenous markups, China

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I. INTRODUCTION

Rising corporate market power has been under the spotlight of recent public debates. However, our understanding of the macroeconomic implications of rising market power is limited. Recent research suggests that market power may have a direct impact on growth (IMF, 2019), factor shares (Caballero et al., 2017, De Loecker and Eeckhout 2017), and inequality (Egbertsson et al., 2018). But little attention has been paid on how rising market power interacts with macroeconomic policies.

This paper fills this gap. We propose and test market power as a transmission mechanism for fiscal policy. We show that following a targeted fiscal stimulus, sectoral output in the targeted sector responds more the more competitive the market is. We argue, both theoretically and empirically, that this relationship is due to sectoral market power over output and prices.

These results are important for two reasons. First, the market competition mechanism provides an explanation for why supply-side factors matter for the effect of fiscal stimulus ("fiscal multiplier"). Understanding this mechanism not only helps policymakers to design fiscal and industrial policies but also helps the economics profession in reconciling the wide range of estimations in the literature. Second, the market competition mechanism provides an explanation for why the effect of fiscal stimulus may vary depending on the target of fiscal stimulus. This mechanism is missing in existing theories of stimulus assume the government allocates the stimulus spending as across sectors (e.g., Nakamura and Steinsson 2014).

In the first part of this paper, we build an analytical model of fiscal stimulus under imperfect product market competition. Our model has two key ingredients: fiscal stimulus targeted to a specific sector and variable markups in the targeted sector. It includes a tractable model of quantity competition à la Cournot in which firms do not fully pass through changes in their marginal costs to prices. We focus on the role of targeted fiscal stimulus in generating variable markups which in turn affect prices and outputs in the targeted sector. Our model shows that following a targeted fiscal stimulus, the responses of real and nominal outputs, prices and markups in the targeted sector depend on market competitiveness. The more competitive the market is, the more sectoral output responds to fiscal stimulus. In addition, the more competitive the market is, the less sectoral prices and markup respond.

The intuition is as follows. Consider an economy with a government who consumes goods from one sector (i.e. the targeted sector) and households who consume goods from multiple sectors. Because government spending is targeted, government demand is less elastic than consumer demand in the targeted sector. A fiscal stimulus thus would lead to a less elastic aggregate demand for output in this sector. The supply-side response to the demand shock depends on the competitiveness of the product market, which in turn determines the overall
response in output and prices. Take as an example the extreme case where the targeted sector is perfectly competitive (and marginal cost is constant), neither markups nor prices respond to the demand shock. Fiscal stimulus will increase output substantially. In an opposite case with monopoly, markups increase in response to lower demand elasticity following the aggregate demand shock. As a result, part of the positive demand shock is absorbed by rising prices and output response will be limited. As we will show in the model, the same intuition applies with a more general setting of market competition and when allowing the fiscal stimulus to also affect the marginal cost of production.

These insights of our model, while intuitive, are difficult to test empirically. One critical challenge is to find cross-sectional variations in market competition that are arguably exogenous to fiscal stimulus and other demand shocks. Whereas most prior papers on market competition rely on cross-industry variations, such an empirical design would be inappropriate to study the transmission of fiscal policy because fiscal stimulus are often targeted. The market structures in the targeted sectors are not representative. Furthermore, it brings additional challenge of separating the direct effect from fiscal stimulus and the indirect effect from sectoral spillovers.

In the second part of the paper, we offer new empirical evidence consistent with the predictions of our model in the context of a large-scale fiscal stimulus in China in 2009-2010. The institutional features of the stimulus allow us to address the empirical challenge using geographical variations for identification.

The Chinese fiscal stimulus provides an almost ideal laboratory for several reasons. First, almost all public spending was carried out by local governments and concentrated on the non-tradable construction sector. Close to 90 percent of the estimated 3.8 trillion Yuan of local government spending was predominantly targeted on infrastructure and housing projects (Table 1).2 From an empirical identification perspective, targeted government spending in localized construction markets means that we can isolate the response to government spending in distinct markets. If the stimulus was targeted in a tradable sector, there would be little reason to expect that the effect of government spending to be localized. Second, ideally for us to examine the market competition channel, local entry barriers across Chinese cities vary in the construction sector depending on local geographical and regulatory features.3 These features are arguably independent of short-run macroeconomic conditions, which create exogenous variations in local construction sector market structure. Third, the capital market is also highly localized in China. Firms heavily rely on local banks for financing. The funding of local government spending during the 2009-2010 stimulus was

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2 It includes railway, road, airport, water conservancy, urban power grids, (urban) housing security, and rural livelihood and infrastructure.

3 Throughout this paper, we use the term “city” to denote a prefectural-level division, the second-level unit of China’s administrative structure, for exposition.
also predominantly funded by local banks. This allows us to use local bank branch data to empirically control for credit availability, a channel shown to also have implications for investment in private firms (Huang et al. 2017).

At the aggregate level, the positive correlation between private investment and market competition in the construction sector during the stimulus period is self-evident. Figure 1 shows that over 2008 to 2013, in cities with more construction firms in 2004 (a proxy for higher market competition in local construction sector), private investment in the construction sector responded more to local government stimulus spending.\(^4\)

![Figure 1: Market Competition and the Effect of Public Spending](image)

To establish a causal link, we exploit the geographic variations in government spending and market competition across Chinese cities. Our empirical tests examine whether investment, markups, and factor prices in the construction sector respond to local government spending differently depending on the competitiveness of the sector. Our identification assumption is that a city did not implement more fiscal stimulus and private firms also did not invest more because the competitiveness of the construction sector was more (or less) competitive than the average city. To ensure the validity of our identification, we use two alternative measures of market competition. The first is the number of firms (normalized by population) in the pre-stimulus period (of 2004). This hinges on the assumptions that firms did not enter or exit the market prior to 2004 in anticipation of the fiscal stimulus and that the market structure remain unchanged from 2004 to the post-stimulus period. The first assumption is likely satisfied because the stimulus (and the preceding global financial crisis) was largely unanticipated in 2004. The second assumption is more restrictive due to rapid development in the construction sector in the mid-2000s in China. Our second measure of market

\(^4\) City-level private investment in the construction sector is constructed as the sum of tangible fixed asset investment of all private construction firms within the city between 2008 to 2013.
competitiveness addresses this concern. We use data from 1998 to 2004 to estimate the number of firms in the local construction sector as a function of geographical land supply constraint, local entry regulations, and province fixed effects. We then use the estimated function to predict construction sector competition during the stimulus for our analysis. As a result, the predicted measure of market competition reflects these geographical and regulatory constraints that are arguably unrelated to local macroeconomic conditions.

Consistent with our theoretical predictions, we find that, in response to local government spending, private investment increases more in the construction sector in cities with a higher level of market competition to begin with. Furthermore, land prices and markups in the construction sector increase less in cities with more market competition. These results, to the best of our knowledge, provides one of the first micro evidence on the interaction between market competition and fiscal policy transmission.

Despite the Chinese focus of our empirical analysis, our theory can be applied to broad empirical settings. Targeted fiscal stimulus is a popular policy tool in many countries.\(^5\) More generally, our model suggests the importance of supply-side factors (and their interactions with market structure) in gauging the effectiveness of fiscal policy.

Our paper is related to several strands of the literature. First, our paper builds on a large on fiscal stimulus. One challenge of this literature is to provide direct empirical evidence to establish the mechanisms channels of fiscal stimulus and reconcile a wide range of empirical estimates. We contribute to this literature by proposing market competition as a specific mechanism and show that it is empirically important in explaining the heterogenous response to fiscal stimulus. Our market competition mechanism works through the endogenous response of markups to demand elasticity. It is, thus, different from existing theoretical mechanisms. The key element in our model that drives this difference is that government stimulus has a sectoral target different from the household’s consumption basket.

Second, our results relate to a recent empirical literature on the macro implication of market power. As we discuss before, this literature has primarily focused on growth, factor shares, and inequality. We complement this literature by addressing the implication of market power on fiscal policy transmission. Regarding identification strategy, prior studies mostly rely on cross-sector or time-series variations for identification. In contrast, we explore geographical variations in market structure to establish a causal link.

\(^5\) Well known examples include the Work Projects Administration (WPA) set up in the US during the 1930s to carry out public infrastructure projects as part of the New Deals and infrastructure investment in the American Recovery and Reinvestment Act of 2009 (ARRA). Infrastructure spending accounts for a large fraction of total stimulus spending in advanced economies (20 percent) as well as in emerging economies (40 percent).
Finally, we contribute to a nascent literature on the implication of large-scale fiscal stimulus in China. Bai et al. (2016) argue that the stimulus has aggregate consequence due to its impact on government debt accumulation and capital allocation. Huang et al. (2017) show that the stimulus may have negative consequence on manufacturing investment because it crowds out funding for private firms. Our paper complements this literature by highlighting a market competition as a separate mechanism. Unlike prior papers that focus on allocation across sectors, our mechanism relies on the complementarity between government and private demand in the same sector.

The paper is organized as follows. Section II presents the theoretical model. Section III describes the empirical model. Section IV discusses the data. Section V presents empirical results. Section VI concludes.

II. Model

A. Set up

Production

The final goods of the economy are produced by a competitive firm using the output of a continuum of sectors $s \in [0, 1]$ as inputs using a CES production function:

$$Y = \left[ \int_0^1 (y_s) \rho \cdot ds \right]^\frac{\rho}{\rho - 1},$$

where $y_s$ is output in sector $s$ and $\rho$ is thus the elasticity of substitution across sectors.

Within the construction sector $h$, there are $N$ firms producing sectoral output in a monopolistic competition. The sectoral output is given by:

$$y_h = \left[ \sum_{i \in h} \frac{y_{hi}^{\eta - 1}}{\eta - 1} \right]^{\frac{\eta}{\eta - 1}}, \quad (1)$$

where $\eta$ is the elasticity of substitution across firms.

Following Epple, Gordon, and Sieg (2010), we assume constant returns to scale in the construction sector. Each firm produces using a combination of land $d$ and all mobile nonland factors $k$:

$$y_{hi} = A k_i^\alpha d_i^{1 - \alpha}, \quad (2)$$

where $A$ is a common productivity shifter. The cost of land development and the nonland factor $k$ are $m$ and $r$ respectively.\(^6\)

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\(^6\) Given that the construction sector is imperfectly competitive, the observed land prices are results of bargaining between local governments and firms. The cost of land development $m$ refers to the technical cost, which is
Household

A representative household in the economy maximizes the consumption of final goods subject to a budget constraint:

\[
\max C = \int_0^1 (c_s) \frac{\rho-1}{\rho} ds, \tag{3}
\]

\[
s.t. \int_0^1 p_s c_s ds = I,
\]

where \( I \) indicates the after-tax disposable income of the household.

Government

We model the fiscal stimulus as a targeted government spending \( G \), which is exclusively used on the construction sector.

Market structure

We assume imperfect competition among individual goods producing firms. We make the following assumptions on market structure.

**Assumption 1** (elasticity of substitution). Goods are imperfect substitutes within the construction sector: \( \eta < \infty \). Goods within a sector are more substitutable than goods across sectors: \( 1 < \rho < \eta \).

**Assumption 2** (factor market). All firms lease nonland factor \( k \) from a frictionless factor market. Construction firms also lease land from the government, who is the sole owner of land. Individual construction firms split its profit with the government through a Nash bargaining process. The share of profits \( B \) to an individual firm depends on the number of firms in the construction sector \( 0 < B(N) < 1 \). The elasticity of profit share with respect to \( N \) is less than 1, that is, \( B'(N) \frac{N}{B(N)} < 1 \).\(^7\)

\(^7\) This assumption is equivalent to assuming that \( \frac{B(N)}{N} \) is decreasing in \( N \), which could be micro-founded using a model with a fixed entry cost. The assumption then ensures that firm-level average profit decreases in the market size \( N \), so that there exists an equilibrium with a finite number of firms.
Assumption 3 (quantity competition). Firms in the construction sector play a static game of quantity competition. Specifically, each firm chooses its output $y_{ht}$, taking as given the total number of firms $N$, the output chosen by other firms, as well as factor prices $r$, $m$.

Under Assumption 3, each construction firm recognizes that sectoral prices and quantities vary when the firm changes its quantity. Its output price is thus determined by the inversed demand function:

$$\frac{p_{hi}}{p_{h}} = \left( \frac{y_{hi}}{y_{h}} \right)^{\frac{1}{\eta}}.$$

Each firm’s profit maximization problem can be written as:

$$\max_{y_{hi}} B(N) \left[ p_{hi} y_{hi} - y_{hi} MC_{hi} \right], \quad (4)$$

where $MC_{hi} = A^{-1} \left( \frac{r}{a} \right)^{\alpha} \left( \frac{m}{1-a} \right)^{1-\alpha}$ is the marginal cost derived from the production function (2).

B. Competitive equilibrium

Equilibrium definition

The competitive equilibrium in this economy is defined as follows:

1. Households take sectoral price indices $\{p_{s}\}$ and after-tax income $I$ as given and maximize total consumption $C$ by solving problem (3).

2. Each construction firm solves the optimization problem (4) taking house price $p_{h}$, and factor costs $r$ and $m$, the number of firms $N$, and other firms’ output as given.

3. The output market clears in each sector. For sectors other than the construction sector, sectoral output is equal to household consumption: $c_{s} = y_{s}, \ \forall s \neq h$; for the construction sector, sectoral output is equal to household consumption plus government spending: $y_{h} = c_{h} + g_{h}$, where $g_{h} = \frac{G}{p_{h}}$.

The competitive equilibrium in this model is a partial equilibrium, as there is no market for the nonland factors. We do so in order to derive intuitive analytical results that can be tested in the empirical analysis. The implications of the model, however, can be generalized to allowing the price of nonland factor, $r$, and productivity, $A$, to respond to the fiscal stimulus. Given that the nonland factor is a mobile factor used in the production of all sectors, its price even in the general equilibrium should be independent of the market structure in the construction sector.
Solving the equilibrium

We solve the competitive equilibrium as follows. Since there is a continuum number of sectors, the aggregate household consumption $C$ and aggregate price index $P$ is not affected by any individual sector.

Household optimization problem (3) solves the relationship between sectoral price index and sectoral household consumption relative to the aggregate indicators:

$$\frac{c_s}{C} = \left(\frac{p_s}{P}\right)^{-\rho}, \ \forall s.$$ 

Define the construction sector output consumed by households and government as $c_h$ and $g_h$ respectively. The market clearing conditions imply the following:

$$y_h = c_h + g_h = p^\rho c_h^{\rho} + \frac{G}{p_h} = \sum_i y_{hi}$$

Construction firm $i$’s optimization problem solves (4). Taking prices and market structure as given, the first-order condition of $i$’s optimization problem thus equates its marginal revenue to its marginal cost:

$$p_{hi} + \frac{\partial p_{hi}}{\partial y_{hi}} y_{hi} = MCh.$$ (6)

**Proposition 1:** The markup of construction firm $i$ can be written as a function of its effective elasticity $\epsilon_i$: $\mu_i \equiv \frac{p_{hi}}{MC_h} = \frac{\epsilon_i}{\epsilon_i - 1}$. Without fiscal stimulus ($G = 0$), firm $i$’s effective demand elasticity $\epsilon_i$ satisfies:

$$\frac{1}{\epsilon_i} = (1 - s_i) \frac{1}{\eta} + s_i \frac{1}{\rho},$$

where $s_i \equiv \frac{p_{hi} y_{hi}}{p_h y_h} = \left(\frac{y_{hi}}{y_h}\right)^{\frac{\eta-1}{\eta}}$ is the market share of firm $i$ in the construction sector $h$. With fiscal stimulus ($G > 0$), Firm $i$’s effective demand elasticity $\epsilon_i$ satisfies:

$$\frac{1}{\epsilon_i} = (1 - s_i) \frac{1}{\eta} + s_i \frac{1}{\eta} \frac{g_h}{g_h + c_h} + \frac{c_h}{g_h + c_h} \frac{1}{\rho}.$$ 

The results of Proposition 1 have very intuitive interpretations. The inverse demand elasticity each firm face is a weighted average of the inverse of within-sector demand elasticity and the inverse of cross-sector demand elasticity. The higher the market share $s_i$ is, the more important firm $i$’s decision is relative to the entire sector. Firm $i$’s effective demand elasticity thus depends more on cross-sector demand elasticity. Without government stimulus, the
cross-sector demand elasticity is only determined by the elasticity of consumer demand $\rho$. Without government stimulus, the cross-sector demand elasticity is determined by the elasticity of government’s demand (equal to 1 because the stimulus is targeted) and the elasticity of consumer demand $\rho$, weighted by the relative size of government and consumer demand.

An immediate implication of Proposition 1 is that with targeted stimulus, firm $i$’s markup $\mu$ is increasing in its market share because $1 < \rho < \eta$ by Assumption 1.\(^8\)

**Proposition 2.** Under proper parameterizations, there is a unique equilibrium in the construction sector that satisfies conditions a) – c).\(^9\)

*Proof:* See Appendix.

Next, we study the impact of government spending $G$ on construction sector output and prices. To derive closed-form solutions, we focus on the following simplifying assumption that limit case in which within-sector elasticity $\eta \to \infty$.

**Assumption 4 (Cournot competition).** Firms in the construction sector produce homogeneous goods: $\eta \to \infty$. They play a static game of Cournot competition. Specifically, each firm chooses its output $y_{hi}$, taking as given the output chosen by other firms, as well as factor prices $r, m$, and the final consumption price $P$ and quantities $C$.

Because construction firms have identical products and cost, Assumption 3 implies that the all firms in the construction sector are symmetric, each with a market share of $1/N$.

**Proposition 3.** For a given positive government spending $G$,

1) the changes in construction sector output $y_h$, real estate price $p_h$, and land price are ambiguous: $\frac{\partial y_h}{\partial G}, \frac{\partial p_h}{\partial G}, \frac{\partial landp}{\partial G}$ can be either positive or negative;

2) markup $\frac{p_h}{MC_h}$ increases; the more competitive the construction sector is (larger $N$), markup increases less: $\frac{\partial^2 (\frac{p_h}{MC_h})}{\partial G \partial N} < 0$;

3) the more competitive the construction sector is (larger $N$), output price $p_h$ and land prices grow at a slower pace: $\frac{\partial^2 log p_h}{\partial G \partial N} < 0, \frac{\partial^2 log landp}{\partial G \partial N} < 0$;

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\(^8\) Under Assumption 3, a firm’s market share is the inverse of the number of the firms within the construction sector. So, markup is decreasing in the number of firms.

\(^9\) A unique competitive equilibrium exists under very general conditions: $G \geq 0, AND P, C, N, MC_h, B(N) > 0$. 
4) the more competitive the construction sector is (larger $N$), the construction sector output increase more: $\frac{\partial^2 p_h y_h}{\partial G \partial N} > 0$.

*Proof:* See Appendix.

**Discussion**

Assumption 1 is the key feature of this model that generate variable markups. The assumption that $1 < \rho < \eta$ implies that given market share, each firm’s markup depends on an weighted average of within-sector elasticity $\eta$ and across-sector elasticity $\rho$. Firm markup is decreasing in the two elasticities and increasing in its market share within the sector. This mechanism is a common feature of models with a within-sector CES production function nested in a cross-sector CES production function.

The key feature that links variable markups to fiscal stimulus is the targeted stimulus spending, which generates differentiated demand elasticities for the government and the households for goods in the targeted sector.

In our baseline model, we assume market structure is predetermined. In particular, we assume the number of firms in the construction sector $N$ is fixed and we do not allow for firm entry and exit. We do so in order to illustrate the mechanism of endogenous markup through changes in aggregate demand elasticity rather than through entry and exit. Nevertheless, under weak assumptions, our main results in Propositions 3 will carry over when we allow for entry and exit. The intuition is the following. Consider the same government spending shock in two markets, because the profit margin in the less competitive market is lower to start with, entry into the more competitive market will have a smaller marginal impact on individual firm’s markup than entry into the less competitive market. As a result, the market response in the more competitive market continues to be smaller than the market up response in the less competitive market as in our baseline model.

### III. The empirical model

**A. Private investment**

We are interested in estimating how private firms the construction sector respond differently to government spending shock during the 2009-2010 stimulus depending on the competitiveness of the sector. We consider the following cross-sectional regression in our baseline specification:

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10 Atkeson and Berstein (2008) use a model with variable markups due to entry and exit to explain deviations from relative purchasing power parity in an international model. Different from their model, our model does not rely on changes in market structure (e.g. through entry and exit) to generate variable markup.
\[ \frac{I_{it}}{K_{it-1}} = \alpha + \beta G_c + \gamma G_c \times \text{Competition}_c + X_{it-1} + \epsilon_{it}, \] (7)

where \( i, c, \) and \( t \) index firm, city and time respectively. The pre-stimulus period (2008) is denoted by \( t - 1 \) and the post-stimulus period (2013) is denoted by \( t \). \( K_{it-1} \) is the value of pre-stimulus fixed assets of firm \( i \) and \( I_{it} / K_{it-1} \) measures cumulative investment (relative to pre-stimulus assets) from 2008 to 2013. \( G_c \) is city-level local government spending during 2008-2013, normalized by the pre-stimulus investment in the construction sector. \( \text{Competition}_c \) is a measure of market competition in the construction sector in city \( c \). \( X_{it-1} \) is a vector of firm- and city-specific controls to be specified below.

Our main variable of interest is the interaction term of government spending \( G_{ct} \) and construction sector competition \( \text{Competition}_c \). We interpret a positive (negative) coefficient of \( \gamma \) as evidence that market competitiveness facilitates (impedes) the transmission of fiscal stimulus to private investment. The identification assumption is that private firms did not invest more because its construction sector was more (or less) competitive than the average city.

The main econometric challenge is that local market competition may be correlated with firm- or city-level shocks to investment opportunities in a way that undermines our identification strategy. Using pre-stimulus information to construct the market competition measure ensures that our market competition measure is not affected by outcomes during the stimulus period. To limit the impact of anticipated future investment opportunities on firm entry and exit decisions, we use the market competition measure in 2004 instead of 2008. While it might not fully rule out entries in anticipation of the large-scale stimulus plan, the fact that we rely on the GFC and post-crisis fiscal stimulus (both of which are unanticipated before the crisis, especially in 2004) means that such biases are likely to be small.

To further mitigate this problem, we explore geographical and regulatory features to predict market competition. The first feature we use is geography-based land supply elasticity following the approach of Saiz (2010). Land supply elasticity is related to land price appreciation in response to demand shocks so that it predicts the level of market competition (i.e. the number of firms). We expect land supply elasticity to be positively correlated with market competition in the construction and real estate development sector.

The second feature we use is province-level entry requirement into the construction sector. Entry requirements—including the minimum startup capital requirement and maximum development scale—vary across provinces. In provinces with more stringent entry requirement, entry into the construction and real estate development sector is more difficult. We thus expect entry requirement to be negatively correlative market competition.
Formally, we estimate market competition as a function of land supply elasticity and entry requirements with pre-stimulus data:

\[
\text{Competition}_{ct} = \alpha + \beta \text{Elas}_c + \gamma \text{EntryReq}_{pt} + \delta_p + \phi_t + \nu_{ct},
\]

where \(c, p, \) and \(t\) index city, province, and time respectively, \(\text{Elas}_c\) is land supply elasticity, \(\text{EntryReq}_{pt}\) is entry requirement. \(\delta_p\) and \(\phi_t\) are province and time fixed effects. We then use fitted values from equation (10) to predict market competition using entry requirement in 2008:

\[
\text{Competition}_{c,2008} = \hat{\alpha} + \hat{\beta} \text{Elas}_c + \hat{\gamma} \text{EntryReq}_{p,2008} + \delta_p.
\]

We then use the predicted market competition \((\text{Competition}_{c,2008})\) from equation (9) to replace \(\text{Competition}_{c}\) measured as the number of construction firms in 2004 in city \(c\) and estimate equation (7).

Our assumption is that geographical and regulatory features are not correlated with investment opportunities at the city-level. For entry requirements, because they are set at the province level, there is little reason to believe that they would be correlated with investment opportunities at the city level unless shocks to investment opportunities occur at the province level, which we control for using province fixed effects. For land supply elasticity, one challenge to our assumption could be that developable land could be correlated with unobserved supply-side shocks to investment opportunities in the construction sector. In our robustness tests, we control for the growth rate of city-level land prices because supply-side shocks would matter mostly through the price change of sector-specific factors (i.e. land). Another channel through which supply-side shocks may matter is credit supply. In our robustness test, we also control for proxies for the efficiency of the local bank sector.\(^{11}\) Our results on market competition are robust to including these controls. One remaining concern is that predicted market competition may be systematically related to future demand shocks (for example, through pre-emptive entry regulation in anticipation to future demand shocks). This does not seem to be the case because predicted market competition is not correlated city-level population growth or wage growth between 2008 and 2013—proxies for city-level demand shocks.\(^{12}\)

### B. Land prices, house prices, and markup

Our first empirical model focus on the (real) quantity of investment. Our second model provides additional evidence on investment-good price. Two main components of investment

\(^{11}\) These proxies include the number of state-owned bank branches as a share of all bank branches and its interaction with stimulus spending.

\(^{12}\) The coefficients on predicted market value on population growth or wage growth are 0.001 and -0.002, with p values of 0.27 and 0.11, respectively.
cost in the construction and real estate development sector are the cost of land and nonland factors, including structure and labor. Here, we focus on the empirical question of whether the effect of public investment on land price depends on local market competition. We focus on land price instead of structure price because land is a non-tradable good whereas structure is tradable, so structure price does not have much variation across cities.

We estimate the following model of land prices using transaction-level data of all land transactions from 2000 to 2016:

\[
P_{zt} = \alpha + \beta G_{ct} + \gamma G_{ct} \times Competition_{ct} + \psi X_{zt} + \tau_c + \rho_t + \epsilon_{zt},
\]

where \( z, c, \) and \( t \) index land transaction, city, and time respectively. \( P_{zt} \) is land price measured by land price (per unit of developable land area) in natural logarithm. \( G_{ct} \) is government spending in city \( c \) in year \( t \).\(^{13}\) \( X_{zt} \) is a vector of land characteristics. \( \tau_c \) and \( \rho_t \) are city and time fixed effects respectively. We cluster the standard error \( \epsilon_{zt} \) at the city level.

We also estimate the following city-level Hedonic land price model:\(^{14}\)

\[
\tilde{P}_{ct} = \alpha + \beta G_{ct} + \gamma G_{ct} \times Competition_{ct} + \nu_{ct},
\]

where \( \tilde{P}_{ct} \) is the Hedonic land price index of city \( c \) at time \( t \) from the following city-level regression:

\[
P_{zt} = \sigma + \varphi X_{zt} + \tilde{P}_{ct} + \epsilon_{zt}
\]

We estimate the equation both with and without one-year lagged hedonic land price index, and the estimate of \( \gamma \) are similar in both cases.

Next, we use city-level house price as dependent variable in model (10) with Hedonic land price index as additional control. We interpret house price as output price in the construction sector and land price as input cost. With the reasonable assumption that other inputs to the construction sector are tradable and thus not city-specific, this model provides evidence on the markup of the construction sector.

\(^{13}\) The pre-stimulus government spending was close to zero, but we include them in the regression to estimate other coefficients and the fixed effects.

\(^{14}\) In an alternative specification, we include in the one-year lagged city-level Hedonic land price index, \( \tilde{P}_{ct-1} \), and we find similar results.
IV. DATA AND METHODOLOGY

A. Data and measurements

Local government spending

Publicly available information on local government spending through off-balance-sheet companies (LGFV) is provided through these companies’ annual balance sheet reports. LGFVs that issue bonds in a given year are required to disclose their balance sheet for the current and the previous two years. This information is collected by a company named Wind Information Co. (WIND).\(^\text{15}\) From individual LGFV balance sheet, we first calculate net investment as the change in tangible assets plus the disposal of fixed assets.\(^\text{16}\) We then aggregate LGFV investment at the city level and normalize by one-year lagged aggregate city real estate investment from city yearbooks.\(^\text{17}\)

We focus on local government stimulus measured through local government’s off-balance-sheet expenditure for three reasons. First, off-balance-sheet expenditure reflects the majority of discretionary stimulus spending.\(^\text{18}\) Chinese local governments are legally prohibited from borrowing or running deficits. To circumvent these restrictions, local governments were allowed to create off-balance-sheet companies to fund the stimulus.\(^\text{19}\) On-balance-sheet spending, in contrast, typically do not reflect the extent local stimulus due to budgetary restrictions. To the extent that the correlation of on- and off-balance-sheet government spending at the city-level does not vary systematically with local market competition, focusing on off-balance-sheet government spending does not affect the estimation of our main variable of interest. Second, one concern about on-balance sheet expenditure is that local governments under budgetary pressure may have incentives to generate revenue by increasing land supply for development, for example by rezoning. Because off-balance-sheet expenditure is not subjected to budget balance rules, we have no obvious reason to believe that local government stimulus through off-balance-sheet LGFVs are related to land supply.

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\(^{15}\) Another publicly available information is the National Audit Office’s auditing reports. The auditing report cover all LGFVs, including those that do not issue bonds, but is only available at the province level.

\(^{16}\) One caveat of the data is that although LGFV were originally established to finance local infrastructure projects, many have later taken on commercial projects. The WIND data report all assets and liabilities of LGFV, including those related to commercial projects. Nevertheless, to the extent that the share of commercial projects in total projects do not vary systematically with our market competition measure, our estimates are not affected.

\(^{17}\) The results hold when we normalize LGFV investment by one-year lagged city-level GDP.

\(^{18}\) Bai et al. (2016) estimate that off-balance-sheet spending accounts for \(\frac{3}{4}\) of total stimulus.

\(^{19}\) Typically, local governments would transfer government-owned land to these off-balance-sheet companies, who would then use the land as collateral to finance the stimulus.
Third, on-balance-sheet expenditure may include government purchases that are contracted to private firms by local governments. In this case, government purchases may be “double counted” by our independent variable $G_{ct}$ and dependent variable $I_{it}$. This problem does not affect off-balance-sheet expenditure because the fixed assets are accounted for on the balance sheet of LGFVs instead of the private contractors.

**Private investment**

The source of firm level data is the 2008 and 2013 National Economic Census. We obtain balance sheet information for 25,935 firms in the construction sector, which includes construction and real estate development firms. The Census also provides information on ownership. We restrict our sample to private firms, defined as firms with (all levels of) government’s ownership no more than 50 percent. We obtain a final sample of 22,357 private firms.

**Market competition**

We measure market competition by the number of firms in the construction and real estate development sector per 10 thousand population. Population data from city yearbooks. For our first market competition measure, we use the 2004 National Economic Census for the number of firms. For our second market competition measure, we infer the number of firms annually from 1998 to 2004 from the 2004 census. We estimate the number of firms as a function of land supply constraint and entry requirement using equation (8). We then construct the market competition measure as number of firms in 2008 that can be predicted by land supply constraint and entry requirement using equation (9).

We use data on land supply elasticity from Shi (2018). Using Geography Information System (GIS), we calculated the area of undevelopable land due to geographical constraints within 30-kilometer radii from the central point of each city. The geographical constraints include bodies of water, country territory boundaries, special district administrative boundaries, and areas with steep slope (greater than 10 percent). A city with a land supply elasticity index of 1 means all areas within 30 kilometers of the city center can be developed. Figure 1 provides an example based on the city of Shenzhen. Within 30-kilometer radii from the center of the city, the shaded undevelopable areas include the sea, mountains with steep slopes, and areas to the south of the Hong Kong SAR boundary.

We also hand collect data on province-level entry requirements in the construction sector from municipal bureaus of construction. In 2000, the Ministry of Housing and Urban-Rural Development of China announced national-level regulatory guidelines on entries into the

20 The census provides information on each firm’s entry year, which we use to infer the number of firms in operation each year.
construction sector. Construction firms were divided into four classes (A to D), with the A-class firms operating at the national level and the rest restricted to operating within cities. Each province then followed the Ministry’s guideline and formulated province-level regulation details. The entry regulations include for each class of construction firms the minimum startup capital and the maximum scale of each project. These provincial-level regulations reflect regulatory constraints faced by almost all the firms in local markets because national (i.e. A-class) firms only account for about 1 percent of the firms (Shi, 2018). We include province-level capital requirements and maximum project scale for the B-D classes in (8) to estimate the predicted market competition.

Firm and city characteristics

We control for the following firm and city characteristics in our baseline specification (equation 7). To control for firm heterogeneity that may be related to investment, we include inventory, leverage, and firm age from the census. To account for cross-city differences in banking sector structure that may be related to (funding to) private investment, we control for the number of state-owned bank branches as a share of total bank branches.21 Our source of bank branch data is China Banking Regulatory Commission’s (CBRC) central registry of bank licenses.22 Individual branches of all financial institution is required to register with the CBRC and obtain a unique license. The central registry data provide information on each license including operation location, opening date and closing date if the branch is closed.

Land and house price

Our source of transaction-level land price and land characteristics is the China Real Estate Index System (CREIS). The CREIS provides land transaction records for 122 cities since late 1990s. For most cities, the land transactions data became available following the nation-wide privatization in the land markets in the early 2000s. For house prices, we use the estimates from Fang et al. (2016), who use loan-level mortgage data to construct city-level hedonic house price indices.

V. RESULTS

Table 2 reports the results on private investment. Columns 1 and 3 report results on regression (7), in which we measure market competition by the number of firms in the construction sector. Columns 2 and 4 use predicted market structure from (9). Columns 1 and 2 control for the banking competition channel by controlling for the share of state-owned bank branches and its interaction with public investment. Columns 3 and 4 additionally

21 See, for example, Acharya (2016) and Huang et al. (2018) for a discussion on the banking channel on stimulus.

control for city-level land prices. All columns include firm-level controls and province fixed effects.

Our main variable of interest—the interaction term of stimulus spending and (actual or predicted) market structure—is positive and significant at the 1 percent level in all specifications. The coefficient is larger when we estimate by predicted market competition than by pre-stimulus competition. It is also larger when we control for land prices. Overall, this result is consistent with the interpretation that product market competition facilitates the transmission of fiscal stimulus to private investment.

To gauge the economic significance of this result, we find it useful to compare the effect of government spending on private investment for a city with a (relatively) uncompetitive market to that with a (relatively) competitive market. Take, for example, two cities at the 25th and 75th percentile respectively of the market competition distribution in our sample. If both cities had the same size of stimulus spending as the average city over our sample period (0.91), our preferred estimate in column 4 suggests that the average private firm investment rate (i.e. investment to fixed assets ratio) in the city at the 75th percentile is 2.4 percentage points higher than the investment rate in the city at the 25th percentile. This difference accounts for 18 percent of the correlation between stimulus spending on private investment on average.

We report evidence on transaction-level land prices in Table 3. As in Table 1, we measure market competition by the number of firms in the construction sector in columns 1 and 3. We use predicted market structure from (9) in columns 2 and 4. To control for the direct effect of land supply elasticity—a predictor of the predicted market competition—on private investment beyond the market competition channel, we include the interaction of land supply elasticity and stimulus spending in columns 2 and 4. We additionally control for the banking competition channel in columns 3 and 4. Our results show that the interaction term of government stimulus and (pre-stimulus or predicted) market structure is negative and significant at the 1 percent level in all specifications. In other words, in cities with a more competitive construction sector, stimulus spending has a smaller effect on land prices. As in Table 2, the estimate is larger when we use predicted market competition than when we use pre-stimulus market competition. The estimates are similar when we control for banking competition.

Similar results carry over to the city-level hedonic land price index (Table 4). The interaction term of stimulus spending and (pre-stimulus or predicted) market structure is negative in all specifications. The estimates are smaller (and significant at the 5 percent level) when we use pre-stimulus market competition and larger (and significant at the 1 percent level) when we use predicted market competition.
Finally, we provide results on city-level house price controlling for Hedonic land price index, which we interpret as evidence on the markup of the construction sector (Table 5). The sample size is reduced to about one third of the land price results (Table 3-4) due to the availability of house price index. The interaction term of stimulus spending and (pre-stimulus or predicted) market structure is negative in all specifications. This is consistent with our model prediction that the effect of stimulus spending on markup is smaller when market competition is higher.

VI. CONCLUSION

With corporate market power on the rise globally, understanding the interaction between market power and fiscal stimulus has important implications as fiscal stimulus has become a common tool in many countries in response to recessions and the slowdown of global growth. In this paper, we propose and test market power as a transmission mechanism for fiscal policy. We present a model of imperfect market competition and fiscal stimulus. Our model has two key ingredients: fiscal stimulus targeted to a specific sector and imperfect competition in the targeted sector. Markup in the target sector endogenously respond to fiscal stimulus. It offers rich implications on the interaction between market competition and the transmission from targeted fiscal stimulus to private investment, markup, and investment goods prices in the targeted sector.

Our model shows that targeted fiscal stimulus reduces the aggregate demand elasticity in the targeted sector. In response, the more competitive the market is, the less markup increases. In addition, the more competitive the market is, the more output increase and the less sectoral prices increase.

We offer empirical evidence consistent with these theoretical predictions, using the large fiscal stimulus in China in 2009-2010. This is, to the best of our knowledge, one of the first empirical evidence on the role of market competition on fiscal policy transmission. Our empirical strategy explores geographical variations in local government stimulus and market competition in the construction sector. We find that, in response to local government stimulus, private investment increases more in the construction sector in cities with high market competition. Furthermore, land prices and markup in the construction sector increase less in the construction sector in cities with high market competition. Despite the Chinese focus of our empirical analysis, the mechanism illustrated in our theory is applicable to other episodes of fiscal stimulus. Testing our theory in other empirical settings is a fruitful venue for future research.

Reference


Fang, Hanming, Quanlin Gu, Wei Xiong, and Li-An Zhou, 2016. Demystifying the Chinese housing boom. *NBER macroeconomics annual* 30, no. 1: 105-166.


### Table 1. Summary statistics

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev</th>
<th>P25</th>
<th>P75</th>
<th>N. Obs</th>
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<td><strong>Firm-level variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment rate</td>
<td>-0.139</td>
<td>0</td>
<td>0.269</td>
<td>-0.015</td>
<td>0</td>
<td>31,085</td>
</tr>
<tr>
<td>Total assets (RMB)</td>
<td>1.90e+08</td>
<td>2.23e+07</td>
<td>1.16e+09</td>
<td>2.81e+06</td>
<td>1.14e+08</td>
<td>31,085</td>
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<tr>
<td>Inventory (RMB)</td>
<td>4.35e+07</td>
<td>2e+03</td>
<td>2.16e+08</td>
<td>0</td>
<td>3.53e+06</td>
<td>33,608</td>
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<td>Leverage ratio</td>
<td>0.603</td>
<td>0.658</td>
<td>0.288</td>
<td>0.392</td>
<td>0.843</td>
<td>20,598</td>
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<td>Firm age</td>
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<td>8.64</td>
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<td>10</td>
<td>203,864</td>
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<td><strong>City-level variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulus spending (2008 – 2013)</td>
<td>0.91</td>
<td>0.61</td>
<td>1.19</td>
<td>0.18</td>
<td>1.18</td>
<td>255</td>
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<td>Market competition measure (2004)</td>
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<td>1.21</td>
<td>2.73</td>
<td>0.73</td>
<td>3.07</td>
<td>262</td>
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<td>Predicted market competition (2008)</td>
<td>4.07</td>
<td>2.93</td>
<td>3.37</td>
<td>1.99</td>
<td>4.77</td>
<td>111</td>
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<tr>
<td>Land supply elasticity (Saiz index)</td>
<td>0.84</td>
<td>0.89</td>
<td>0.19</td>
<td>0.77</td>
<td>0.96</td>
<td>111</td>
</tr>
<tr>
<td>Bank branches</td>
<td>17.97</td>
<td>6</td>
<td>39.30</td>
<td>2</td>
<td>17</td>
<td>12,377</td>
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<tr>
<td>SOB/total bank branches</td>
<td>0.681</td>
<td>0.933</td>
<td>0.387</td>
<td>0.333</td>
<td>1</td>
<td>12,377</td>
</tr>
<tr>
<td>Population (10,000)</td>
<td>451.5</td>
<td>383.8</td>
<td>381.1</td>
<td>251.0</td>
<td>594.5</td>
<td>4,005</td>
</tr>
<tr>
<td>GDP per capita (1000 RMB)</td>
<td>32.69</td>
<td>24.70</td>
<td>27.58</td>
<td>13.50</td>
<td>43.10</td>
<td>3,886</td>
</tr>
<tr>
<td>Hedonic land price growth (annual)</td>
<td>-0.01</td>
<td>0.03</td>
<td>0.59</td>
<td>-0.24</td>
<td>0.29</td>
<td>5,247</td>
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<td><strong>Transaction-level variable</strong></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Land price (per square meter)</td>
<td>3537.99</td>
<td>1514.8</td>
<td>8862.62</td>
<td>749.99</td>
<td>3321.96</td>
<td>143,563</td>
</tr>
</tbody>
</table>

Note: Firm level: investment rate is measured as the cumulative change in total fixed assets between 2008 and 2013 divided by the value of fixed assets in 2008; total assets, firm age, leverage ratio (debt-to-asset ratio), and inventory value are based on the 2008 Economic Census. City level: LGFV investment is normalized by the total value of city-level real estate investment in 2008; bank branches, SOB share, population, GDP per capita, and land price growth are city-year observations depending on availability.
Table 2. Results on private investment

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private investment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public investment</td>
<td>-0.0754***</td>
<td>-0.134***</td>
<td>-0.0991***</td>
<td>-0.149***</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.019)</td>
<td>(0.016)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>Market competition</td>
<td>-0.00125</td>
<td>-0.00745***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.003)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predicted market competition</td>
<td></td>
<td>-0.000268</td>
<td>0.0022</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public investment x market</td>
<td>0.00482***</td>
<td>0.0126***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>competition</td>
<td>(0.001)</td>
<td>(0.002)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public investment x predicted</td>
<td></td>
<td>0.00959***</td>
<td>0.0112***</td>
<td></td>
</tr>
<tr>
<td>market competition</td>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>Banking competition</td>
<td>0.232***</td>
<td>0.409***</td>
<td>0.591***</td>
<td>0.686***</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
<td>(0.025)</td>
<td>(0.029)</td>
<td>(0.036)</td>
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<tr>
<td>Public investment x Banking</td>
<td>0.0429***</td>
<td>0.0772***</td>
<td>0.031*</td>
<td>0.101***</td>
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<tr>
<td>competition</td>
<td>(0.012)</td>
<td>(0.021)</td>
<td>(0.016)</td>
<td>(0.024)</td>
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<tr>
<td>Hedonic land price index</td>
<td>-5.84e-04***</td>
<td>-4.76e-04***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.61e-05)</td>
<td>(5.78e-05)</td>
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</tbody>
</table>

Firm-level controls            YES        YES        YES        YES
Province FE                     YES        YES        YES        YES
Observations                    12,173     8,593      7,652       6,886
R-squared                       0.268      0.293      0.298       0.324

Note: This table reports the results on investment of private construction firms. Standard errors clustered at the city level are shown in brackets. ***, **, and * represent statistical significance at the 1 percent, 5 percent, and 10 percent, respectively.
Table 3. Results on transaction-level land price

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>log (land price per square meter)</td>
<td></td>
<td></td>
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<tr>
<td>Stimulus spending</td>
<td>0.0507***</td>
<td>0.165**</td>
<td>-0.0182</td>
<td>-0.0776</td>
</tr>
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<td></td>
<td>(0.014)</td>
<td>(0.078)</td>
<td>(0.020)</td>
<td>(0.086)</td>
</tr>
<tr>
<td>Predicted market structure</td>
<td>-0.00035</td>
<td>-0.00212</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulus spending x Market structure</td>
<td>-2.14e-05***</td>
<td>-2.24e-05***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.52E-06)</td>
<td>(3.52E-06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulus spending x Predicted market structure</td>
<td>-0.0148***</td>
<td>-0.0135***</td>
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<tr>
<td></td>
<td>(0.005)</td>
<td>(0.005)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulus spending x Land supply elasticity</td>
<td>-0.0714</td>
<td>-0.0609</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.083)</td>
<td>(0.085)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulus spending x Banking competition</td>
<td>0.137***</td>
<td>0.224***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.037)</td>
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<tr>
<td>City FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year FE</td>
<td>YES</td>
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<td>YES</td>
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</tr>
<tr>
<td>Observations</td>
<td>132,183</td>
<td>50,004</td>
<td>131,631</td>
<td>49,832</td>
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<tr>
<td>R-squared</td>
<td>0.301</td>
<td>0.266</td>
<td>0.302</td>
<td>0.266</td>
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</table>

Note: This table reports the results on transaction-level land prices. Standard errors clustered at the city level are shown in brackets. ***, **, and * represent statistical significance at the 1 percent, 5 percent, and 10 percent, respectively.
### Table 4. Results on Hedonic land price index

<table>
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<tr>
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<th>(1)</th>
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<tbody>
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<td><strong>Hedonic land price index</strong></td>
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<td></td>
</tr>
<tr>
<td>Stimulus spending</td>
<td>0.00124</td>
<td>0.336**</td>
<td>0.0111</td>
<td>0.344***</td>
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<tr>
<td></td>
<td>(0.013)</td>
<td>(0.150)</td>
<td>(0.030)</td>
<td>(0.131)</td>
</tr>
<tr>
<td>Predicted market structure</td>
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<td>0.0185***</td>
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<td></td>
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<td>(0.006)</td>
<td></td>
<td>(0.005)</td>
</tr>
<tr>
<td>Stimulus spending x Market structure</td>
<td>-3.06e-05**</td>
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<td></td>
<td>(1.21E-05)</td>
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<td>Stimulus spending x Predicted market structure</td>
<td>-0.0581***</td>
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<tr>
<td></td>
<td>(0.016)</td>
<td>(0.014)</td>
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<td></td>
</tr>
<tr>
<td>Stimulus spending x Land supply elasticity</td>
<td>-0.177</td>
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<td></td>
<td>(0.108)</td>
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<td>Stimulus spending x Banking competition</td>
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<td>0.185***</td>
<td></td>
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<tr>
<td></td>
<td>(0.027)</td>
<td>(0.031)</td>
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<tr>
<td>City FE</td>
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<td>YES</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>Year FE</td>
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<td>YES</td>
<td>YES</td>
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<td>Observations</td>
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<tr>
<td>R-squared</td>
<td>0.031</td>
<td>0.074</td>
<td>0.037</td>
<td>0.070</td>
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</table>

Note: This table reports the results on Hedonic price index. Standard errors clustered at the city level are shown in brackets. ***, **, and * represent statistical significance at the 1 percent, 5 percent, and 10 percent, respectively.
Table 5. Results on sectoral markup

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>House price index</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hedonic land price index</td>
<td>0.005</td>
<td>0.024</td>
<td>0.007</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>(0.038)</td>
<td>(0.084)</td>
<td>(0.041)</td>
<td>(0.084)</td>
</tr>
<tr>
<td>Stimulus spending</td>
<td>0.0135</td>
<td>0.716</td>
<td>0.107</td>
<td>0.811</td>
</tr>
<tr>
<td></td>
<td>(0.065)</td>
<td>(0.567)</td>
<td>(0.089)</td>
<td>(0.542)</td>
</tr>
<tr>
<td>Predicted market structure</td>
<td>0.003</td>
<td>0.003</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulus spending x Market structure</td>
<td>-2.43e-05*</td>
<td>-2.39e-05*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.38E-05)</td>
<td>(1.41E-05)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulus spending x Predicted market structure</td>
<td>-0.0458***</td>
<td>-0.0433***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0152)</td>
<td>(0.0158)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulus spending x Land supply elasticity</td>
<td>-0.504</td>
<td>-0.559</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.613)</td>
<td>(0.591)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulus spending x Banking competition</td>
<td>-0.140</td>
<td>-0.111</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.117)</td>
<td>(0.140)</td>
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<td>YES</td>
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<td>Year FE</td>
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<td>Observations</td>
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<td>645</td>
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<td>R-squared</td>
<td>0.90</td>
<td>0.92</td>
<td>0.90</td>
<td>0.92</td>
</tr>
</tbody>
</table>

Note: This table reports the results on sectoral markup. Standard errors clustered at the city level are shown in brackets. ***, **, and * represent statistical significance at the 1 percent, 5 percent, and 10 percent, respectively.
Figure 1: Developable land in the city of Shenzhen
Appendix

Proof of Proposition 1

The firm-level markup can be derived from profit maximizing problem. First-order condition (5) implies that:

\[ p_h + \frac{\partial p_h}{\partial y_h} y_h = MC_h. \]

When government spending \( G = 0 \),

\[ \frac{p_{hi}}{p} = \frac{p_{hi} p_h}{p_h p} = \left(\frac{y_{hi}}{y_h}\right)^{\frac{1}{\eta}} \left(\frac{y_h}{C}\right)^{-\frac{1}{\rho}}. \]

We rewrite the first order condition as:

\[ 1 + \frac{1}{PC^\rho} \frac{\partial}{\partial y_{hi}} \left(\frac{1}{y_{hi}} \frac{1}{y_h} \frac{1}{\rho}\right) = \frac{MC_h}{p_{hi}} \]

Rearranging the equation and plugging in \( \frac{\partial y_{hi}}{\partial y_h} = y_h^{1/\eta} y_{hi}^{-1/\eta} \) from equation (2):

\[ 1 - \frac{1}{\eta} + \left(\frac{1}{\eta} - \frac{1}{\rho}\right) \left(\frac{y_{hi}}{y_h}\right)^{\frac{1}{\eta} - 1} = \frac{MC_h}{p_{hi}} \]

Also note that \( \left(\frac{y_{hi}}{y_h}\right)^{\frac{1}{\eta}} = s_i \), thus the inverse demand elasticity is:

\[ \frac{1}{\epsilon_i} = (1 - s_i) \frac{1}{\eta} + s_i \frac{1}{\rho}. \]

When government spending \( G > 0 \),

\[ p^\rho C p_h^{-\rho} + \frac{G}{p_h} = y_h \]

\[ \Rightarrow \frac{\partial p_h}{\partial y_h} = -\frac{1}{G p_h^{2} + \rho p^\rho C p_h^{-\rho - 1}}. \]

The first-order condition thus becomes:

\[ p_{hi} + \frac{\partial p_{hi}}{\partial p_h} \frac{\partial p_h}{\partial y_h} \frac{\partial y_h}{\partial y_{hi}} y_{hi} = MC_h \]

\[ \Rightarrow p_h \cdot \left[ 1 - \frac{1}{\eta} \left(1 - \left(\frac{y_{hi}}{y_h}\right)^{\frac{\eta-1}{\eta}}\right) - \frac{G p_h^{\rho - 1} + P^\rho C}{G p_h^{\rho - 1} + \rho p^\rho C} \cdot \left(\frac{y_{hi}}{y_h}\right)^{\frac{\eta-1}{\eta}} \right] = MC_h. \]

Note that

\[ \frac{p_h}{p} = \left(\frac{c_h}{C}\right)^{-1/\rho} \Rightarrow P^\rho C = p_h^\rho c_h \]

Therefore

\[ G p_h^\rho - 1 + P^\rho C G p_h^\rho - 1 + P C = 1 G p_h^\rho - 1 G p_h^\rho - 1 + P^\rho C + P C G p_h^\rho - 1 + P^\rho C \rho \]
Proof of Proposition 2

Equation (5) imply

\[ \frac{\partial p_h}{\partial y_h} = -\frac{1}{Gp_h^{\rho - 1} + \rho P \rho C} \]

and equation (2) imply

\[ \frac{\partial y_h}{\partial y_{hi}} = y_h^{1/\eta} y_{hi}^{-1/\eta} \]

under Assumption 3.

Substituting these into equation (6) gives

\[ B(N)p_h \left[ 1 - \frac{1}{\eta} \left( 1 - \left( \frac{y_{hi}}{y_h} \right)^{\eta^{-1}} \right) - \frac{Gp_h^{\rho - 1} + P \rho C}{Gp_h^{\rho - 1} + \rho P \rho C} \cdot \left( \frac{y_{hi}}{y_h} \right)^{\eta^{-1}} \right] = MC_h, \]

or

\[ 1 - \frac{1}{\eta} \left( 1 - \left( \frac{y_{hi}}{y_h} \right)^{\eta^{-1}} \right) - \frac{Gp_h^{\rho - 1} + P \rho C}{Gp_h^{\rho - 1} + \rho P \rho C} \cdot \left( \frac{y_{hi}}{y_h} \right)^{\eta^{-1}} = \frac{MC_h}{B(N)p_h}. \]  

(A1)

We note that the existence and uniqueness of equilibrium does not require \( \rho > 1 \) as we assume in Assumption 1. When \( \rho > 1 \) and \( \rho < 1 \), we prove the unique equilibrium using the intermediate value theorem. For the rest of the proof, we define \( LHS \) as the left-hand-side of equation (A1) and \( RHS \) as the right-hand-side of equation (A1).

When \( p_h \to 0 \), \( LHS \to 1 - \frac{N-1}{\eta N} - \frac{1}{\rho N} \) (\( \rho > 1 \)) or \( 1 - \frac{N-1}{\eta N} - \frac{1}{N} \) (\( \rho < 1 \)) and \( RHS \to +\infty \);

when \( p_h \to +\infty \), \( LHS \to 1 - \frac{N-1}{\eta N} - \frac{1}{N} \) (\( \rho > 1 \)) or \( 1 - \frac{N-1}{\eta N} - \frac{1}{\rho N} \) (\( \rho < 1 \)) and \( RHS \to 0 \). So, in both cases, \( LHS < RHS \) when \( p_h \to 0 \) and \( LHS > RHS \) when \( p_h \to +\infty \). In addition, \( \frac{\partial LHS}{\partial p_h} < 0 \) and \( \frac{\partial RHS}{\partial p_h} < 0 \). So, both sides of equation (A1) are monotonic and strictly decreasing in \( p_h \). From the intermediate value theorem, there exists a unique \( p_h \) such that equilibrium condition (A1) holds.
When $\rho = 1$, sectoral outputs are aggregated using a Cobb-Douglas function. Equation (A1) thus turns into:

$$1 - \frac{N - 1}{\eta N} \frac{Gp_h^{\rho-1} + P^\rho C}{N(Gp_h^{\rho-1} + \rho P^\rho C)} = \frac{MC_h}{B(N)p_h}$$

Given that $G \geq 0; P, C, N, MC_h, B(N) > 0$, there is a unique $p_h$ such that equation (A1) holds.

□

**Proof of Proposition 3**

**Proposition 3.1**

For any given set of parameters, the equilibrium price is captured by equilibrium condition (A1) and minimum marginal cost equation. Combining the two equations, we get:

$$B(N)p_h \left[1 - \frac{Gp_h^{\rho-1} + P^\rho C}{N(Gp_h^{\rho-1} + \rho P^\rho C)}\right] = MC_h = A^{-1} \left(\frac{r}{\alpha}\right)^{\alpha} \left(\frac{m}{1 - \alpha}\right)^{1 - \alpha} \quad \text{(A2)}$$

The left-hand-side of the equation is the demand curve of real estate product, and the right-hand-side of the equation is the supply curve of real estate producers.

Following a positive shock to government spending $G$, demand curve shifts upward. The response of the supply curve ($MC_h$) is ambiguous, depending on the impacts of government spending on productivity $A$ and cost of capital $r$. In the cases where government-led projects improve local infrastructure and facilitate the production of real estate firms, $A'(G) > 0$, an increase in $G$ lowers the marginal cost of producing real estate products and moves the supply curve moves downward. As a result, $\frac{\partial p_h}{\partial G} > 0$. In other cases where government investment crowds out the funding of private investment, i.e. $r'(G) > 0$. This implies that an increase in $G$ makes nonland factor $k$ costlier for real estate firms\(^{23}\), which effectively moves the supply curve upward. When the supply curve responds more relative to the demand curve, $\frac{\partial p_h}{\partial G} < 0$.

When studying the response of real and nominal output, equation (5) implies that real estate output $y_h$ is decreasing in $p_h$ and increasing in $G$:

$$y_h = P^\rho C p_h^{-\rho} + Gp_h^{-1}$$

Therefore,

$$\frac{\partial y_h}{\partial G} = \frac{\partial p_h}{\partial G} \left( -\rho P^\rho C p_h^{-\rho-1} - Gp_h^{-2} \right) + p_h^{-1}$$

\(^{23}\) For example, Huang et al. (2018) document the “financial crowding out” channel in the same stimulus episode in China.
\[
\frac{\partial p_h y_h}{\partial G} = \frac{\partial (P^\rho C p_h^{1-\rho} + G)}{\partial G} = (1 - \rho)P^\rho C p_h^{-\rho} \frac{\partial p_h}{\partial G} + 1
\]

Since \( \frac{\partial p_h}{\partial G} \) can be positive or negative, and that \( P^\rho C \) is a free parameter in this model, an increase in \( G \) could have ambiguous impacts on both \( \frac{\partial y_h}{\partial G} \) and \( \frac{\partial p_h y_h}{\partial G} \).

**Proposition 3.2**

From equation (A2), the inverse markup in the real estate market can be written as:

\[
\frac{1}{\mu} \equiv \frac{MC_h}{p_h} = B(N) \left[ 1 - \frac{G p_h^{\rho-1} + P^\rho C}{N(G p_h^{\rho-1} + \rho P^\rho C)} \right]
\]

Define \( \Phi(N) \equiv NB(N)^{-1} \). \( \Phi^{-1}(N) > 0 \) because \( B'(N) \frac{N}{B(N)} < 1 \).

\[
\frac{\partial^2 (1/\mu)}{\partial G \partial N} = \frac{\partial^2 \left( \frac{\rho - 1}{}P^\rho C \right)}{\Phi(N)(G p_h^{\rho-1} + \rho P^\rho C)} \frac{\partial G \partial N}{\partial \Phi(N)} = \frac{(\rho - 1)P^\rho C \Phi'(N)(G p_h^{\rho-1} + \rho P^\rho C)}{\Phi^2(N)(G p_h^{\rho-1} + \rho P^\rho C)^2} > 0
\]

because \( \rho > 1 \) and \( \Phi'(N) > 0 \).

\[
\Rightarrow \frac{\partial^2 \mu}{\partial G \partial N} < 0
\]

**Proposition 3.3**

We prove this part using equation (A2). We take the second-order derivative with respect to \( G \) and \( N \) for both sides of the equation. For the left-hand side,

\[
\frac{\partial^2 \left[ B(N)p_h \left( 1 - \frac{G p_h^{\rho-1} + P^\rho C}{N(G p_h^{\rho-1} + \rho P^\rho C)} \right) \right]}{\partial G \partial N} > 0
\]

Following the proof of Proposition 3.2. For the right-hand side,

\[
\frac{\partial^2 MC_h}{\partial G \partial N} = 0
\]

Therefore, for a given government spending \( G \), the demand curve shifts upward less when \( N \) is larger while the change in the supply curve is independent of \( N \). It follows that

\[24\] In the benchmark scenario where \( G = 0 \), \( p_h = MC_h \times \frac{\rho N}{\rho N-1} \) is independent from household demand \( P^\rho C \).
\[
\frac{\partial^2 p_h}{\partial G \partial N} < 0
\]

and
\[
\frac{\partial^2 \log p_h}{\partial G \partial N} = \frac{\partial^2 p_h}{\partial G \partial N} < 0
\]

We back out the land price \(landp\) by calculating the profit distribution between real estate developers and the government. For simplicity, we further assume that the total land supply is fixed at \(\bar{S}\).\(^{25}\) Therefore,

\[
landp \times \bar{S} = (1 - \alpha) [MC_h y_h + (1 - B(N))(p_h - MC_h)y_h],
\]

where \(MC_h y_h\) is the total cost of real estate production; and \((1 - B(N))(p_h - MC_h)y_h\) is the additional profits transferred from real estate developers to the government. As a result:

\[
landp \propto (1 - B(N))p_h y_h + B(N)MC_h y_h.
\]

And the impact of market structure on the growth rate of land price is:

\[
\frac{\partial^2 \log landp}{\partial G \partial N} = \frac{\partial^2 \log [(1 - B(N))p_h y_h + B(N)MC_h y_h]}{\partial G \partial N}.
\]

From proposition 3.2,

\[
\frac{\partial^2 \mu}{\partial G \partial N} < 0,
\]

where \(\mu = \frac{p_h}{MC_h}\) is the mark up in the real estate sector. Therefore, it is easy to show that

\[
\frac{\partial^2 \log p_h y_h}{\partial G \partial N} = \frac{\partial^2 \log MC_h y_h}{\partial G \partial N} + \frac{\partial^2 \log \mu}{\partial G \partial N} < \frac{\partial^2 \log MC_h y_h}{\partial G \partial N},
\]

\[
\frac{\partial^2 \log MC_h y_h}{\partial G \partial N} = \frac{\partial^2 \log p_h y_h}{\partial G \partial N} - \frac{\partial^2 \mu}{\partial G \partial N}.
\]

In addition, we know that \(B(N)\) is decreasing in \(N\) and that

\[
\frac{\partial^2 \log (MC_h y_h)}{\partial G \partial N} = \frac{\partial^2 \log MC_h}{\partial G \partial N} + \frac{\partial^2 \log y_h}{\partial G \partial N} = 0 + \frac{1}{y_h^2} \frac{\partial^2 y_h}{\partial p_h} \frac{\partial^2 p_h}{\partial G \partial N} < 0.
\]

Thus,

\(^{25}\) The result will hold as long as the elasticity of land supply is larger than 1, which implies the increase in real estate demand is not fully absorbed by the supply of land. The housing supply elasticity estimates in the literature are mostly greater than 1 (Green, Malpezzi, and Mayo (2005); Saiz (2008); Wang, Chan, and Xu (2012)). Since housing supply is relative more elastic than land supply, we consider the assumption as rather general.
\[
\frac{\partial^2 \log \text{land}_p}{\partial G \partial N} = \frac{\partial^2 \log \left[ (1 - B(N))p_{h,y} + B(N)MC_{h,y} \right]}{\partial G \partial N} < \frac{\partial^2 \log (MC_{h,y})}{\partial G \partial N} < 0.
\]

Land price grows at a slower pace when the real estate market is more competitive.

**Proposition 3.4**

From equation (5), nominal output from the real estate sector is:

\[
p_{h,y} = P^\rho C p_h^{1-\rho} + G.
\]

Therefore,

\[
\frac{\partial^2 p_{h,y}}{\partial G \partial N} = \rho(\rho - 1)P^\rho C p_h^{-\rho} \frac{\partial^2 p_h}{\partial G \partial N} > 0.
\]