The Effect of Public Investment on Private Investment: Theory and Evidence on the Local Market Competition Channel[1]

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Abstract

We develop a model of imperfect competition with variable markups to analyze the role of market competition in the transmission of targeted fiscal stimulus. We find that the more competitive the market is, the more sectoral output responds to fiscal stimulus in the targeted sector. The more competitive the market is, the less sectoral prices, sector-specific factor prices, and markup respond. We offer new empirical evidence consistent with these theoretical predictions in the context of the large fiscal stimulus in China in 2009-2010. Overall, our results support the view that market competition facilitates the transmission of fiscal stimulus.

JEL: E22, G21, G23, G31, H54, L13, R31
Keywords: Public investment, fiscal stimulus, market competition, variable markup, China

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I. INTRODUCTION

Rising market power has been under the spotlight of recent public debates. However, our understanding of the macroeconomic implications of rising market power is limited. Most research focuses on the direct impact of market power on growth (IMF, 2019), factor shares (Caballero et al., 2017, De Loecker and Eeckhout 2017), and inequality (Eggertsson et al., 2018). Little attention has been paid on how rising market power interacts with macroeconomic policies, including fiscal stimulus.

This paper asks whether rising market power impedes the transmission of fiscal stimulus. In the first part of this paper, we build an analytical model of imperfect market competition and fiscal stimulus. Our model has two key ingredients: fiscal stimulus targeted to a specific sector and variable markups in the targeted sector. It includes a rich yet tractable model of quantity competition à la Cornot 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 affects prices and outputs in the targeted sector.

Our model shows that in response to targeted public investment, the changes of sectoral real and nominal outputs, sector-specific factor prices and markup are ambiguous. Nevertheless, the changes depend on product market competition in the targeted sector unambiguously under general assumptions. The more competitive the market is, the more sectoral output responds to fiscal stimulus in the targeted sector. In addition, the more competitive the market is, the less sectoral prices, sector-specific factor prices, and markup respond. The intuition is as follows. Imperfect product market competition generates variable markups in the targeted sector because markup reflects different demand elasticities from the government and consumers. Targeted fiscal stimulus generates a positive demand shock in the targeted sector from the government but not for consumers.[2] When government demand is more inelastic than consumer demand, the overall demand elasticity in the targeted sector becomes smaller following a fiscal stimulus. Because variable markups reflect the supply-side response to the demand shock, market competition matters for the sensitivity of markup to fiscal stimulus, which in turn determines the overall response in output and prices.

Our model offers new insights to evaluate the transmission of fiscal stimulus. The New Keynesian model, which has been widely used to study fiscal stimulus, could be micro founded by imperfect market competition but would not generate long-run implications on the interaction between market competition and fiscal stimulus (Dixon 1987, Mankiw 1988,

[2] Atkeson and Berstein (2008) use a model with variable markup 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. Our results hold even if the market structure is not affected by the fiscal stimulus

Nakamura and Steinsson 2013). This is because market rigidity (and hence price rigidity) only exists in the short run and that government and consumers have the same demand elasticity in the New Keynesian model. Thus, a firm's markup in the targeted sector only depends on the assumed market structure and vanishes in the long run. It does not respond to fiscal stimulus.[3]

In the second part of the paper, we provide new empirical evidence consistent with the predictions of our model in the context of large scale fiscal stimulus in China in 2009-2010. We bring a variety of complementary evidence on investment, markups, and factor prices in the targeted sector following the stimulus.

The Chinese fiscal stimulus provides an ideal setting to study the role of market competition in the transmission of fiscal policy for several reasons. First, almost all the public investment was carried out by local governments and highly concentrated on the 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), which we broadly refer to "public investment" in this paper.[4] From an empirical identification perspective, targeted public investment in localized markets means that we can isolate public and private investment in distinct markets. For a tradable sector, there would be little reason to expect that the effect of public investment is localized. Second, ideally for us to examine the market competition channels, local entry barrier is high in the construction and real estate development sector. Cross-sectional variations in market structure reflects local geographic and regulatory features that are arguably independent of short-run macroeconomic conditions. Third, the capital market is also highly localized in China. Private business heavily relies on local banks for financing. The funding of local government investment during the 2009-2010 stimulus was also predominantly funded by local banks. This allows us to empirically control for credit availability, a channel shown to have implications for private investment (Huang et al. 2017).

Consistent with our theoretical predictions, we find that, in response to public investment during fiscal stimulus, private investment increases more in the construction and real estate development sector in cities with more product market competition. Furthermore, land prices and markups in the in the construction and real estate development sector increase less in cities with more product market competition. Overall, our results support the view that market competitivness facilitates the transmission of fiscal stimulus.

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[3] Another difference is that in New Keynesian models, fiscal stimulus only affects aggregate demand whereas in our model it affects both demand and supply, with supply the side effect generated from the impact of fiscal stimulus on the productivity of the targeted sector and on the mobile factor used in all sectors. This implies that in our model, fiscal stimulus may "crowd out" private investment.

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

Despite the Chinese focus of our empirical model, our theory can be applied to broad empirical settings. The assumption on targeted fiscal stimulus is general because many fiscal stimulus packages around the world have a sectoral focus.[5] More generally, our model suggests highlights 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 literature on the relationship between public and private investment. We contribute to this literature by highlighting the important role of market competition in this relationship both theoretically and empirically. Empirically establishing the causal link is a challenge in the literature. Our empirical strategy explores arguable exogenous variations in market structure to establish a causal link.

Second, our results relate to a recent empirical literature on cross-sectional fiscal multipliers. This literature has primarily focused on using exogenous cross-sectional variations the exposure to aggregate fiscal shocks to estimate fiscal multiplier. We show instead that product market structure is empirically important in explaining the heterogenous response of private investment to public investment.

Third, we contribute to a nascent literature on local government financing through the shadow banking sector. A recent paper by Huang et al. (2017) also looks at how local government financing during the Chinese fiscal stimulus affects investment. Their sample, however, is the manufacturing sector. By focusing on the construction and real estate development sector—the sector with directed public investment—our results speak directly to the complementarity between public and private investment in the same sector. As such, our results are not affected by sector reallocation, a potential confounding factor of the cross-sectional fiscal multipliers.

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.

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[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).

II. MODEL

A. Set up

Technology

The final goods of the economy are produced by a CES aggregation of the outputs of a continuum of sectors:

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

where y_s is output in sector s and ρ is thus the elasticity of substitution across sectors

Within the real estate development sector, there are N firms producing sectoral output in a monopolistic competition.[6] The elasticity of substitution across firms within the real estate sector is $\eta > 1$. Each firm produces real estate output using a combination of land s and all mobile nonland factors k:

$$y_{hi} = Ak_i^{\alpha} s_i^{1-\alpha}, \tag{1}$$

$$y_h = \left[\sum_{i\in h} y_{hi}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}. \tag{2}$$

We follow Epple, Gordon, and Sieg (2010) and assume real estate production is constant returns to scale. The cost of land development and the nonland factor k are m and r respectively.

Household's problem

Households maximize the consumption of final good subject to a budget constraint:

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

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

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

[6] In our model discussion, the real estate sector refers to real estate development firms, rather than real estate finance firms.

Public investment

We model the fiscal stimulus as a targeted government spending G, which is exclusively used on the real estate sector.

Real estate firm's problem

A given firm i purchases nonland factor k from the factor market and land m from the government and produces real estate properties. Since the government is the only seller of land, we assume that firm i must split its profit with the government through a Nash bargaining. The share of firm i is $B(\cdot)$, which is decreasing in the total number of real estate firms, N.

Each real estate firm maximizes its total profit taking prices, the total number of firms N, and other firms' outputs as given:

$$\max_{y_{hi}} \; B(N)[p_{hi}y_{hi} - y_{hi}MC_h], \tag{4}$$

where $MC_h = A^{-1}\left(\frac{r}{\alpha}\right)^{\alpha}\left(\frac{m}{1-\alpha}\right)^{1-\alpha}$ is the marginal cost derived from real estate production function (1).

B. Competitive equilibrium

Equilibrium definition

The equilibrium in this economy is defined as follows:

1. Households take sectoral price index p_s and after-tax income I as given and maximize total consumption C by solving problem (3).

2. Each real estate firm solves the optimization problem (4) taking house price p_h and factor prices r and m as given.

3. The output market clears in each sector. For sectors other than the real estate sector, sectoral output is equal to household consumption: $c_s = y_s, \;\; \forall s \neq h$; for the real estate sector, sectoral output is equal to household consumption plus government spending: $y_h = c_h + \frac{G}{p_h}$.

Solving the competitive equilibrium.

We solve the model as follows. Since there is a continuum number of sector, 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:

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

Define the real estate sector output consumed by households and government as y_h^C and y_h^G respectively. The market clearing conditions c) imply the following:

$$y_h = c_h + \frac{G}{p_h} = P^\rho C p_h^{-\rho} + \frac{G}{p_h} = \sum_i y_{hi} \tag{5}$$

Real estate firm i's optimization problem solves (4). Taking prices and market structure as given, the first-order condition of i's optimization problem thus becomes:

$$B(N) \cdot \left(p_{hi} + \frac{\partial p_h}{\partial y_h}\frac{\partial y_h}{\partial y_{hi}} y_{hi}\right) = MC_h, \tag{6}$$

where

$$\frac{\partial p_h}{\partial y_h} = -\frac{1}{G p_h^{-2} + \rho P^\rho C p_h^{-\rho-1}}, \tag{7}$$

following equation (5) and

$$\frac{\partial y_h}{\partial y_{hi}} = y_h^{1/\eta} y_{hi}^{-1/\eta}, \tag{8}$$

following equation (2) because all firms within the real estate sector are symmetric and compete in monopolistic competition. Equations (6)-(8) characterize the equilibrium

Proposition 1: Without government intervention ($G = 0$), the markup of real estate firm i can be written as $\mu_i = \frac{p_{hi}}{MC_h} = \frac{\epsilon_i}{\epsilon_i - 1}$; where the effective demand elasticity ϵ 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 real estate sector h.

Intuitively, the inverse demand elasticity each firm face is a weighted average of the inverse of within-sector demand elasticity, η, and the inverse of cross-sector demand elasticity, ρ. 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 in turn depends more on cross-sector demand elasticity ρ.

Under our assumption that all firms within the real estate sector are symmetric,

$$s_i = \frac{1}{N},$$

so the effective demand elasticity of a representative real estate firm is:

$$\epsilon = \left[\frac{N-1}{\eta N} + \frac{1}{\rho N}\right]^{-1}.$$

Under the condition that $\eta > \rho$, the more competitive the real estate market is (larger N), the smaller the markup μ is.

Proposition 2. Under proper parameterizations,[7] there is a unique equilibrium in the real estate sector that satisfies conditions a) – c).

Proof: See Appendix.

Next, we study the impact of government spending G on real estate sector output and prices. To derive closed-form solutions, we focus on the limit case in which within-sector elasticity $\eta \to \infty$. This is equivalent to assuming that all firms in the real estate sector produce homogeneous goods and conduct Cournot competition. The real estate output produced by different firms are perfect substitutes, therefore (6) can be written as:

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

Rearranging the equation, real estate firms face the following demand elasticity:

$$\epsilon = N\left[\frac{G}{G + c_h} + \frac{c_h}{G + c_h} \cdot \rho\right],$$

where $c_h = P^\rho C p_h^{1-\rho}$ is households, real estate consumption.
Without the fiscal stimulus ($G = 0$), the demand elasticity becomes:

$$\epsilon = \rho N$$

When government spending is directed only to the real estate sector, $p_h y_h^G = G$, which implies that the government demand elasticity is 1. In comparison, (3) implies that the demand elasticity of households is fixed at ρ. Depending on the relative size of government spending G and households, real estate consumption, the effective demand elasticity of each firm is a weighted average of government and households demand elasticities for real estate. As long as $\rho \neq 1$, real estate sector markups endogenously respond to government spending G.

Proposition 3. For a given positive government spending G,

1) the changes in real estate 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;

[7] A unique competitive equilibrium exists under very general conditions: $G \geq 0, and\ P, C, N, MC_h, B(N) > 0$.

2) when $\rho > 1$, markup $\frac{p_h}{MC_h}$ increases; the more competitive the real estate market is (larger N), markup increases less: $\frac{\partial^2\left(\frac{p_h}{MC_h}\right)}{\partial G \partial N} < 0$
3) when $\rho > 1$, the more competitive the real estate market is (larger N), real estate price p_h and land prices grow at a slower pace: $\frac{\partial^2 \log p_h}{\partial G \partial N} < 0$, $\frac{\partial^2 \log landp}{\partial G \partial N} < 0$.
4) when $\rho > 1$, the more competitive the real estate market is (larger N), the real estate output increase more: $\frac{\partial^2 p_h y_h}{\partial G \partial N} > 0$;

Proof: See Appendix.

The assumption that $\rho > 1$ is fairly general and is consistent with households' preference for consumption variety.

III. The empirical model

A. Private investment

We are interested in estimating how the effect of public investment on private investment during the 2009-2010 stimulus depends on local market structure. In our main specification, we consider the following model for investment:

$$\frac{I_{it}}{K_{it-1}} = \alpha + \beta PublicI_{ct} + \gamma PublicI_{ct} \times Market_c + \epsilon_{it}, \qquad (9)$$

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} measure investment rate (relative to pre-stimulus assets) in the post-stimulus period. $PublicI_{ct}$ is city-level public investment during 2009-2013. $Market_c$ is city-level market competition, measured by the pre-stimulus (2004)[8] number of firms in the construction and real estate development sector, our sector of interest as we will explain later.

Our main variable of interest is the interaction term of public investment and market competition. We interpret a positive (negative) coefficient of γ as evidence that market competitiveness facilitates (impedes) the transmission of fiscal stimulus to private investment. The *identification assumption* is that a city did not implement more public investment during fiscal stimulus and private firms also did not invest more because its product market was more or less competitive than the average.

[8] We use 2004 instead of 2008 here to avoid the possibility that more firms entered the real estate sector in anticipation of a large-scale stimulus by the government.

The main econometric challenge is that local real estate market competition may be correlated with firm- or city-level shocks to investment opportunities in a way that undermines our identification strategy. To mitigate this problem, we use pre-sample information to construct the market competition measure. This 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. Furthermore, as we will show, investment does not correlate with market structure in our sample.

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, which 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 use the land supply elasticity index from Shi (2018) following the approach in Saiz (2010). A city with a land supply elasticity index of 1 means all areas within 30 kilometers of the city center can be developed. 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 construction and real estate development. Entry requirements—including the minimum startup capital requirement, maximum development scale and years of experience—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.

Our assumption is that these geographical and regulatory features are not correlated with investment opportunities at the city-level. There is no obvious reason why developable land in a city would be correlated with investment opportunities other than through entry and exit in the construction and real estate development sector. Besides, in our robustness tests, we control for public investment interacted with land supply elasticity, and our results on market competition still hold. For the 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 can control for using province fixed effects.

Formally, we estimate market competition as a function of land supply elasticity and entry requirements with pre-stimulus (pre-2004) data:

$$Market_{ct} = \alpha + \beta Elas_c + \gamma EntryReq_{pt} + \delta_p + \phi_t + \nu_{ct}, \qquad (10)$$

where *c*, *p*, and *t* index city, province, and time respectively, $Elas_c$ is land supply elasticity, $EntryReq_{pt}$ is entry requirement. δ_p and ϕ_t are province and time fixed effects. We then use fitted values from equation (8) to predict market competition using contemporaneous entry requirement:

$$\widehat{Market}_{ct} = \hat{\alpha} + \hat{\beta} Elas_c + \hat{\gamma} EntryReq_{pt} + \hat{\delta}_p. \qquad (11)$$

We then use the predicted value $\widehat{Market}_{ct}$ from equation (11) to estimate equation (9).

B. Land price, house price, 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 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:

$$P_{zt} = \alpha + \beta PublicI_{ct} + \gamma PublicI_{ct} \times Market_c + \varphi X_{zt} + \tau_c + \rho_t + \varepsilon_{zt}, \qquad (12)$$

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) or floor price (per unit of developable floor area), in natural logarithm. X_{zt} is a vector of land characteristics. τ_c and ρ_t are city and time fixed effects respectively. The sample period covers both before and after the stimulus.

We also estimate the following Hedonic land price model:

$$P_{zt} = \sigma + \varphi X_{zt} + \hat{\tau}_{ct} + \epsilon_{zt}$$

where $\hat{\tau}_{ct}$ is the Hedonic land price index of city *c* at time *t* from the following city-level regression:

$$\hat{\tau}_{ct} = (\rho\hat{\tau}_{c,t-1} +)\alpha + \beta PublicI_{ct} + \gamma PublicI_{ct} \times Market_{ct} + \nu_{ct}.$$

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

Next, we use city-level house price as dependent variable in model (12) with Hedonic land price index (Fang et al. 2016) as additional control. We interpret house price as output price in the real estate sector and land price as input cost. With the reasonable assumption that other inputs to the real estate sector are tradable and thus not city-specific, this model provides evidence on the real estate markups of the real estate sector.

IV. Data and Methodology

A. Data and measurements

Local government investment

Publicly available information on local government investment 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 years. This information is collected by a company called Wind Information Co. (WIND).[9] From individual LGFV balance sheet, we first calculate net investment as the change in tangible assets plus the disposal of fixed assets.[10] We then aggregate LGFV investment at the city level and normalize by one-year lagged aggregate city real estate investment[11] from city yearbooks.

We focus on public investment measured through local government's off-balance-sheet expenditure instead of on-balance-sheet expenditure of two reasons. First, on-balance-sheet expenditure may include public investment that is contracted to private firms by local governments. In this case, public investment may be "double counted" by our independent variable $PublicI_{ct}$ 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. Second, local governments are required to balance their on-balance-sheet budgets. One concern is that local governments under budgetary pressure may have incentives to generate revenue by increasing land supply for development, for example by rezoning. However, off-balance-sheet expenditure is not subjected to budget balance rules. We have no obvious reason to believe that public investment through off-balance-sheet LGFVs are related to land supply. To the extent that the correlation of on- and off-balance-sheet public investment at the city-level does not vary systematically with local market competition, focusing on off-balance-sheet public investment does not affect the estimation

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[9] 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.

[10] 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.

[11] The results hold when we normalize LGFV investment by one-year lagged city-level GDP.

of our main variable of interest. Furthermore, public investment through the off-balance-sheet channel accounts for about three quarter of the public investment during the 2009-2010 stimulus (Bai et a. Table 1).[12]

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 and real estate development sectors. 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 structure

We measure the competition in the construction and real estate sectors by the number of firms in the pre-stimulus period. Our source is the 2004 National Economic Census. We normalize by population from city yearbooks to account for differences in city size.

To account for cross-city differences in banking sector structure, we control for the state-owned bank branches as a share of total bank branches. Our source of bank branch data is China Banking Regulatory Commission's central registry of bank branch licenses[13]..

V. RESULTS

Table 2 reports the results on private investment. Column 1 reports results on model (7), in which we use actual market structure is measured by the number of firms in the construction and real estate development sector. Column 2 uses predicted market structure from (9). Columns 3-4 additionally control for banking competition.

Our main variable of interest—the interaction term of public investment 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 actual competition. It is also larger when we control for banking competition. Overall, this result is consistent with the interpretation that product market competition facilitates the transmission of fiscal stimulus from public investment to private investment.

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[12] This is estimating by assuming the off-balance sheet spending on each category is the same as reported by the National Audit Office in June 2013.

[13] URL: http://xukezheng.cbrc.gov.cn/ilicence/licence/licenceQuery.jsp. See Acharya et al. (2016) for more details.

To gauge the economic significance of this result, we find it useful to compare the effect of public investment 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 pubic investment as the average over our sample period (0.91), our estimate in column 1 suggests that the average private firm investment is 0.6 percent per unit of fixed assets in the city at the 25th percentile and 1.8 percent per unit of fixed assets in the city at the 27th percentile. This difference accounts for 13 percent of the correlation between public investment on private investment on average. A similar calculation using our estimates from columns 2-4 suggest that the difference accounting for 15 to 24 percent of this correlation.

We report evidence on transaction-level land prices in Table 3. The interaction term of public investment and (actual or predicted) market structure is negative and significant at the 1 percent level in all specifications. This result suggests that in cities with more competitive product market competition, public investment has a smaller effect on land price. Similar to Table 2, the estimate is larger when we use predicted market competition than actual market competition. The results are not affected when we control for banking competition.

Similar results carry over to city-level hedonic land price index (Table 4). The interaction term of public investment and (actual or predicted) market structure is negative in all specifications. The estimates are smaller (significant at the 5 percent level) when we use actual market competition and larger (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 (Fang et al. 2016), which we interpret as evidence on the real estate markups of the real estate sector (Table 5). The sample size is reduced to about one third of the land price results (Table3-4) due to the availability of house price index. Our results show that the interaction term of public investment and (actual or predicted) market structure is negative in all specifications. This is consistent with our model prediction that the effect of public investment on markups is smaller when market competition is higher.

VI. CONCLUSION

With 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. This paper asks whether rising market power impedes the transmission of fiscal stimulus. In the first part of this paper, we build an analytical model of imperfect market competition and fiscal stimulus. Our model has two key ingredients: fiscal stimulus targeted to a specific sector and variable markups in the targeted sector. 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 in response to targeted public investment, the changes of sectoral real and nominal outputs, sector-specific factor prices and markup are ambiguous. Nevertheless, the changes depend on product market competition in the targeted sector unambiguously under general assumptions. The more competitive the market is, the more sectoral output responds to fiscal stimulus in the targeted sector. In addition, the more competitive the market is, the less sectoral prices, sector-specific factor prices, and markup respond.

We offer new empirical evidence consistent with these theoretical predictions in the context of the large fiscal stimulus in China in 2009-2010. Our empirical strategy explores geographical variations in local public and private investment in the construction and real estate development sector—a sector which local fiscal stimulus concentrated on. We find that, in response to public investment during fiscal stimulus, private investment increases more in the construction and real estate development sector in cities with more product market competition. Furthermore, land prices and markups in the construction and real estate development sector increase less in the construction and real estate development sector in cities with more product market competition. Overall, our results support the view that market competition facilitates the transmission of fiscal stimulus.

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Table 1. Summary statistics

	Mean	Median	Std. Dev	P25	P75	N. Obs
	Firm-level variables (2008 – 2013, private firms)					
Investment rate	-0.139	0	0.269	-0.015	0	31,085
Assets	1.90e+08	2.23e+07	1.16e+09	2.81e+06	1.14e+08	31,085
Profit margin	-0.115	0.008	1.106	-0.003	0.075	22,144
	City-level variables					
LGFV investment (2008 – 2013)	0.91	0.61	1.19	0.18	1.18	255
Market competition measure (2004)	2.10	1.21	2.73	0.73	3.07	262
Predicted market competition (2008)	4.07	2.93	3.37	1.99	4.77	111
Land supply elasticity (Saiz index)	0.84	0.89	0.19	0.77	0.96	111
Bank branches	19.55	7	41.15	2	19	10,755
SOB branches	10.71	4	21.29	1	11	10,755
Population (10,000)	451.5	383.8	381.1	251.0	594.5	4,005
GDP per capita (1000 RMB)	32.69	24.70	27.58	13.50	43.10	3,886
Hedonic land price growth (annual)	-0.01	0.03	0.59	-0.24	0.29	5,247

Table 2. Results on private investment

	(1)	(2)	(3)	(4)
	Private investment			
Public investment	-0.0560***	-0.0945***	-0.0903***	-0.121***
	(0.003)	(0.006)	(0.007)	(0.012)
Market structure	0.00526***		-0.000877	
	(0.001)		(0.001)	
Predicted market structure		0.0125***		0.0129***
		(0.001)		(0.002)
Public investment x market structure	0.00302***		0.00862***	
	(0.001)		(0.001)	
Public investment x predicted market structure		0.00514***		0.00828***
		(0.001)		(0.001)
Banking competition			0.208***	0.406***
			(0.012)	(0.019)
Public investment x Banking competition			0.0397***	0.0489***
			(0.009)	(0.014)
Province FE	YES	YES	YES	YES
Observations	132,183	50,004	131,631	49,832
R-squared	0.301	0.266	0.302	0.266

Table 3. Results on transaction-level land price

	(1)	(2)	(3)	(4)
	log (land price per square meter)			
Public investment	0.0507***	0.165**	-0.0182	-0.0776
	(0.014)	(0.078)	(0.020)	(0.086)
Predicted market structure		-0.00035		-0.00212
		(0.002)		(0.002)
Public investment x Market structure	-2.14e-05***		-2.24e-05***	
	(3.52E-06)		(3.52E-06)	
Public investment x Predicted market structure		-0.0148***		-0.0135***
		(0.005)		(0.005)
Public investment x Saiz index		-0.0714		-0.0609
		(0.083)		(0.085)
Public investment x Banking competition			0.137***	0.224***
			(0.027)	(0.037)
City FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	132,183	50,004	131,631	49,832
R-squared	0.301	0.266	0.302	0.266

Table 4. Results on Hedonic land price index

	(1)	(2)	(3)	(4)
	Hedonic land price index			
Public investment	0.00124	0.336**	0.0111	0.344***
	(0.013)	(0.150)	(0.030)	(0.131)
Predicted market structure		0.0185***		0.0144***
		(0.006)		(0.005)
Public investment x Market structure	-3.06e-05**		-3.04e-05**	
	(1.21E-05)		(1.24E-05)	
Public investment x Predicted market structure		-0.0581***		-0.0509***
		(0.016)		(0.014)
Public investment x Saiz index		-0.177		-0.129
		(0.108)		(0.094)
Public investment x Banking competition			0.137***	0.185***
			(0.027)	(0.031)
City FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	2,055	848	1,955	829
R-squared	0.031	0.074	0.037	0.07

Table 5. Results on sectoral markups

	(1)	(2)	(3)	(4)
	House price index			
Hedonic land price index	0.005	0.024	0.007	0.038
	(0.038)	(0.084)	(0.041)	(0.084)
Public investment	0.0135	0.716	0.107	0.811
	(0.065)	(0.567)	(0.089)	(0.542)
Predicted market structure		0.003		0.003
		(0.003)		(0.003)
Public investment x Market structure	-2.43e-05*		-2.39e-05*	
	(1.38E-05)		(1.41E-05)	
Public investment x Predicted market structure		-0.0458***		-0.0433***
		(0.0152)		(0.0158)
Public investment x Saiz index		-0.504		-0.559
		(0.613)		(0.591)
Public investment x Banking competition			-0.140	-0.111
			(0.117)	(0.140)
City FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	669	379	645	372
R-squared	0.90	0.92	0.90	0.92

Appendix

Proof of Proposition 1.

We prove the existence of the unique equilibrium under three circumstances: $\rho = 1$, $\rho > 1$, and $\rho < 1$.

Equation (6)-(8) imply

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

or

$$1 - \frac{1}{\eta}\left(1 - \left(\frac{y_{hi}}{y_h}\right)^{\frac{\eta-1}{\eta}}\right) - \frac{Gp_h^{\rho-1} + P^\rho C}{Gp_h^{\rho-1} + \rho P^\rho C} \cdot \left(\frac{y_{hi}}{y_h}\right)^{\frac{\eta-1}{\eta}} = \frac{MC_h}{B(N)p_h}. \quad \text{(A1)}$$

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.

In the cases where $\rho > 1$ or $\rho < 1$, 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.

□

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:

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

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[14], 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:

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

Therefore,

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

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

Since $\frac{\partial p_h}{\partial G}$ can be positive or negative, and that $P^\rho C$ is a free parameter in this model[15], 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:

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

Therefore, redefining $\Phi(N) = NB(N)^{-1}$,

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[14] For example, Huang et al. (2018) document the "financial crowding out" channel in the same stimulus episode in China.

[15] In the benchmark scenario where $G = 0$, $p_h = MC_h \times \frac{\rho N}{\rho N - 1}$ is independent from household demand $P^\rho C$.

$$\frac{\partial^2(1/\mu)}{\partial G\partial N} = \frac{\partial^2 \frac{(\rho-1)P^\rho C}{\Phi(N)(Gp_h^{\rho-1}+\rho P^\rho C)}}{\partial G\partial N}$$
$$= \frac{(\rho-1)P^\rho C\Phi'(N)\left(Gp_h^{\rho-1}+\rho P^\rho C\right)}{\Phi^2(N)\left(Gp_h^{\rho-1}+\rho P^\rho C\right)^2} > 0$$
$$\Rightarrow \frac{\partial^2\mu}{\partial G\partial N} < 0$$

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:

$$\frac{\partial^2\left[B(N)p_h\left(1-\frac{Gp_h^{\rho-1}+P^\rho C}{N\left(Gp_h^{\rho-1}+\rho P^\rho C\right)}\right)\right]}{\partial G\partial N} = \frac{\partial^2 \frac{(\rho-1)P^\rho C}{NB(N)^{-1}\left(Gp_h^{\rho-1}+\rho P^\rho C\right)}}{\partial G\partial N}$$

Define $C(N) = NB(N)^{-1}$, so that $C'(N) > 0$. When $\rho > 1$,

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

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

Therefore, for a given government spending G, the demand curve shifts upward less when the market is more competitive (larger N):

$$\frac{\partial^2 p_h}{\partial G\partial N} < 0$$

The growth rate of house prices is also marginally smaller for a larger N:

$$\frac{\partial^2 \log p_h}{\partial G\partial N} = \frac{\partial^2 p_h}{\partial G\partial N} < 0$$

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 $\bar{S}$.[16] Therefore,

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[16] 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.

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

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

$$landp \propto \big(1-B(N)\big)p_h y_h + B(N)MC_h y_h.$$

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

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

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

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

Thus,

$$\frac{\partial^2 \log landp}{\partial G \partial N} = \frac{\partial^2 \log\left[\big(1-B(N)\big)p_h y_h + B(N)MC_h y_h\right]}{\partial G \partial N}$$
$$< \frac{\partial^2 \log(MC_h y_h)}{\partial G \partial N} < 0.$$

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:

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

Therefore,

$$\frac{\partial^2 p_h y_h}{\partial G \partial N} = \rho(\rho-1)P^\rho C p_h^{-1-\rho}\frac{\partial^2 p_h}{\partial G \partial N} > 0.$$

□