Rural-Urban Migration, Structural Transformation, and Housing Markets in China*

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Abstract

This paper investigates the interrelationship between urbanization, structural transformation, and the post-2000 Chinese housing boom through the lens of a dynamic spatial equilibrium model that features migration and a rich housing market structure with mortgages. Urbanization and structural transformation emerge as key drivers of China's house price boom, while at the same time rising house prices impede these forces of economic transition. Policies to boost urbanization can be undone by the endogenous price response. Land supply expansion ameliorates this negative feedback. Overall, housing markets powerfully shape the path of economic development.

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1 Introduction

In recent decades, many countries have undergone profound economic changes in the form of large sectoral reallocation from agriculture to manufacturing and services, significant urbanization, and sustained housing booms that have contributed both to higher living costs and rising household wealth. These trends beg an important question: what is the nature and significance of the relationship between these phenomena? Specifically, to what extent does the economic development process naturally give rise to the observed pronounced housing booms, or must other forces—including policy interventions—also be at play? In addition, do rising housing costs jeopardize economic development by impeding migration, or does the prospect of financial gains from urban house price appreciation stimulate geographic and sectoral reallocation?

China serves as the focal point of analysis for this paper given the speed and magnitude of these changes there. China's transition from a largely rural, agrarian society to an increasingly urban, industrialized economy with rapidly rising house prices is evident in figure 1, which focuses on the sample period of 2001 to 2014. As shown in the first two panels, China has witnessed a rapid decline in its agricultural GDP share and a rise in its urban population share—trends that first emerged after 1978 but which have persisted since the turn of the millennium despite a stagnant urban-rural income gap.[1] House prices have also skyrocketed since China implemented market-based land reforms around the turn of the century, potentially fueled by urbanization.[2]

[1]The urban-rural income gap is measured as the ratio of per-capita non-agricultural GDP to agricultural GDP multiplied by the relative price of agricultural to non-agricultural goods. Per-capita non-agricultural (agricultural) GDP is real non-agricultural (agricultural) GDP divided by urban (rural) population. The relative price of agricultural to non-agricultural goods is the ratio of the producer price of agricultural goods to the GDP deflator.

[2]This paper uses hedonic price data until 2014 from Fang, Gu, Xiong and Zhou (2016).

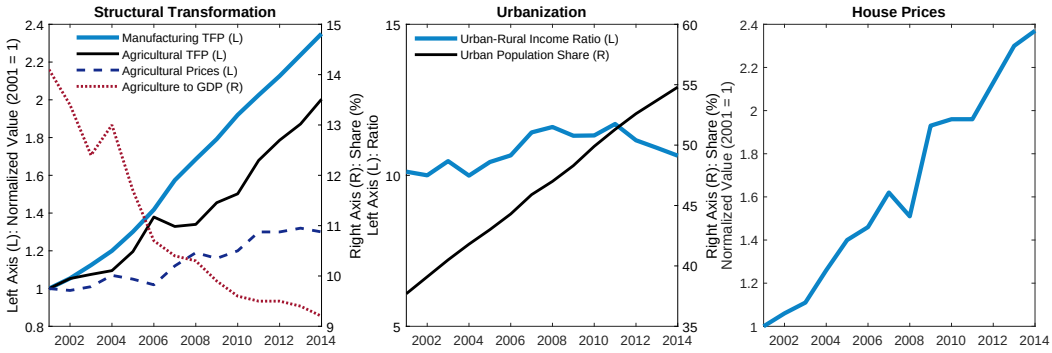

Figure 1: Stylized facts on China's economic transition and housing boom. Sources: (productivity, agricultural prices, agriculture to GDP, population, urban-rural income) CSY; (house prices) Fang et al. (2016).

This paper investigates the above questions through the lens of a dynamic spatial equilibrium model. Its foundation is a two-region, multi-sector open economy with costly migration. Key features added on top of this core structure include an incomplete markets consumption-saving framework, housing demand that incorporates tenure choice (own vs. rent) and a property ladder, and long-term collateralized borrowing, and institutional restrictions related to mobility, leverage, and land supply that are pertinent to China. Unlike in static spatial models, housing is both a consumption good and a durable asset where future appreciation and capital gains influence current decisions. Mortgages allow households to separate the timing of home purchases from that of income. Moreover, modeling mortgages as long-term debt rather than one-period contracts distinguishes between the stock and flow of credit, which is important for analyzing the effect changing credit policies.

The quantitative analysis parametrizes the model, simulates China's structural transformation, urbanization, and housing boom, and performs a number of counterfactual exercises to uncover the forces operating between these processes and to evaluate policies intended to accelerate economic

development. The baseline simulation subjects the model to a one-time unexpected arrival of news about the future path of sectoral productivities, net mobility costs (which includes city amenities and a residual component), agricultural prices, and land supply. With the exception of the net mobility cost residual—which is inferred from observed migration flows—all paths come directly from the data.

The baseline results show that income and mobility cost dynamics are both key drivers of rural-urban migration, which is also affected by the response of housing markets. Combined, income and population growth rationalize almost the entire 137% increase in national house prices in China from 2001 to 2014. The model uncovers a dynamic nexus between housing markets and migration. Migration amplifies the house price response to income changes while also creating medium-run momentum and overshooting with long-run partial mean reversion. This *migration accelerator* is thus dynamic in nature and is influenced by households' expectations and the institutional environment surrounding borrowing constraints and mobility restrictions.

Operating in the opposite direction, housing markets impact the extent and pace of migration and, with it, structural transformation. Ex ante, it is unclear whether house price appreciation should help or hinder migration given its dual nature as both a consumption good and an asset. On the one hand, inflated urban housing costs make city living less affordable, which acts as a disincentive to migrate. On the other hand, expectations of future house price appreciation create the incentive to move early to buy a house both to lock-in housing costs before prices rise and to then build wealth from the subsequent appreciation. These dynamic, forward-looking considerations have an important effect on the extent and timing of migration, but on balance, the quantitative analysis finds a *house price decelerator* whereby rising house

prices stunt migration. To understand the importance of the house price decelerator, the model suggests that the rise in house prices between 2001 and 2014 attenuated 29% of the cumulative rural-urban migration that would have occurred had prices remained constant along with 21% of the decline in agriculture-to-GDP.

The above channels between house prices and migration emphasize the importance of a dynamic analysis and a careful consideration of the rich features of the Chinese housing and mortgage markets as well as its institutional environment. Moreover, these channels also play a major role in determining the effectiveness of migration, leverage, and land supply policies aimed at accelerating China's economic transition that this paper studies. The first policy loosens migration restrictions to encourage more people to move to the city. While this policy directly serves to enhance urbanization, it also stimulates greater house price appreciation that in turn neutralizes the direct effect in the short run and greatly attenuates it in the long run. The second policy exercise relaxes down payment requirements in an effort to make it easier for urban residents to buy a house, thereby making it more appealing to move to the city. As with the previous experiment, the indirect effect via the house price decelerator largely offsets the direct effect, and thus the policy is not effective at increasing migration. The pitfall of the mobility and leverage policies for migration is that they are largely undone by the fact that they impact housing demand, which drives up prices and reduces the incentive to migrate. By contrast, expanding the availability of new land for construction successfully accelerates urbanization and structural transformation by targeting housing supply.

In summary, the two-way link between housing and migration reveals that rapid urbanization puts tremendous pressure on house prices, and the ability to

accommodate an influx of migrants without a steep escalation in prices shapes the path of economic development. Moreover, these channels have first-order implications for the efficacy of policy interventions.

1.1 Related Literature

A large literature studies China's rapid development, while a small but growing body of papers are investigating China's housing boom. Zhu (2012) offers a summary of the scholarship on China's development, while Chen (2020) gives a comprehensive overview of the burgeoning research on Chinese housing markets. This paper is more in line with the approach in Wu, Gyourko and Deng (2016), though the interaction of credit and population shifts can generate bubble-like price behavior consistent with Chen and Wen (2017). A key innovation here is that structural transformation acts as a major driver of migration and price appreciation. Many studies on structural transformation use equilibrium models without spatial considerations, a summary of which is in Herrendorf, Rogerson and Valentinyi (2014). Hansen and Prescott (2002) and Ngai and Pissarides (2007) emphasize the role of different productivity growth rates in driving structural change. In this paper, migration is sensitive to such gaps, but other factors also prove necessary.

A notably smaller literature exists on dynamic rural-urban migration. Glomm (1992) studies migration caused by higher urban productivity from agglomeration effects. Robert E. Lucas (2004) identifies human capital accumulation as a dynamic driver of migration. More recently, Bond, Riezman and Wang (2016) demonstrate that trade liberalization in capital-intensive, import-competing sectors prior to China's WTO accession has accelerated migration, capital accumulation, and economic growth. Tombe and Zhu

(2019) find that reduction in internal trade and migration costs account for almost two-fifths of aggregate labor productivity growth in China from 2000 to 2005—even more important than international trade liberalization. Also focusing on China, Liao, Wang, Wang and Yip (2020) show that education-based migration plays an equally important role as work-based migration for urbanization. None of these papers considers the role of housing.

A substantial contribution of this paper to the housing literature involves the finding that structural transformation and urbanization can generate sustained housing booms. Moreover, the underlying transmission mechanisms give rise to dynamic impulse responses that feature medium-term momentum and long-run partial mean reversion, which the structural housing literature often has a difficult time producing. Relative to the bulk of spatial economics papers that are static in nature, this paper reveals the importance of dynamic forward-looking behavior,tenure choice that creates a dual consumption-asset role for housing, and credit access that disentangles migration and home purchase decisions from the timing of income and prices. In this sense, the paper here relates to a large literature that explores financial frictions as drivers of housing boom-bust episodes (e.g., see Garriga, Manuelli and Peralta-Alva (2019) and Garriga and Hedlund (2018), or Davis and Van Nieuwerburgh (2015) and Piazzesi and Schneider (2016) for summaries). More broadly, this paper also relates to a longstanding literature that establishes the importance of housing demand factors for house price behavior, such as Davis and Heathcote (2007), Iacoviello (2005), Iacoviello and Neri (2010), Liu, Miao and Zha (2016) and Liu et al. (2016).

2 The Model

The model economy contains a unit measure of infinitely-lived households who reside in either a rural or urban area. Rural households own and operate farms in the tradable agricultural/farm sector (f). Households living in the city work either in the urban production sector (labeled as manufacturing (m) but which encompasses all non-housing urban output) or in residential construction and have access to open financial markets. Agents work where they live, but rural workers can migrate to the city. The urban good m is the numeraire.

2.1 Production

Rural households each produce Z_{ft} farm goods, where Z_{ft} denotes agricultural productivity. Thus, total farm output $Y_{ft} = Z_{ft}N_{ft}$ depends on Z_{ft} and the rural population N_{ft}. Urban "manufacturers" produce $Y_{mt} = Z_{mt}N_{mt}$ goods from urban labor N_{mt} hired at wage rate $w_t = Z_{mt}$ that can be used as final consumption or as intermediate structures to build houses and apartments.

The residential construction sector sells tenant-occupied apartments ($j = a$) and owner-occupied housing ($j = h$) at price p_{jt} produced from new land L_{jt} issued by the government at price p_{ljt}, structures S_{jt} from the numeraire "manufacturing" sector, and urban labor N_{jt} using a constant returns to scale technology, $Y_{jt} = Z_j F_j(L_{jt}, \Upsilon(S_{jt}, N_{jt}))$. Profit maximization implies

$$p_{ljt} = p_{jt} Z_j \frac{\partial F_j}{\partial L_j}, \tag{1}$$

$$1 = p_{jt} Z_j \frac{\partial F_j}{\partial \Upsilon} \frac{\partial \Upsilon}{\partial S_j}, \tag{2}$$

$$w_t = p_{jt} Z_j \frac{\partial F_j}{\partial \Upsilon} \frac{\partial \Upsilon}{\partial N_j} \tag{3}$$

The law of motion for the two stocks is $K_{jt} = (1 - \delta_j)K_{j,t-1} + Y_{jt}$, where δ_j is depreciation, and $\delta_a > \delta_h$ reflects greater wear and tear by tenants.[3]

Absentee rental companies lease apartments to urban residents at rent r_{at}. Rental companies must be indifferent between selling an apartment and retaining it for rental purposes and future resale, which implies the following relationship between apartment prices and rents:

$$p_{at} = r_{at} + \frac{1 - \delta_a}{1 + i_{t+1}} p_{a,t+1}. \tag{4}$$

2.2 Households

Agents receive utility $u(x_{ft}, x_{mt}, x_{ht})$ from farm goods x_{ft}, manufactured goods x_{mt}, and housing services x_{ht} and discount at the rate β. Also, depending on whether they live in the rural or urban area, agents differ in terms of the level and riskiness of income, housing options, and access to financial markets.

2.2.1 Rural Households

Rural households receive deterministic farm income Z_{ft}, and they costlessly obtain housing services $x_{ht} = h_f$ from nontradable, self-built farm houses h_f. Rural households also lack access to financial markets, which implies that they are hand-to-mouth consumers. Even so, they must still choose how to allocate their spending between manufactured and farm goods, the latter of which trade at relative price p_{ft} and require minimum subsistence consumption $\underline{x}_f$.

Households in rural areas are identical hand-to-mouth income-earners except that they differ with respect to the net migration cost $\xi_t \epsilon$ they pay if

[3] Residential depreciation helps ensure stationarity. At the individual owner level, housing depreciation manifests in the form of stochastic house fires with probability δ_h. However, by assumption, the government fully insures these events by purchasing new houses for the owners and charging $\delta_h p_{ht} h$ each period for the insurance.

they move to the urban area, where ξ_t is a common, time-varying component and ϵ is a permanent type drawn from distribution $\Psi(\epsilon)$ with support $[\underline{\epsilon}, \infty)$. Smaller values of ϵ signify either lower gross mobility costs or a higher premium placed on urban amenities. For simplicity, urban-to-rural migration is not allowed, though this restriction never binds in any of the quantitative exercises.

2.2.2 Urban Households

Urban households receive stochastic labor market earnings $w_t e_t s_t$, where s_t is a persistent shock that follows transitions $\pi(s_{t+1}|s_t)$, e_t is a transitory shock drawn from $G(e_t)$, and w_t is the wage. Newly arrived migrants from the rural area draw their initial s_t from the stationary distribution $\Pi(s_t)$. Because labor markets are competitive and the manufacturing technology is linear, it must be the case that $w_t = Z_{mt}$. In addition, the government supplements income with transfers $\mathcal{T}_t$ to provide a consumption floor.[4]

City residents can be either renters or owners. Renters pay r_{at} each period for an apartment h_a that provides services $x_{ht} = h_a$. With probability η_t, urban residents receive a hukou permit that allows them to buy an owner-occupied house $h \in \mathcal{H} = \{h_1, h_2, \ldots, h_N\} > h_a$ at unit price p_{ht} that provide flows $x_{ht} = \zeta h$, $\zeta \geq 1$.[5] Lastly, urban residents can save and owners can borrow using mortgages. The respective interest rates i_t and r_{dt} on savings and mortgages are exogenous, reflecting that they are primarily controlled by the government. Mortgages are long-term contracts with a minimum down payment ratio θ_t and an amortization schedule that decays geometrically at rate γ.

[4]The transfer also prevents low income renters from facing an empty budget set.

[5]The model abstracts from multiple ownership, but capital gains from rising prices still provide an investment motive to buy. Empirically, the 2011 China Household Finance Survey finds that only 15% owned multiple houses, likely due to high minimum down payments on non-primary residences of 60–70%, as reported by Chen, Wang, Xu and Zha (2020).

2.2.3 Household Decision Problems

Rural workers are characterized by their net mobility cost ϵ. In the city, renters have cash at hand y_t (the sum of earnings $w_t e_t s_t$, transfers $\mathcal{T}_t$, and savings b_t), persistent shock s_t, and an indicator for hukou permit status denoted as a superscript. Owners also have house h_t and mortgage d_t.

Rural Rural workers make consumption and migration decisions that solve

$$V_t^{rural}(\epsilon) = \max_{x_{mt}, x_{ft} \geq 0} u(x_{mt}, x_{ft}, h_f) + \beta \max\left\{V_{t+1}^{rural}(\epsilon), \mathbb{E}V_{t+1}^{rent,0}(y_{t+1}, s_{t+1}) - \xi_{t+1}\epsilon\right\}$$

$$\text{subject to}$$

$$\begin{aligned} p_{ft}x_{ft} + x_{mt} &= p_{ft}Z_{ft} \\ y_{t+1} &= w_{t+1}e_{t+1}s_{t+1} + \mathcal{T}_{t+1}, \end{aligned} \tag{5}$$

which gives a cutoff ϵ_{t+1}^* for the marginal migrant. Remaining rural households entering period $t+1$ (those with $\epsilon > \epsilon_t^*$) migrate if $\epsilon \leq \epsilon_{t+1}^*$, where

$$\epsilon_{t+1}^* \equiv \max\left\{\epsilon_t^*, \left[\mathbb{E}V_{t+1}^{rent,0}(y_{t+1}, s_{t+1}) - V_{t+1}^{rural}\left(\epsilon_{t+1}^*\right)\right]/\xi_{t+1}\right\}. \tag{6}$$

Urban Renters in the city without hukou permits make consumption and savings decisions that solve

$$V_t^{rent,0}(y_t, s_t) = \max_{\substack{x_{ft}, x_{mt}, \\ b_{t+1} \geq 0}} u(x_{ft}, x_{mt}, h_a) + \beta\mathbb{E}\left[\begin{array}{c} \eta_t \max\{V_{t+1}^{rent,1}(y_{t+1}, s_{t+1}), V_{t+1}^{buy}(y_{t+1}, s_{t+1})\} \\ +(1-\eta_t)V_{t+1}^{rent,0}(y_{t+1}, s_{t+1}) \end{array}\right]$$

$$\text{subject to}$$

$$\begin{aligned} p_{ft}x_{ft} + x_{mt} + p_a h_a + b_{t+1} &= y_t \\ y_{t+1} &= w_{t+1}e_{t+1}s_{t+1} + (1+i_{t+1})b_{t+1} + \mathcal{T}_{t+1}, \end{aligned} \tag{7}$$

where renters who receive a permit next period decide whether or not to buy.

Urban renters with hukou permits choose consumption, savings, and—after receiving their shocks next period—whether to remain as renters. They solve

$$V_t^{rent,1}(y_t, s_t) = \max_{\substack{x_{ft}, x_{mt}, \\ b_{t+1}}} u(x_{ft}, x_{mt}, h_a) + \beta \mathbb{E}\left[\max\{V_{t+1}^{rent,1}(y_{t+1}, s_{t+1}), V_{t+1}^{buy}(y_{t+1}, s_{t+1})\}\right]$$

subject to

$$\begin{aligned} p_{ft}x_{ft} + x_{mt} + p_a h_a + b_{t+1} &= y_t \\ y_{t+1} &= w_{t+1}e_{t+1}s_{t+1} + (1 + i_{t+1})\, b_{t+1} + \mathcal{T}_{t+1}, \end{aligned} \tag{8}$$

which features the same constraints as in household problem (7).

Homebuyers choose their desired house type, mortgage size (subject to the minimum down payment ratio), consumption, and savings to solve

$$V_t^{buy}(y_t, s_t) = \max_{\substack{x_{ft}, x_{mt}, \\ b_{t+1}, d_{t+1}, \\ h_{t+1} \in \mathcal{H}}} u(x_{ft}, x_{mt}, \zeta h_{t+1}) + \beta \mathbb{E}\left[\begin{array}{c} \max\left\{(1-\rho)V_{t+1}^{rent,0}\left(y_{t+1}^{rent}, s_{t+1}\right)\right. \\ +\rho V_{t+1}^{rent,1}\left(y_{t+1}^{rent}, s_{t+1}\right), \\ \left. V_{t+1}^{own}\left(y_{t+1}^{own}, h_{t+1}, d_{t+1}, s_{t+1}\right)\right\} \end{array}\right]$$

subject to

$$\begin{aligned} p_{ft}x_{ft} + x_{mt} + (1 + \tau_b + \delta_h)p_{ht}h_{t+1} + b_{t+1} &= y_t + d_{t+1} \\ d_{t+1} &\leq (1 - \theta_t)p_{ht}h_{t+1} \\ y_{t+1}^{rent} &= w_{t+1}e_{t+1}s_{t+1} + (1 + i_{t+1})\, b_{t+1} + (1 - \tau_s)p_{h,t+1}h_{t+1} - (1 + r_{d,t+1})\, d_{t+1} + \mathcal{T}_{t+1} \\ y_{t+1}^{own} &= w_{t+1}e_{t+1}s_{t+1} + (1 + i_{t+1})\, b_{t+1}, \end{aligned} \tag{9}$$

where in the continuation, the buyer can remain an owner or sell and become a renter, retaining a hukou permit with probability $\rho \in [0, 1]$.[6]

[6]This parsimoniously captures the probability that a household moves within the same city and keeps their hukou permit or moves to a different city and loses their hukou permit.

Lastly, existing owners choose their consumption and savings while their mortgage amortizes at the rate γ. Their value function is

$$V_t^{own}\left(y_t, h, d_t, s_t\right) = \max_{\substack{x_{ft}, x_{mt}, \\ b_{t+1}}} u(x_{ft}, x_{mt}, \zeta h) + \beta \mathbb{E}\left[\begin{array}{c} \max\left\{(1-\rho)V_{t+1}^{rent,0}\left(y_{t+1}^{rent}, s_{t+1}\right)\right. \\ +\rho V_{t+1}^{rent,1}\left(y_{t+1}^{rent}, s_{t+1}\right), \\ \left. V_{t+1}^{own}\left(y_{t+1}^{own}, h, d_{t+1}, s_{t+1}\right)\right\} \end{array}\right]$$

subject to

$$\begin{aligned} p_{ft}x_{ft} + x_{mt} + \delta_h p_{ht} h + b_{t+1} + (\gamma + r_{dt})d_t &= y_t \\ d_{t+1} &= (1-\gamma)d_t \\ y_{t+1}^{rent} &= w_{t+1}e_{t+1}s_{t+1} + (1+i_{t+1})\, b_{t+1} + (1-\tau_s)p_{h,t+1}h - (1+r_{d,t+1})\, d_{t+1} + \mathcal{T}_{t+1} \\ y_{t+1}^{own} &= w_{t+1}e_{t+1}s_{t+1} + (1+i_{t+1})\, b_{t+1}, \end{aligned} \tag{10}$$

where y_{t+1}^{own} and y_{t+1}^{rent} are as in household problem (9), except with house h (owner state variable) on the right side instead of h_{t+1} (buyer choice variable).

2.3 Government

The government exogenously issues quantities $\overline{L}_{jt}$ of land to the segmented apartment ($j = a$) and housing ($j = h$) markets. Land proceeds finance transfers $\mathcal{T}_t$ and insurance claims for depreciated housing, with the government consuming any residual revenues. Section 4.3.3 considers the case where the government endogenously supplies land.

2.4 Equilibrium

Given prices $\{p_{ft}, i_t, r_{dt}\}$ and policies $\{\overline{L}_{at}, \overline{L}_{ht}, \eta_t, \theta_t\}$, a dynamic spatial equilibrium (DSE) is quantities $\{N_{ft}, N_{mt}, N_{at}, N_{ht}, S_{at}, S_{ht}, L_{at}, L_{ht}, K_{at}, K_{ht}\}$, prices $\{p_{at}, r_{at}, p_{ht}, p_{lat}, p_{lht}, w_t\}$, household value functions $\{V_t^{rural}, V_t^{rent},$

V_t^{buy},$V_t^{own}\}$ and associated policy functions, migration cutoffs $\{\epsilon_t^*\}$, and end-of-period distributions $\{\Phi_t^{rent}, \Phi_t^{own}\}$ that satisfy several conditions. First, households, firms, and rental companies optimize as in sections 2.1 and 2.2. Second, the rural population satisfies

$$N_{ft} = 1 - \Psi(\epsilon_t^*). \tag{11}$$

Third, the urban labor market clears,

$$N_{mt} + N_{at} + N_{ht} = \int d\Phi_t^{rent} + \int d\Phi_t^{own} = 1 - N_{ft}. \tag{12}$$

Fourth, the land markets clear for $j = a, h$,

$$L_{jt} = \overline{L}_{jt}. \tag{13}$$

Fifth, the urban housing and rental markets clear,

$$\int h_t d\Phi_t^{own} = (1 - \delta_h) K_{h,t-1} + Y_{ht} \tag{14}$$

$$h_a \int d\Phi_t^{rent} = (1 - \delta_a) K_{a,t-1} + Y_{at}. \tag{15}$$

Lastly, the end-of-period urban area distributions are generated by the household decision rules and stochastic processes.

3 Parametrization

The results in section 4 analyze and compare different equilibrium transition paths over the sample period of 2001–2014 that are induced by changes either to the economic landscape or to policy. The calibration strategy for such an

analysis often involves determining parameters using a combination of direct external evidence and a joint procedure that minimizes the distance between the initial equilibrium of the model and a set of data moments. The approach here is similar except that it also uses the final equilibrium following a baseline set of shocks (described in section 4.1.1) to target some more recent data moments. The length of a model period is one year.

3.1 Production

This section describes the parametrization of producers in the economy.

3.1.1 Technology

Initial urban wages are normalized to 1 by setting $Z_{m0} = 1$. Rural productivity Z_{f0} is set to match the 2001 urban-rural income gap of $Z_{m0}/Z_{f0} = 10.12$ from the China Statistical Yearbook (CSY).[7]

The production function for residential construction is given by

$$F_j(L_{jt}, \Upsilon(S_{jt}, N_{jt})) = L_{jt}^{\alpha_{Lj}} \Upsilon(S_{jt}, N_{jt})^{1-\alpha_{Lj}} \tag{16}$$

$$\Upsilon(S_{jt}, N_{jt}) = S_{jt}^{\alpha_S} N_{jt}^{1-\alpha_S} \tag{17}$$

where the structures share $\alpha_S = 0.3$ is consistent with Favilukis, Ludvigson and Van Nieuwerburgh (2017), and α_{Lj} reflects the average ratio between the value of each residence type $j = a, h$ and land. For houses, $\alpha_{Lh} = 0.27$ is a population-weighted average across tier-1, tier-2, and tier-3 cities using

[7] The urban-rural income gap is measured as the ratio of per-capita non-agricultural GDP to agricultural GDP multiplied by the relative price of agricultural to non-agricultural goods. Per-capita non-agricultural (agricultural) GDP is real non-agricultural (agricultural) GDP divided by urban(rural) population. The relative price of agricultural to non-agricultural goods is the ratio of the producer price of agricultural goods to the GDP deflator.

estimates from Deng, Tang, Wang and Wu (2022), which is then scaled down by one-third to $\alpha_{La} = 0.18$ for tenant-occupied apartments given their higher density of structures to land. The productivities Z_{j0} are chosen to normalize initial house prices to $p_{h0} = 1$ and rents to $r_{a0} = 0.05$ so that $p_{h0}/r_{a0} = 20$.[8]

3.1.2 Housing

The annual depreciation rate for housing is set to $\delta_h = 0.025$ following Favilukis et al. (2017), whereas apartments depreciate at a higher rate of $\delta_a = 0.05$, which is consistent with the higher maintenance costs for tenant-occupied properties in Chambers, Garriga and Schlagenhauf (2009). The rural house size is normalized to $h_f = 1$.[9] The small urban house size is set to $h_1 = 3$ to be three times average urban earnings, while the apartment h_a and larger house h_2 are set such that $h_1/h_a = 1.31$ and $h_2/h_1 = 4.45$, respectively, to be consistent with quality-adjusted dwellings data from the Hang Lung Center for Real Estate at Tsinghua University (CRE).[10]

Home buyers pay a transaction cost $\tau_b = 0.005$ as in Garriga and Hedlund (2020). Sellers incur cost $\tau_s = 0.12$, which mirrors Guren, McKay, Nakamura and Steinsson (2020) and is inclusive of fees, moving costs, and liquidity discounts, as discussed in Piazzesi and Schneider (2016).

[8] In large cities, the ratio can exceed 50, while in small cities, the number can be below 10. The ratio of 20 can be viewed as an approximate national average in the early 2000s.

[9] The rural house size does not enter the rural budget constraint and cannot be separately identified from the minimum support of the mobility cost distribution in the joint calibration.

[10] The ratio of living space in owner-occupied to rental-occupied housing is 1.31, even though the ratio of purchased space is closer to 2. Unlike single-family standalone units which are common in the U.S. and Europe, houses in China are more often apartments and condos. Purchased space includes common areas, stairs/elevators, etc, whereas actual living space is about two-thirds of the purchased space. The 4.45 ratio for the large house to small house is the product of the raw space ratio between villas and regular houses (2.03) in the CHFS and the quality ratio (2.19) between them.

3.2 Households

This section describes the parametrization of households in the economy.

3.2.1 Preferences

Households exhibit nested, non-homothetic CES and constant relative risk aversion preferences. Specifically, $u(x_f, x_m, x_h) = U(C(x_f, x_m), x_h)$, where

$$U(C, x_h) = \frac{\left[\left(\phi_c C^{\frac{\nu_c - 1}{\nu_c}} + (1-\phi_c) x_h^{\frac{\nu_c - 1}{\nu_c}}\right)^{\frac{\nu_c}{\nu_c - 1}}\right]^{1-\sigma}}{1-\sigma} \tag{18}$$

$$C(x_f, x_m) = \left(\phi_f [x_f - \underline{x}_f]^{\frac{\nu_f - 1}{\nu_f}} + (1-\phi_f) x_m^{\frac{\nu_f - 1}{\nu_f}}\right)^{\frac{\nu_f}{\nu_f - 1}}. \tag{19}$$

The coefficient of relative risk aversion is set to a standard $\sigma = 2$, and the intratemporal elasticity of substitution between consumption and housing is $\nu_c = 0.487$ based on Li, Liu, Yang and Yao (2016). The minimum subsistence threshold $\underline{x}_f$ for agricultural consumption is set to 25% of average per capita rural agricultural consumption.[11] The discount factor β, utility shares ϕ_c and ϕ_f, elasticity ν_f, and homeownership utility premium ζ are all determined in the joint calibration. The discount factor β is informative for the amount of liquid financial assets in the economy, and the share ϕ_c affects the fraction that urban households spend on housing. The agricultural share ϕ_f and elasticity ν_f help determine agricultural spending in the initial and final equilibria (the latter induced by the baseline shocks described in section 4.1.1). The ownership premium ζ has a first-order impact on the homeownership rate.

[11] Using U.S. historical data dating back to 1870, Alvarez-Peláez and Díaz (2005) estimate a minimum consumption to average consumption ratio in the range of 28% to 40%. The calibration uses 25% because China was more industrialized in 2001 than the U.S. in 1870.

3.2.2 Mobility Costs

The cumulative density function for net mobility costs is

$$\Psi(\epsilon) = 1 - \left(\frac{\underline{\epsilon}}{\epsilon}\right)^{\kappa}, \tag{20}$$

where $\kappa = 2.8$ is set to be within the common range for the migration literature, e.g. Liao et al. (2020). The unobserved common component ξ_t of net mobility costs is decomposed into $\ln(\xi_t) = -\ln(\xi_{qt}) + \ln(\widetilde{\xi}_t)$, where ξ_{qt} stands for urban housing quality (or city quality, for short) and is measured by the ratio of the aggregate hedonic house price index to the National Bureau of Statistics (NBS) non-hedonic house price index. The unobserved residual $\widetilde{\xi}_t$ encapsulates gross mobility costs net of all other difficult to measure urban amenities. The initial values of both components are normalized to 1. The minimum support $\underline{\epsilon}$ and the final residual net mobility cost $\widetilde{\xi}_\infty$ are outputs from the joint calibration and play an important role in matching the urban population share at the beginning and end of the sample. Section 3.4 explains in more detail.

3.2.3 Urban Income Process

The stochastic labor endowment $e_t s_t$ follows

$$\ln(s_t) = \rho_s \ln(s_{t-1}) + \varepsilon_t \tag{21}$$

$$\varepsilon_t \sim \mathcal{N}(0, \sigma_\varepsilon^2) \tag{22}$$

$$\ln(e_t) \sim \mathcal{N}(0, \sigma_e^2). \tag{23}$$

with parameters $\rho_s = 0.9172$, $\sigma_\varepsilon^2 = 0.0469$, and $\sigma_e^2 = 0.03$ from Fan, Song and Wang (2010). The persistent component is discretized using the Rouwenhorst method into a three-state Markov chain with transition matrix π.

3.3 Government and Finance

This section describes parameters related to policy and financial instruments.

3.3.1 Government Policy

The minimum down payment ratio is $\theta = 0.3$ in accordance with policy during 2001 – 2014.[12] The decay rate for outstanding mortgage balances is $\gamma = 0.0333$ to approximate a 30-year amortization. The probability that an urban resident receives a hukou permit is $\eta = 0.3$, which corresponds to an expected wait time of just over 3 years as reported by Liao et al. (2020), and the probability of keeping a hukou permit after selling is set to $\rho = 0.37$.[13] The initial land supplied by the government is normalized to $\overline{L}_{j0} = 1$ for $j = a, h$.

The transfers ensure that urban residents never face an empty budget set—namely, that they can afford an apartment, subsistence agricultural consumption, and have income for other goods. The functional form satisfies

$$\mathcal{T}_t(e_t s_t) = \max\{0, r_{at} h_a + p_{ft} \underline{x}_f + \chi w_t \underline{es} - w_t e_t s_t\} \tag{24}$$

with $\chi = 0.5$ and where $\underline{es}$ is the lowest income realization.[14]

3.3.2 Interest Rates

The literature reports a range of estimates for the rate of return to savings in China. This paper sets $i = 0.08$, which is slightly lower than the 10% used in

[12] The down payment was temporarily lowered to 20% during the global financial crisis.

[13] Based on data from the 2005 One Percent Population Survey, 63% of urban-to-urban movers migrated to another city where they often lose their hukou permit, with 37% moving within the city where they keep their permit.

[14] It turns out that, for the overall parametrization, $w_t \underline{es} > r_{at} h_a + p_{ft} \underline{x}_f + \chi w_t \underline{es}$ at most points in time—implying that nobody receives any transfers—and never does more than 0.5% of the population ever receive a net transfer during the equilibrium transition path.

Table 1: Joint Parametrization

Description	Model	Data	Source
2001 Rural Population Share	62.3%	62.3%	CSY[a] 2016
2014 Rural Population Share*	45.2%	45.2%	CSY[a] 2016
2001 Agricultural Spend Share	14.1%	14.1%	CSY[a] 2016
2014 Agricultural Spend Share*	9.4%	9.2%	CSY[a] 2016
Homeownership Rate	82.4%	82.6%	Census[b] 2000
Financial Assets to GDP	1.5	1.5	UHS[c] 2007
Housing Spend Share (Owners)	24.4%	24.5%	CHFS[d] 2014, 2016

*Final equilibrium. [a]China Statistical Yearbook; [b]Average over tier-1, 2, and 3 cities; [c]Urban Household Survey; [d]China Family Panel Survey.

Hsieh and Klenow (2009) because of the absence of physical capital and other high-return assets in the model here. The mortgage rate is $r_d = 0.06$.

3.4 Joint Parametrization

The remaining parameters are determined jointly within the model to match characteristics of the Chinese economy over the sample period of 2001 to 2014. Table 1 provides the empirical moments, data sources, and closeness of fit. The procedure utilizes the initial equilibrium to target a set of moments that involve household portfolios, expenditure shares, and the population split across rural and urban areas in the early post-land-reform years. In addition, the model targets two moments from 2014—the rural population share and the agricultural spending share—using the long-run equilibrium that corresponds to the 2014 values of the shocks described in section 4.1.1.[15] Table 2 summarizes all of the model parameters.

[15]An even more precise procedure that computes the entire equilibrium transition path starting in 2001 for each parameter combination to target the 2014 data using the thirteenth period of the transition would be very costly and deliver minimal accuracy gains.

Table 2: Summary of Model Parameters

Description	Parameter	Value	Explanation
Technology			
Manufacturing Productivity	Z_{m0}	1	Section 3.1.1
Agricultural Productivity	Z_{f0}	0.099	Section 3.1.1
Housing Productivity	Z_h	0.829	Section 3.1.1
Apartment Productivity	Z_a	1.658	Section 3.1.1
Housing Land Share	α_{Lh}	0.27	Section 3.1.1
Apartment Land Share	α_{La}	0.18	Section 3.1.1
Structures Share	α_S	0.3	Section 3.1.1
Housing			
Housing Depreciation	δ_h	0.025	Section 3.1.2
Apartment Depreciation	δ_a	0.05	Section 3.1.2
Rural House Size	h_f	1	Section 3.1.2
Urban Apartment Size	h_a	2.29	Section 3.1.2
Small Urban House Size	h_1	3	Section 3.1.2
Large Urban House Size	h_2	13.35	Section 3.1.2
Buyer Transaction Cost	τ_b	0.005	Section 3.1.2
Seller Transaction Cost	τ_s	0.12	Section 3.1.2
Preferences			
Risk Aversion	σ	2	Section 3.2.1
Discount Factor	β	0.850	Joint Calibration
$U(C, x_h)$: Intratemporal Substitution	ν_C	0.487	Section 3.2.1
$U(C, x_h)$: Weight on C	ϕ_c	0.056	Joint Calibration
$U(C, x_h)$: Homeownership Premium	ζ	1.45	Joint Calibration
$C(x_f, x_m)$: Intratemporal Substitution	ν_f	2.107	Joint Calibration
$C(x_f, x_m)$: Weight on x_f	ϕ_f	0.287	Joint Calibration
$C(x_f, x_m)$: Subsistence x_f	$\underline{x}_f$	0.004	Section 3.2.1
Net Mobility Costs			
Curvature of CDF	κ	2.8	Section 3.2.2
Lower Support of CDF	$\underline{\epsilon}$	8.493	Joint Calibration
Initial City Quality	$\xi_{\underline{q},0}$	1	Section 3.2.2
Initial Common Net Mobility Cost	$\widetilde{\xi}_0$	1	Section 3.2.2
End-of-Sample City Quality	$\xi_{\underline{q},T}$	1.277	Section 3.2.2
End-of-Sample Residual Net Mobility Cost	$\widetilde{\xi}_T$	0.636	Joint Calibration
Urban Income Process			
Autocorrelation of Persistent Shock	ρ_s	0.9172	Section 3.2.3
Variance of Persistent Shock	σ^2_ε	0.0469	Section 3.2.3
Variance of Transitory Shock	σ^2_e	0.03	Section 3.2.3
Government Policy			
Income Floor Ratio	χ	0.5	Section 3.3.1
Minimum Down Payment Ratio	θ	0.3	Section 3.3.1
Mortgage Amortization Rate	γ	0.0333	Section 3.3.1
Hukou Receipt Probability	η	0.3	Section 3.3.1
Hukou Retention Probability	ρ	0.37	Section 3.3.1
Initial Housing Land	$\overline{L}_{h0}$	1	Section 3.3.1
Initial Apartment Land	$\overline{L}_{a0}$	1	Section 3.3.1
Interest Rates			
Savings Interest Rate	i	0.08	Section 3.3.2
Mortgage Interest Rate	r_d	0.06	Section 3.3.2

4 Results

The central issues investigated in this paper surround the relationship between structural transformation, urbanization, and the house price boom in China in the time period since the government implemented market-oriented housing and land policy reforms near the turn of this century. Through the lens of the model, this section employs quantitative exercises to understand the drivers of China's experience from 2001 to 2014, to address the bi-directional relationship between housing and migration, and to examine the impact of different potential policy interventions on the pace of economic change.

4.1 Reconstructing China's Economic Transition

This section employs the model to reproduce China's structural transformation and urbanization with the goals of quantifying the forces behind this transition and understanding the extent to which they explain the Chinese housing boom.

4.1.1 Baseline Model Fit

This section reconstructs China's structural transformation during the sample period by exposing the model to a one-time unanticipated sequence of several shocks. Agents in the economy learn about the new paths all at once, after which point the economy gradually transitions from its initial parametrized equilibrium to a new long run. However, the analysis focuses on the part of the equilibrium transition path that falls within the 2001–2014 sample period.

The baseline simulation takes as inputs the extrapolated paths of measured manufacturing and agriculture productivities, the path of agricultural prices, and the (smoothed) trajectories of land supply and city quality from 2001 to

Table 3: Reconstructing China's Structural Transformation

Description	Method	Explanation
Manufacturing TFP	Exogenous	$\{Z_{mt}\}_{t=1,\ldots,T}$ from 2001 – 2014 data[a]
Agricultural TFP	Exogenous	$\{Z_{ft}\}_{t=1,\ldots,T}$ from 2001 – 2014 data[a]
Agricultural Prices	Exogenous	$\{p_{ft}\}_{t=1,\ldots,T}$ from 2001 – 2014 data[a]
Land Supply	Exogenous	$\{L_{jt}\}_{t=1,\ldots,T}^{j=h,a}$ from 2001 – 2014 data[b]
City Quality	Exogenous	$\{\xi_{qt}\}_{t=1,\ldots,T}$ from 2001 – 2014 data[c,a]
Rural Population	Targeted	$\left\{\widetilde{\xi}_t\right\}_{t=1,\ldots,T}$ targets 2001–2014 data[c,a]

[a]Extrapolated. [b]One-time jump based on smoothed data. [c]Smoothed data.

2014.[16,17] Absent segmented land supply data, the baseline assumes identical growth rates of $\overline{L}_{ht}$ and $\overline{L}_{at}$. The baseline computes the unobserved residual net mobility cost sequence $\{\widetilde{\xi}_t\}$ by targeting the three-year moving average of rural-urban migration in the data. Importantly, subsequent counterfactuals leave this sequence unchanged to ensure an *endogenous* pace of urbanization. Table 3 summarizes these sample paths.[18]

The first panel of figure 2 plots the time series for the exogenous paths of productivity, agricultural prices, and land supply. The implied urban-rural income ratio in the model, $\frac{Z_{mt}}{p_{ft}Z_{ft}}$, closely tracks the measured income ratio from the data, with only a minor divergence opening up in the last couple of years. Importantly, while urban workers on average have much higher incomes than do rural workers—by approximately a factor of ten—this gap actually

[16]An exogenous path of p_{ft} recognizes that global markets set the price for agricultural goods and allows for the fact that China's reliance on agricultural imports has grown over time, as discussed by Gale, Hansen and Jewison (2015).

[17]The smoothing eliminates excess high frequency volatility. For the extrapolation, each data series is extended using a logistic function with smooth pasting and an asymptote that ensures a long-run change double the size of the change observed during the sample period. Adjusting the asymptote has minimal impact on equilibrium dynamics in the sample.

[18]The baseline keeps η_t fixed given that the loosening of hukou restrictions began near the end of the sample period and was confined to small and medium-sized cities. Exogenous agricultural prices allow for imports, which is consistent with Gale et al. (2015).

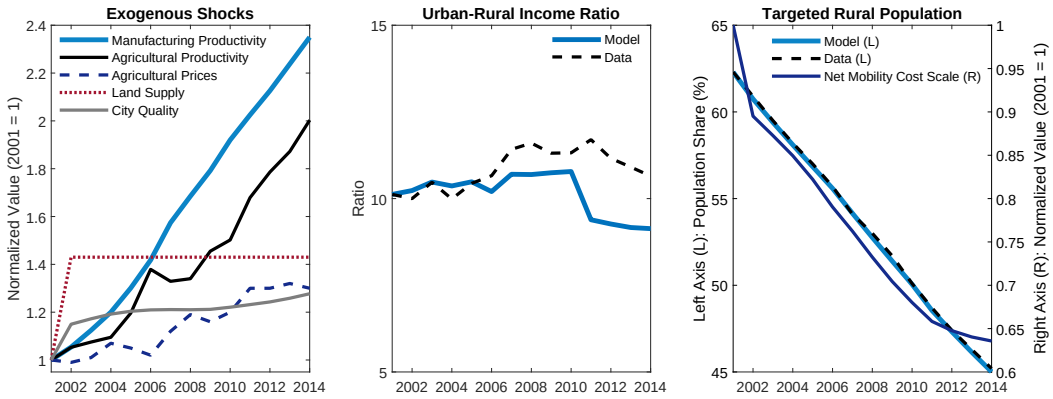

Figure 2: Baseline shocks. Sources: (productivity, agricultural prices, rural population, urban-rural income) CSY; (land supply, city quality) CRE.

remains relatively stable throughout the entire sample period. As a result, the model suggests that relative income dynamics and observed increases in city quality cannot account alone for the substantial decline in the rural population share from 62.3% to 45.2% between 2001 and 2014. To rationalize the observed decline, the third panel shows that the unobserved net mobility cost component $\{\widetilde{\xi}_t\}$ must also fall by 36%, representing either a drop-off in *gross* mobility costs or a rise in urban amenities not captured by the existing city quality measure.

Apart from matching this targeted population shift, the baseline simulation successfully reproduces the *untargeted* dynamics of house prices, as depicted in the left panel of figure 3. In particular, equilibrium house prices climb by 134% over thirteen model periods (years), which aligns well with the 137% increase in the data from 2001 to 2014.[19] Although the entire time series from the data for the homeownership rate is not readily available, the middle panel reveals that

[19]The price-rent ratio exhibits some short-run volatility but converges to 40 in the long run from an initial value of 20. As a robustness check, keeping rents flat with a perfectly elastic supply of apartment space has a negligible impact on the main findings. This result suggests that, in light of the segmentation between rental and owner-occupied markets, the tenure decision is driven more by the tension between the utility benefits of ownership and the presence of hukou and borrowing constraints than by the level of rents.

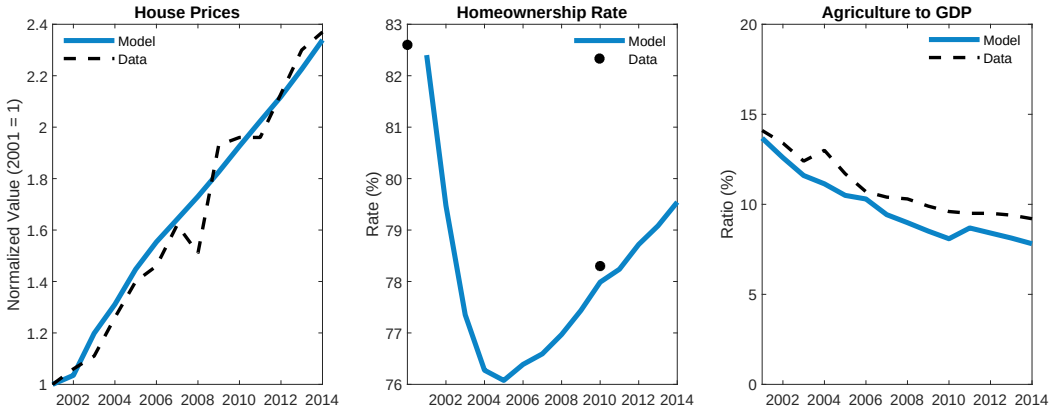

Figure 3: Baseline model vs. data. Sources: (house prices) Fang et al. (2016); (homeownership rate) Census; (agriculture to GDP) CSY.

model generates equilibrium homeownership dynamics consistent with the two empirical observations from the Census. In 2010, homeownership in the model comes out to 78.0% as compared to 78.3% in the data. The pattern of declining homeownership rates in the early years of the transition can be ascribed to the rapid influx of rural workers, who are initially renters and take time both to acquire a hukou permit and build up sufficient savings for a down payment. Lastly, the right panel of figure 3 reveals that the dynamics of the agriculture to GDP ratio in the model closely follow those of the data—falling by 5.9 and 4.9 percentage points, respectively, driven by the reduction in agricultural labor as rural workers migrate to the city and acquire manufacturing jobs.

4.1.2 Understanding the Drivers of China's Transition

As a decomposition of the forces driving China's economic transition and housing boom, table 4 shows the time-varying equilibrium impact of toggling individual shocks. To explain the seventeen percentage point baseline rise in the urban population share despite a stable urban-rural income ratio requires

Table 4: The Dynamic Effects of Each Shock

Scenario	*Urban Pop*		*Ag-to-GDP*		*House Prices*		*Ownership*	
	$\Delta_{t=2}$	$\Delta_{t=13}$	$\Delta_{t=2}$	$\Delta_{t=13}$	$\Delta_{t=2}$	$\Delta_{t=13}$	$\Delta_{t=2}$	$\Delta_{t=13}$
Baseline	2.9	17.3	−2.1	−5.9	19.8	133.9	−5.0	−2.9
50% Slower ξ_{qt}	0.0	3.9	−0.7	−1.0	17.7	121.4	−0.0	2.3
50% Slower Z_{mt}	1.9	12.8	−0.9	−1.2	8.2	72.2	−3.4	−3.7
Fixed Z_{ft}	10.6	45.7	−5.6	−12.7	25.9	154.4	−15.8	−8.8
Fixed p_{ft}	4.9	29.5	−3.1	−9.9	22.5	142.1	−8.1	−6.2
Fixed $\overline{L}_{jt}$	2.3	16.6	−1.8	−5.6	27.8	145.3	−4.5	−3.4

$\Delta_{t=n}$ are percentage point changes through year n of the transition. The final two rows reduce the growth factors of Z_{mt} and ξ_{qt} by 50% relative to the baseline path.

that net migration costs fall. To isolate this channel, the second row of table 4 shows what occurs with 50% slower growth in the city quality component ξ_{qt} of net mobility costs.[20] Rural-urban migration falls from 17.3 to 3.9 percentage points, which in turn stymies structural transformation by eliminating most of the baseline 5.9 percentage point decline in the agriculture-to-GDP ratio. The drop in migration also shaves over twelve percentage points of house price growth during the sample and reverses the homeownership decline that is the product of competing forces. In particular, rising urban income boosts the homeownership rate by enabling more existing city residents to purchase houses, but it also attracts migrant renters to the city, thereby depressing homeownership due to a composition effect until the migrants acquire a hukou permit and sufficient savings for a down payment. By cutting migration, slower city quality growth weakens this composition effect. Overall, this importance of amenities for housing demand is in line with Han, Han and Zhu (2018).

Holding either agricultural productivity Z_{ft} or prices p_{ft} fixed—as shown in the fourth and fifth rows of table 4, respectively—leads to significantly *higher* rural-urban migration in the face of rising urban incomes. With

[20] A change in the dynamics of the residual component $\widetilde{\xi}_t$ is isomorphic.

fixed agricultural productivity, the urban population share increases by 10.6 percentage points after two years and by an astounding forty-six percentage points after thirteen years. This migration surge causes house prices to increase by 154.4% in year thirteen compared to 133.9% in the baseline. The influx of migrant renters temporarily depresses the homeownership rate by nearly sixteen percentage points, although it gradually recovers over time, as shown in appendix figure 11. Fixing agricultural prices delivers qualitatively the same albeit quantitatively smaller results. In summary, reducing rural income growth increases migration to the city and fuels an urban housing boom.

As one might anticipate, reducing urban income growth operates in the reverse manner. At the extreme, fixing urban manufacturing productivity Z_{mt} entirely is rather uninteresting, because doing so eliminates all upward pressure on city house prices both from existing city residents and would-be migrants who no longer have the incentive to move. Thus, instead of this extreme case, the third row of table 4 and appendix figure 11 consider a scenario that slows down manufacturing growth by 50%, which cuts baseline rural-migration by over one quarter. In this scenario, house prices only rise by 72.2% by the end of the sample. The last row of table 4 indicates that fixing land supply modestly lowers migration and raises house prices, as discussed further in section 4.3.3.

Taken together, the results in table 4 indicate that income differentials and net mobility costs both have dramatic effects on migration, while urban income growth has the single largest impact on house prices. However, the amount of migration also has first-order effects on house prices as well as homeownership. Put another way, no single force is solely responsible for the evolution of any one part of the structural transformation, migration, and housing boom observed in China. These patterns are interlinked.

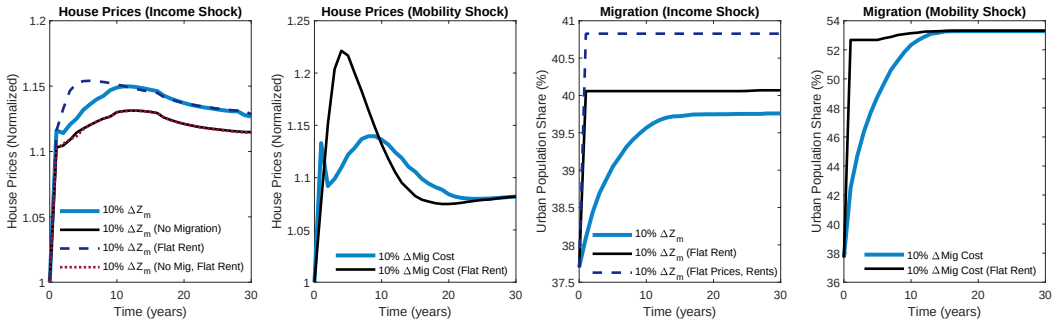

Figure 4: The impulse response of house prices and migration to either a permanent income or mobility shock, both with endogenous and flat rents.

4.2 The Housing-Migration Nexus

Given that the baseline simulation successfully reproduces China's post-2000 economic transition—especially the untargeted large house price boom—this section engages in a deeper exploration of the two-way link between housing and migration. At a glance, this section finds that the endogenous migration response amplifies and accelerates the reaction of house prices to income shocks, particularly in the medium run. At the same time, this house price acceleration impedes the flow of migration as rising housing costs erode some of the benefits of moving to the city.

4.2.1 From Migration to House Prices: The Migration Accelerator

To assess the impact of migration on house prices and study the mechanisms revealed in the baseline decomposition, the left panel of figure 4 plots the impulse response of house prices to an unanticipated, permanent 10% income shock in the full model relative to a version without the ability to migrate. The option to relocate gives rise to a *migration accelerator* that amplifies the initial response of house prices to higher income, creates medium-run momentum and overshooting via accelerated house price appreciation, and culminates in

long-run partial mean reversion as the marginal impact of migration on house prices fades. These effects are especially evident by comparing the curves with an elastic supply of apartments that leads to flat rents.

The medium-run price momentum arises from time delays in housing demand associated with obtaining a hukou permit and building savings for the 30% minimum down payment, which causes house prices to respond gradually to the rapid influx of migrants. A more elastic supply of apartments accentuates this price momentum by making it easier for new migrants to accumulate a down payment and purchase a house. The amplification of prices on impact emerges from the forward-looking behavior of initial city residents who buy immediately before price momentum drives costs even higher. Lastly, the long-run partial mean reversion in house prices is a product of time delays in the ability of housing supply to accommodate the rising demand.

The second panel provides an even more direct glimpse at the migration accelerator by depicting the impulse response of prices to an unanticipated permanent decline in mobility costs, both with endogenous rents and flat rents. In both cases, house prices exhibit substantial momentum, overshooting, and mean reversion, which gives the appearance of a "bubble" even though all the dynamics are driven by fundamentals. The flat rents case gives rise to greater momentum for two reasons. First, conditional on the amount of migration, new urban residents can more quickly save for a down payment, as discussed previously. Second, more people migrate to the city when rents are fixed, as is evident in the final two panels.

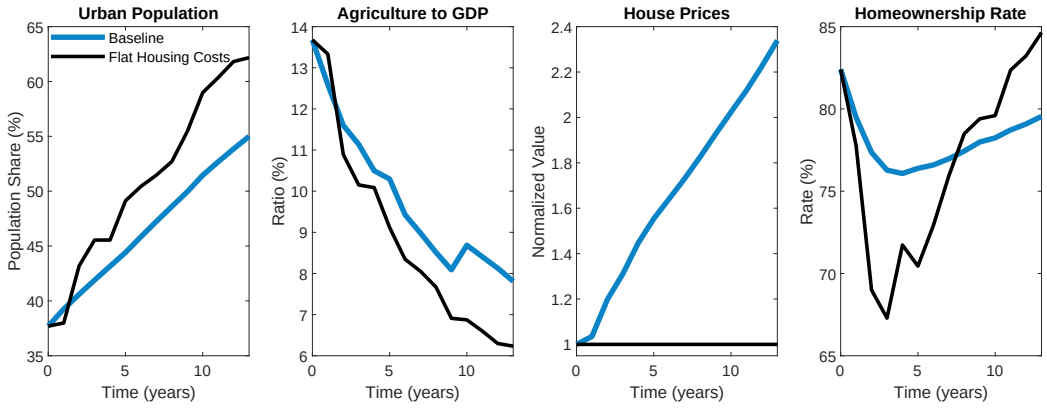

Figure 5: The impact of house price growth on structural transformation. Urban migration is significantly higher absent the rise in housing costs.

4.2.2 From Housing to Migration: The House Price Decelerator

Causality also operates from housing to migration. When house prices and apartment rents remain flat (as in the case of perfectly elastic supply), the positive urban income shock generates a 3.1 percentage point increase in the urban population, as shown in the third panel of figure 4. However, the endogenous rise in house prices (keeping rents fixed) attenuates 24% of this migration response—representing a *house price decelerator* that describes the negative effect of rising house prices on migration. Future appreciation also impacts current migration. For example, flat house prices for the first ten years after the income shock followed by an exogenous one-time, permanent doubling of prices erases 7% of the migration response. However, if the sudden appreciation occurs five years earlier, 49% of the migration response evaporates, indicating that the time horizon matters. Fewer migrants move if they anticipate that they will face difficulties obtaining a hukou permit and saving for a down payment before prices jump.

How different would China's economic transition look if the city could

have accommodated migration without a steep rise in housing costs? Figure 5 compares the baseline to a case with a perfectly elastic supply of housing (both houses and apartments). Relative to the case with flat housing costs, the figure shows that the post-2000 housing boom in the baseline attenuates 29% of the cumulative rural-urban migration, 21% of the structural transformation (the sector reallocation measured as the decline in agriculture-to-GDP), and depresses homeownership by five percentage points after the transitory compositional impact of a surge in migrant renters dissipates.

4.3 Policies to Accelerate the Economic Transition

This section undertakes a positive analysis to explore policies designed to facilitate greater urbanization and structural transformation. Housing markets emerge as a key factor that can help or hinder these policies.

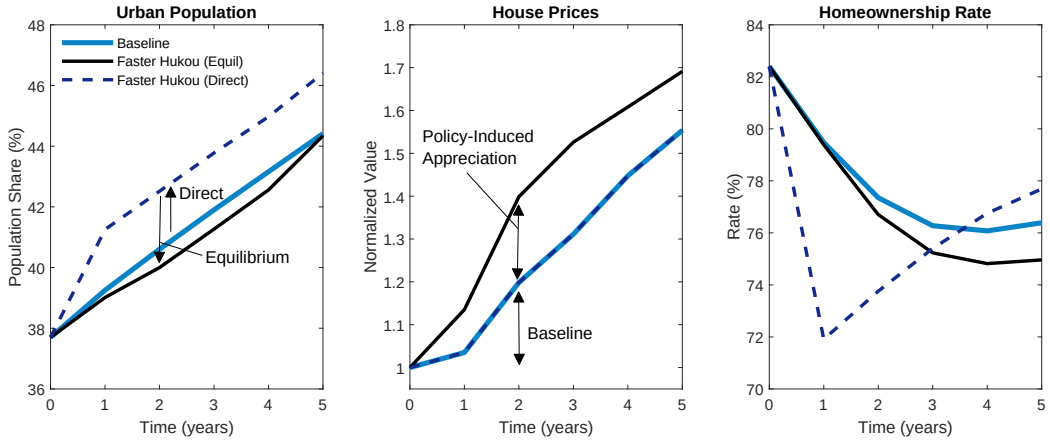

Figure 6: The effect of accelerating hukou permits. Higher equilibrium house prices that raise the cost of urban living more than reverse the direct effect.

4.3.1 Residency Policies

Urban homeownership offers higher quality housing relative to the rural area, but only city residents with hukou permits can access this benefit. In the baseline simulation corresponding to 2001–2014, the expected waiting time to receive a hukou permit is just over three years. However, China has modified hukou restrictions at various points in time, such as in 2014 when it abolished the hukou system in small cities and towns and eased restrictions in midsize cities. To capture the essence of these reforms in the model, the policy experiment here cuts the waiting time for a hukou permit to about 18 months (by doubling η). Importantly, migrants must still save for a down payment.

Reducing hukou waiting times makes moving to the city more attractive by allowing migrants to more quickly enjoy higher housing utility and to purchase earlier in the process of urbanization before prices rise even higher. Ignoring the endogenous house price response, the left panel of figure 6 shows that the policy directly increases the urban population by 1.9 percentage points after two years, which is on top of the three percentage points of baseline migration. However, the policy doubles the amount of house price appreciation in the first two years, which more than erases the direct effect, causing short-run migration to be slower under the policy relative to the baseline. Over longer horizons, house prices remain higher with the hukou relaxation than under the baseline in an absolute sense, but the relative gap shrinks—and with it, the indirect effect. By the end of the sample period, the house price response still reverses about half of the direct migration response to faster hukou permits.

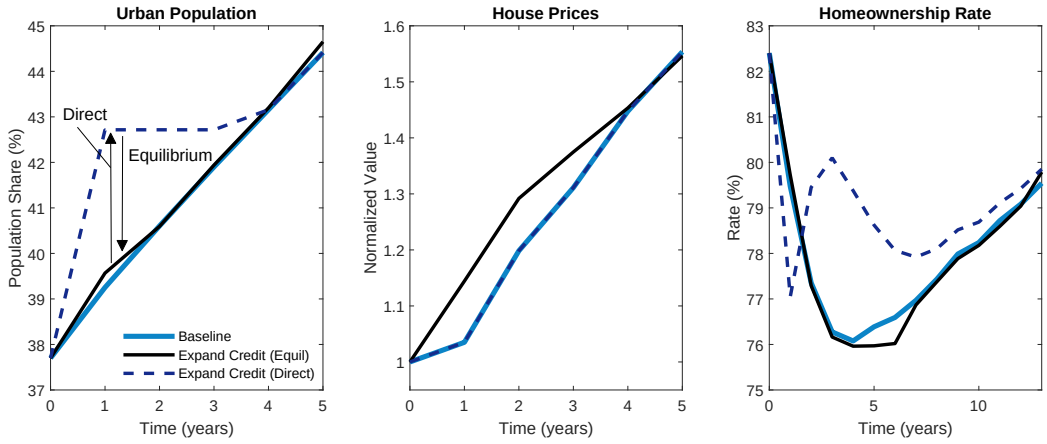

Figure 7: The impact of expanding credit with a 0% minimum down payment. The equilibrium increase in house prices attenuates the surge in migration.

4.3.2 Credit Policies

Given the importance of housing to the migration decision, credit policy is another lever to impact the pace of economic transformation. As detailed in Chen et al. (2020) and Chen (2020), China has adjusted minimum down payments over time. For example, in 2014Q4, China reduced the minimum down payment from 70% to 30% for second homes and from 30% to 20% for primary homes before tightening in 2016. This paper abstracts from multiple ownership but can evaluate the efficacy of credit policy on migration by comparing a time-0 permanent loosening of minimum down payments from 30% to 0% with a permanent tightening from 30% to 50%.

The relaxation in credit makes moving to the city more attractive, allowing migrants to purchase immediately upon receipt of a hukou permit before prices rise further. As evidenced in the left panel of figure 7, the direct effect of the credit relaxation is to rapidly accelerate short-run migration, adding 3.5 percentage points to the urban population after year one on top of the 1.6 percentage point baseline increase. On impact, the homeownership rate

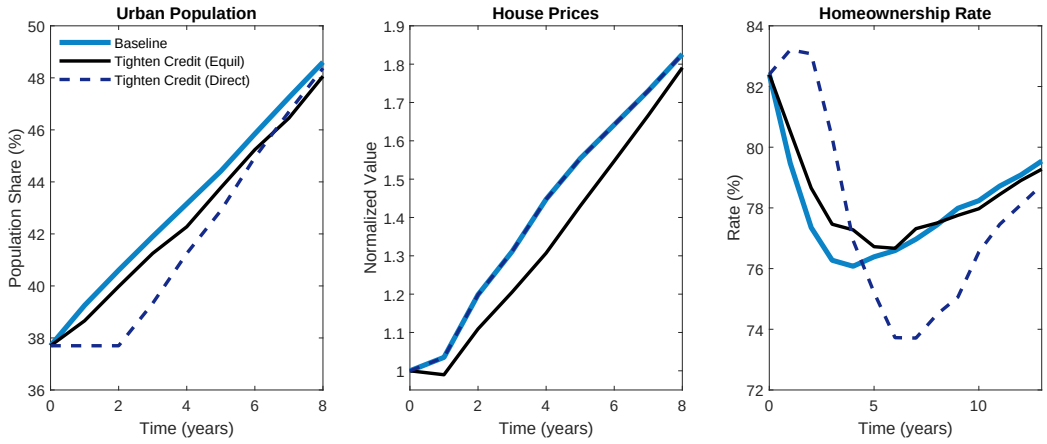

Figure 8: The impact of tightening credit with a 50% minimum down payment. The equilibrium drop in house prices mediates the decline in migration.

still declines mechanically due to the composition effect from migrant renters without hukou permits moving to the city. However, the homeownership recovers more quickly as prospective buyers more easily enter the market without needing to make a down payment. However, the surge in equilibrium house prices from looser credit neutralizes the migration influx, rendering the policy ineffective. Tightening credit to cool the housing market and stimulate migration also is not a success because of the negative direct effects of limiting access to home buying. As seen in figure 8, slower house price growth partially offsets the direct effect, indicating an asymmetry in the potency of the price effect between credit loosening and credit tightening.

4.3.3 Land Policies

In the previous policy experiments, the housing-migration channel operated through changes to housing demand and created a negative feedback loop that partly or fully counteracted the direct effect of the policies on migration. This section introduces land supply as a mechanism to boost rural-urban migration

Figure 9: The response to a large expansion in land supply.

by slowing house price growth.

In the first policy experiment, the government exogenously increases by a factor of three the quantity of new land available for construction relative to 2001. For the sake of comparison, new land supply in the baseline transition is 143% of 2001 levels. Unlike in the previous policy experiments, house prices are the *only* channel by which this policy affects migration, i.e. there is no direct effect. As shown in figure 9, the land supply expansion slows house price growth, which induces greater migration and structural transformation. Quantitatively, house prices appreciate by 108% after five years versus 134% in the baseline, causing an additional 1.3 percentage point rise in the urban population share and a 0.5 percentage point decline in the agriculture-to-GDP ratio. Short-run homeownership declines more rapidly because of the previous composition effect, with little long-run change relative to the baseline.

The salutary impact of land supply expansions on migration suggests that it may be an effective tool to utilize in concert with other policies to dampen house price increases induced by the policies. This price appreciation was particularly detrimental in the case of the faster hukou permitting from section

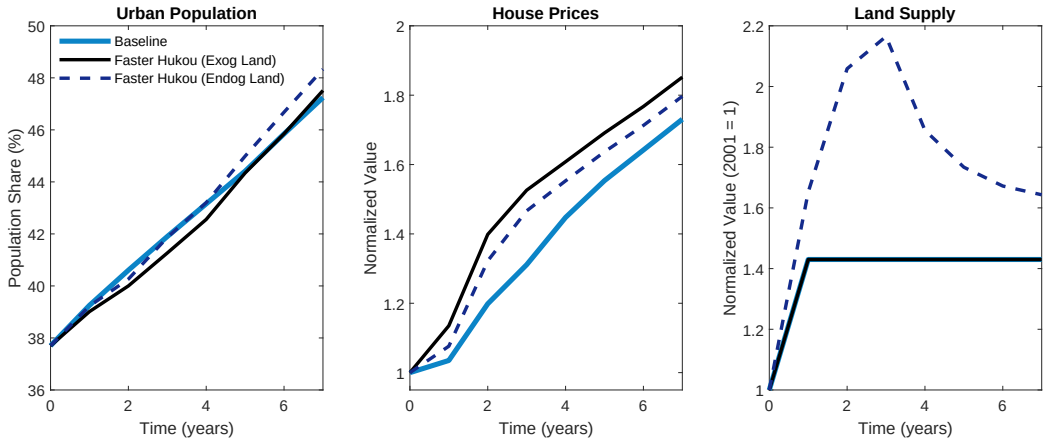

Figure 10: Endogenous land supply and the response to faster hukou permits.

4.3.1, more than reversing the intent of the policy. Rather than exogenously increase land to counteract this reversal, this section allows the government to adjust land supply in response to housing market conditions. Specifically, the government chooses how much of each type of new land, L_{ht} and L_{at}, to make available to maximize revenues from land sales net of time-varying development costs by solving

$$\max_{L_{jt}} p_{ljt} L_{jt} - \frac{\vartheta_{jt}}{2} L_{jt}^2. \tag{25}$$

The costs ϑ_{jt} are calibrated to replicate the exogenous land supply paths in the baseline. With the development costs fixed at their baseline trajectories, the government optimally chooses to make more land available in response to rising prices after the implementation of faster hukou permitting, as shown in the right panel of figure 10. In turn, the greater availability of new land for construction dampens the rise in house prices attributable to the policy-induced surge in housing demand from faster hukou permitting. As a result, migration to the city increases relative to the case with exogenous

land supply, eventually surpassing the baseline level after four years, albeit by a small magnitude. Thus, the endogenous land supply expansion neutralizes the negative feedback of price appreciation to urbanization.

5 Conclusion

This paper develops a dynamic multi-sector heterogeneous agent equilibrium model that features rural-urban migration and a rich housing market structure with mortgage borrowing to investigate the interaction between urbanization, structural transformation, and rapid house price appreciation in China. Urbanization and structural transformation emerge as key drivers of China's house price boom, with a housing migration accelerator magnifying the impact of urban income growth on prices. Concurrently, endogenously rising house prices deter rural-urban migration, impede structural transformation, and undermine—partly or completely—policies aimed at accelerating China's transition. Land supply expansion is a promising way to boost urbanization and structural transformation by restraining price growth. Investigating other avenues through which housing regulations and financial market structure shape China's economic transition—both in the past and future—is for later.

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A Supplementary Tables and Figures

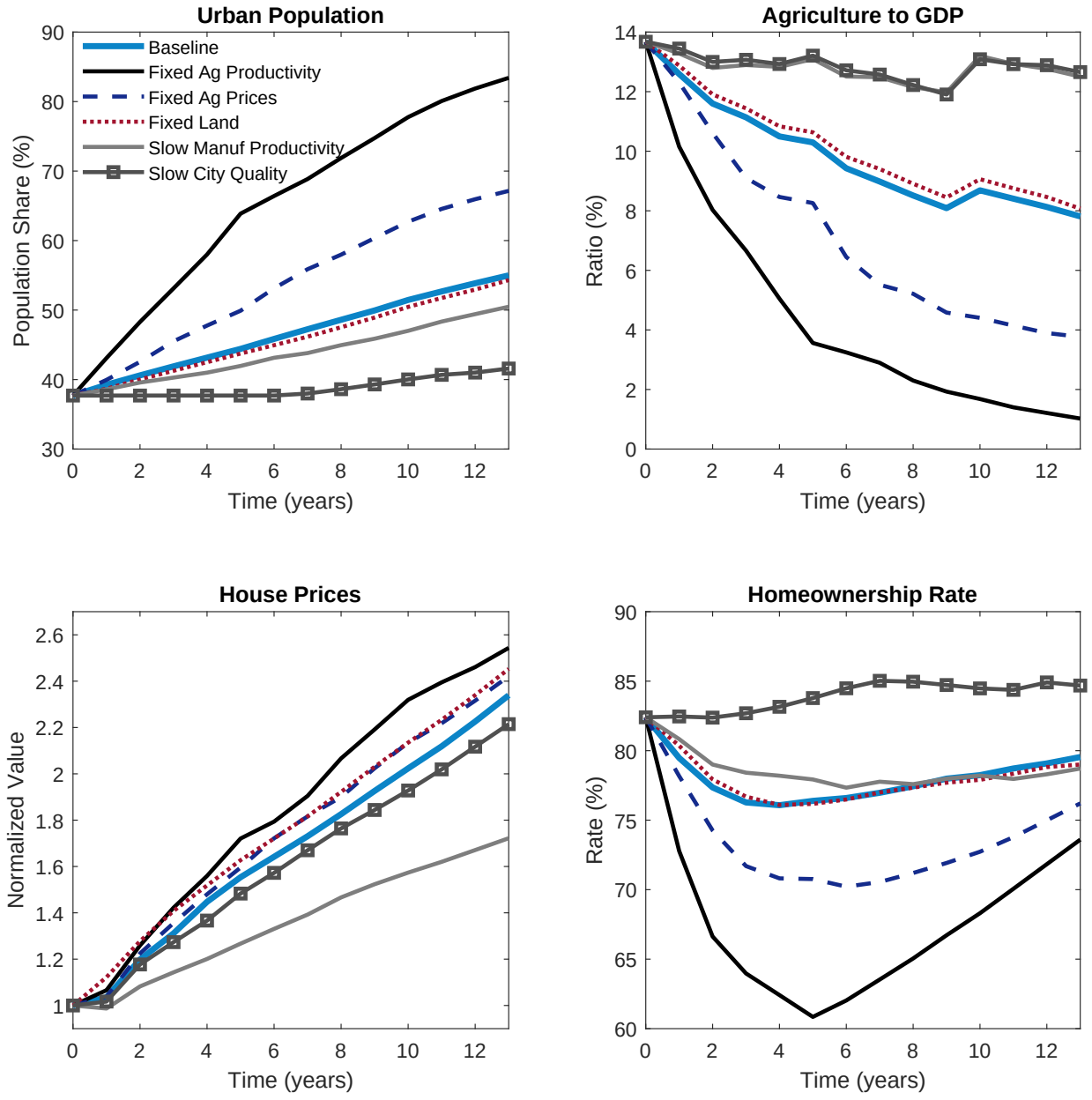

Figure 11: Comparing the shocks. This figure refers to the same experiments in table 4.

This figure accompanies table 3 in section 4.1.1 in showing the contribution of each factor to the transition dynamics of China's macroeconomy and housing market.