The Impact of Local Fiscal and Migration Policies on Human Capital Accumulation and Inequality in China*

Holger Sieg[1]

University of Pennsylvania and NBER, U.S.A

Chamna Yoon

Korea Advanced Institute of Science and Technology, Republic of Korea

Jipeng Zhang

Southwestern University of Finance and Economics, China

February 25, 2022

*Manuscript received August 2021; revised February 2022.

[1]We would like to thank the editor of the journal, Dirk Krüger, three anonymous referees, Hanming Fang, Shihe Fu, Xintong Han, Chao He, Jinfeng Ge, Bo Li, Yuan Liu, Shengzhi Mao, Jiawei Mo, Andy Postlewaite, Harro von Senger, Xuezhu Shi, Ruichao Si, Hong Song, Rongsheng Tang, Wei You, Zhigang Yuan, Zhi Wang, Junfu Zhang, Min Zhang, Qinghua Zhang, as well as seminar participants at numerous universities and conferences for comments and suggestions.

Abstract

We develop and estimate a spatial overlapping generations model with heterogeneous households to study the feasibility of a recently proposed reform of internal migration policies that offers the potential of decreasing inequality within China. We find that this policy change significantly increases the college attainment of migrant children born in rural areas and, therefore, promises to increase the number of high-skill workers. However, it requires significant tax increases to offset the reduction of the positive fiscal externalities provided by migrants.

JEL Classification: C5, D5, E6, H7, J6, R1

Keywords: Migration Controls, Spatial Equilibrium, Overlapping Generations Model, Fiscal Externalities, Urban Fiscal Policies, Fiscal Decentralization, Human Capital Accumulation, Educational Attainment, Inequality and Social Mobility.

Running Head: Local Fiscal and Migration Policies

1. Introduction

There have been large differences in the economic development among regions and cities in China since the country embraced market-based reforms in the late 1970s. This inequality in spatial development has caused large internal migration flows as households from rural areas have sought economic opportunities for themselves and their children in urban areas. The Chinese government has managed these internal migration flows using a sophisticated system of residency rights known as the Hukou system. Moreover, it has delegated the provision of a variety of important public goods and services to local governments while undermining the incentives for local governments to cover the costs for migrant households. Our empirical analysis suggests that internal migrants that did not obtain full urban residency rights have not enjoyed the same access to local public goods and services as city residents.[2] Unequal access to educational opportunities implies that children of migrants have lower levels of human capital accumulation than children of residents. As a consequence, the current local fiscal and internal migration control policies have restricted access to educational opportunities and, thus, created barriers to mobility across the income and wealth distributions.

It is, therefore, essential to evaluate the feasibility of alternative policies. The objective of this paper is to develop and estimate a new spatial overlapping generations model to study the long-term impact of a recently proposed policy change that aims to give full residency rights to all migrants to tier-3 cities in China.[3] We find that this policy change significantly increases the college attainment of migrant children born in rural areas and, therefore, promises to increase the number of high-skill workers. However, the reform requires significant tax increases

[2] As discussed in detail below, we refer to these types of migrants as " temporary" migrants while migrants that obtain local Hukou are referred to as "permanent" migrants.

[3] Tier 1 cities are Beijing, Shanghai, Guangzhou, and Shenzhen. Tier 2 consists of the provincial capital cities and a few vice-provincial cities. Tier 3 consists of all other major cities in China.

to offset the reduction of the positive fiscal externalities provided by migrants. Furthermore, we find that these reforms are too limited in scope to have a significant impact on the intergenerational transmission of human capital. Large inequalities in educational funding remain even after these new internal migration policies have been implemented since educational expenditures in most tier 1 and tier 2 cities, as well as all rural areas, are unaffected by these reforms. More drastic measures are necessary to significantly reduce the inequalities in access to educational opportunities within China.

Our model is in the spirit of the seminal paper by Au and Henderson (2006) who first suggested studying rural-urban migration in China using an empirical spatial equilibrium model. We also build on the pioneering research on overlapping generations models with heterogeneous local fiscal policies which have been used to study the impact of local public good provision on the intergenerational transmission of human capital.[4] We treat cities as local labor and housing markets. Following Moretti (2011) and Diamond (2016), households are mobile and have heterogenous skills. Moreover, there may be agglomeration externalities that depend on the endogenous household sorting by skill. Given the large heterogeneity in productivity across cities, households have strong incentives to migrate to higher productivity cities that pay higher wages and have a higher quality of local public good provision. However, they face mobility costs and must pay higher housing prices in more attractive urban areas.

The Hukou policy then determines the fraction of temporary migrants that do not enjoy full residency rights in each city. Moreover, the Hukou policy implies that temporary migrants require lower expenditures on education and other public goods and services than residents.[5] We use wedges for public good provision to capture important distortions faced

[4]These OLG models were developed by Bénabou (1996, 2002) and Fernandez and Rogerson (1996, 1998, 2003) and are dynamic extensions of static models with systems of local jurisdictions discussed in Epple and Romer (1991) and estimated in Epple and Sieg (1999). See also Epple, Romano and Sieg (2012) for a literature review.

[5]Hukou policies also distort land use and employment allocations in rural areas as discussed by Ngai,

by migrants in the local economies.[6] These wedges make migration less attractive and, thus, lead to an inefficient allocation of labor among cities. Moreover, migrant households must decide whether or not to leave their children behind with relatives in less developed areas. As a consequence, the endogenous spatial sorting of households and the heterogeneity of educational quality among cities significantly affect the human capital accumulation of children of residents and migrants. We characterize the equilibrium of this model allowing for non-stationarities in economic development, i.e., we do not assume that the economy is on a balanced growth path. Since equilibria can only be computed numerically, we develop a quantitative model that captures the key institutional restrictions of the Hukou system.

We show that the parameters of the model can be estimated using a sequential method of moments estimator. We implement the estimator using data from the 2000 Chinese Census, the 2011 Migrants Dynamic Monitoring Survey, the 2017 China Household Finance Survey, the 2013-2017 Statistical Yearbooks of Chinese cities, and the 2018 annual report of Ministry of Finance. The 2017 China Household Finance Survey is particularly useful since it provides unique data on residency status, household income, consumption, housing, and locational choices, as well as the intergenerational transmission of human capital. In contrast to other commonly used data sets, it also contains retrospective questions on migration which allows us to study the long-term change of a household's Hukou status.

We find that the parameter estimates are plausible. A parsimonious model captures the key features observed in the data. Our empirical model focuses on migration between tier 1, tier 2, and tier 3 cities, as well as less developed cities and rural places in China. The model captures the observed migration patterns within China since the era of housing market

Pissarides and Wang (2019).

[6]Chari, Kehoe and McGrattan (2007) introduced wedges to capture distortions in quantitive general equilibrium models.

reforms in the late 1990s, the heterogeneity in fiscal policies across cities, and the differences in housing and labor market conditions. Finally, we estimate the fiscal externalities that arise in equilibrium. Aggregating the fiscal externalities at the city level, our estimated measures range between 6 and 15 percent of total city revenues. We thus conclude that migrants provide large fiscal externalities to all cities.

We then use the estimated model to assess the impact of a recent policy initiative that is likely to affect the long-term allocations of migrants within China. In March 2014, the Central Committee of the CCP and the State Council released a National Urbanization Plan (2014-2020) which emphasized urban Hukou reform as part of a national strategy to increase urbanization. In July 2014, the State Council issued additional Policies on the Reform of Household Registration System that further clarified the plan for full liberalization of Hukou in small and medium cities. We use these reforms to guide our policy experiments. In particular, we simulate the impact of policies that extend full residency rights to all migrants in tier 3 cities. Recall that most tier 1 and many tier 2 cities are already so large that it may be difficult to increase their populations.[7] In our baseline analysis, we use local tax revenues to finance these additional expenditures.

We find that these reforms are likely to achieve the target of granting urban Hukou to 100 million temporary migrants that was affirmed by China's State Council in 2016.[8] As a consequence, an additional 11 to 15 million children receive a college education. These positive effects arise since the number of children that are educated in tier 3 schools increases substantially while the number of children that are educated in rural schools decreases by

[7]This is consistent with the findings by Au and Henderson (2006), Bosker, Brakman and Garretsen (2012), Desmet and Rossi-Hansberg (2013), and Tombe and Zhu (2019) that most Chinese cities, except for the largest ones, are too small relative to their optimal size.

[8]According to China's population Census in 2020, China has 376 million temporary migrants, approximately one-fourth of the total population.

almost the same margin. Hence, the net increase in college attainment is largely due to the fact that school quality increases for children of temporary migrants. The attainment effects on children of residents in all cities are negligible. This shows that it is possible to design policies that extend access to higher education for children of temporary migrants without hurting the educational achievement of all other children. These reforms primarily require an investment in new schools in tier 3 cities. However, these reforms are not large enough to significantly affect the intergenerational transmission of human capital in the economy.

One problem with these reforms is that they place the tax burden on tier 3 cities. Not surprisingly the effects on human capital accumulation would have been larger if the central government had decided to use a national consumption tax instead of relying on local taxes to pay for the additional expenditures. A national tax imposes a lower tax burden on tier 3 cities. Another drawback of these reforms is that they do not fundamentally address the low level of educational expenditures in rural areas. They also do not affect spending in tier 1 and tier 2 cities which are much higher than the spending in the rest of the country. Thus large inequalities in access to educational opportunities remain even after the reforms have been successfully implemented. Larger achievement gains can be obtained by including tier 2 cities in the set of cities that grant full residency rights to migrants. However, such a policy change would also require much larger tax increases.

Our paper is related to the previous literature that has studied the Hokou system. Whalley and Zhang (2013), Piketty, Yang and Zucman (2019), and Hao, Sun, Tombe and Zhu (2020) have documented that migration controls in China lead to an inefficient allocation of labor among cities and increase inequality. Wu and You (2020) show that completely removing Hukou-related migration restrictions promises increases in GNP and large welfare gains. Ngai, Pissarides and Wang (2019) and Chari, Liu and Wang (2021) point out that Hukou-based

land property rights restrict the ability to trade land for agricultural production, which leads to an over-employment in agriculture. In contrast to these papers, we do not explicitly model land markets, but capture differences in non-labor income by locations. Instead, we focus on the intrinsic relationship between the Hukou system and urban fiscal policies which is less well understood. We show that internal migrants provide large positive fiscal externalities to all cities in China. As a consequence, reforming the Hukou system requires a large change in urban fiscal policies and intergovernmental transfers. We then study the impact of a recent reform proposal on the long-run access to educational opportunities in China. By enlarging the pool of high-skill labor, these policies also promise to increase overall economic growth as discussed by Fang and Herrendorf (2020) who highlight the importance of high-skill workers for the development of a high-value-added service sector in China.

Our study is also related to previous empirical studies that have focused on access to local public schools by migrant children (Chen and Feng, 2013), the cognitive achievement of left-behind children (Zhang et al., 2014), the human capital accumulation of migrants (Heckman, 2005), the intergenerational mobility (Fan, Yi and Zhang, 2021), and the integration of migrant children into the local school system (Huang, 2020). None of these papers document the importance of fiscal externalities or provided a comprehensive analysis of local fiscal and migration policies within the context of an estimated spatial overlapping generations equilibrium model with heterogeneous households. Hence, these papers do not capture the general equilibrium effects that are likely to be important in assessing large policy changes.

There is also an emerging literature that has evaluated the short-term impact of the 2014 Hukou reform on migration, local labor market, educational achievement, and the welfare of children left behind. Examples are Zhang, Wang and Lu (2019), An, Qin, Wu and You (2020) and Xu, Wang, Zhang and Hu (2022). Our policy analysis differs from these types of

studies in, at least, two important ways. First, we compute the path that the economy would have taken if the proposed changes of the Hukou policies had been in place in 2000. We thus do not provide a retrospective analysis of the impact of the reforms implemented in 2014.[9] Second, these studies focus on the short-term adjustments immediately after the reforms were announced. Our model focuses on long-run adjustments over a 30-year period. Our model is, therefore, not well-suited to make predictions necessary to assess the short-term impacts of the these reforms. Nevertheless, our findings are broadly consistent with the these studies, which show that the 2014 Hukou reform increased migration rates, decreased the proportion of migrants who leave their children behind, and increased the Hukou registration probability.

This paper also contributes to the literature that has studied the impact of migrants on wages and inequality beyond China. For example, Bryan and Morten (2019) have analyzed how internal migration affects productivity in Indonesia. They find a significant increase in labor productivity from removing all mobility barriers. Similarly, it is related to research that analyzes the effects of migration from neighboring countries. For example, Piyapromdee (2021) studies the impact of immigration from Mexico to the U.S. on wages, internal migration, and welfare. Her findings suggest that a skill selective immigration policy leads to welfare gains for low-skill workers, but welfare losses for high-skill workers. In contrast to these papers, we focus on an explicit policy change that is aimed to reduce mobility costs by granting temporary migrants full access to local public goods and services. Our analysis speaks to the impact of differential access to primary and secondary education on the eventual distribution of educational attainment. We, therefore, highlight the intrinsic link between state and local fiscal policies, regional mobility, and the intergenerational persis-

[9]We also do not predict what will happen in China in the next decades after the actual reforms had been fully implemented in 2020. Such an analysis would require additional assumptions about the current distribution of the housing endowments and, more importantly, future productivity shocks and returns to education.

tence of human capital, earnings, and thus inequality. In particular, our analysis suggests that the decentralization of educational policies needs to be combined with intergovernmental transfers that offset the tendencies of decentralization to create substantial inequalities in human capital acquisition. As such, this paper offers some general insights into the causes of inequality that go beyond the specific institutions in China.

The rest of the paper is organized as follows. Section 2 introduces our main data sources and documents some important stylized facts. In Section 3 we provide new estimates that characterize the college attainment gap between children of residents and children of migrants. Section 4 develops our overlapping generations model that we use to assess potential reform options. Section 5 discusses the estimation of the model. Section 6 discusses our parameter estimates, the goodness of fit of our model, and presents the estimates of the fiscal externalities. We turn to counterfactual policy analysis in Section 7 and study a recently proposed alternative to the current Hukou policy. Section 8 offers some conclusions drawn from the analysis and discusses future research opportunities.

2. Data

The main sample used in this analysis is based on the 2017 China Household Finance Survey (CHFS), which provides detailed information on residency status, household income, consumption, housing and locational choices. Moreover, the structure of this data set allows us to follow migrant households over time and study the change of a household's Hukou status. In contrast to other commonly used data sets such as the Migrants Dynamic Monitoring Survey (MDMS), the CHFS allows us to study the transition of Hukou status as well as the intergenerational transmission of human capital of migrants with and without local Hukou.[10]

[10]provides more detailed information on all the data sources.

Our empirical analysis considers four locations with three tiers of cities and one rural, less-developed area. Hence, a migrant in our analysis is a household that moves across these four location types. Our analysis abstracts from mobility within tier 1, tier 2, or tier 3 cities. Thus, we deviate from the previous literature that defines a migrant as somebody who moves across townships or counties. Instead, we focus on moves across the three types of city tiers and rural areas. Importantly, all moves from rural to urban areas including those within a prefecture are counted as migrants in our empirical analysis. Thus, our analysis accounts for the large scale of rural-urban migration during China's rapid urbanization since the late 1990s. Hukou registration may have slowed but has not prevented the migration of hundreds of millions of households from rural areas to the cities in China during the past two decades. When households move from a rural region to a city, or from a lower-tier city to a higher-tier city they often cannot obtain a local urban Hukou registration. As a consequence, there exists a large group of migrants in most cities who work and live in a location without local urban Hukou.[11]

Table 1: Migration by City Tier

	Population Shares			Share of Migrants with Agricultural Hukou		
	Tier 1	Tier 2	Tier 3	Tier 1	Tier 2	Tier 3
Permanent Migrants	13.5	15.8	20.3	61.3	75.9	92.6
Temporary Migrants	25.7	30.7	32.2	71.6	87.4	97.2
Residents	60.8	53.5	47.5	—	—	—
	Share of Migrants that Changed Hukou Status			Share of Agricultural Hukou among Permanent Migrants		
	Tier 1	Tier 2	Tier 3	Tier 1	Tier 2	Tier 3
Low-skill Migrants	26.0	27.5	31.5	63.9	81.2	96.0
High-skill Migrants	47.0	52.5	67.1	58.8	67.6	86.2

Note: These statistics are computed based on the CHFS 2017.

[11] Appendix A.2 provides additional information about the evolution of the Hukou system.

Table 1 shows the status of residents and migrants by city tier using data from the CHFS in 2017. We use detailed information on migration histories in the CHFS to document the pattern of migration dynamics.Migrants with a change in Hukou status (permanent migrants) account for 13 to 20 percent of a city's population. The share of temporary migrants ranges between 26 and 32 percent. Hence, migrants constitute 39 to 52 percent of a city's population. Residents are those households that live in the city in which they obtained urban Hukou at birth or change their Hukou status from rural to urban due to the expansion of cities (without having to relocate). The share of residents ranges between 48 and 61 percent across city tiers.

Table 1 also shows that 61.3 (75.9, 92.6) percent of permanent migrants changed Hukou status from rural (agricultural) to urban Hukou in tier 1 (tier 2, tier 3) cities. The share of temporary migrants that had an agricultural hukou is 71.6 (87.4, 97.2) percent in tier 1 (tier 2, tier 3) cities, which is even larger than the corresponding share for permanent migrants. These patterns also exist for the different skill groups as shown in the lower part of Table 1. For high-skill migrants, the share of agricultural Hukou is smaller than for low-skill migrants since high-skilled migrants are more likely to have had urban Hukou in the previous city.

One key criterion that affects the likelihood of obtaining the local urban Hukou for migrants is the level of education or skill. We divide the population into two types. Low-skill households have a head who has, at most, a high school degree. High-skill household heads attended, at least, a two-year college. Table 1 also reports the fraction of low- and high-skill permanent migrants, i.e. migrant households that obtained local urban status in the destination city. Table 1 shows that the fraction of migrants that changed Hukou status is lowest in tier 1 cities and highest in tier 3 cities. Not surprisingly, the fraction of households that became permanent migrants is significantly larger for high-skill than low-skill households.

To get some additional insights we have also estimated logit models that control for addi-

Table 2: The Registration of Local Hukou

	(1)	(2)	(3)
Household head	0.247	0.258	0.301
with college degree	(0.010)	(0.010)	(0.011)
Tier 2 residence		0.034	0.056
		(0.015)	(0.014)
Tier 3 residence		0.097	0.142
		(0.016)	(0.014)
Tier 1 origin			0.158
			(0.072)
Tier 2 origin			0.206
			(0.036)
Tier 3 origin			0.149
			(0.019)
Household characteristics			Y
Observations	8352	8352	7872
Pseudo R^2	0.045	0.050	0.174

Note: All columns report marginal effects from logit models. The sample is based on the CHFS 2017.

tional sources of observed heterogeneity using the sample of migrant households in the CHFS 2017. Table 2 reports the marginal effects estimated from logit regressions that predict the likelihood that the head of a migrant household can obtain a local urban Hukou registration. The results reported in Column (1) suggest that that the probability of obtaining a local urban Hukou registration is approximately 25 percentage points larger for high-skill households than for low-skill households. In Columns (2) and (3) we also control for the city tier of residence and the city tier of origin. Overall our findings are similar to the ones reported in Column (1). Not surprisingly, it is more difficult for migrants to obtain local Hukou in tier 1 cities than in tier 2 or tier 3 cities. Moreover, migrants from cities are more likely to obtain local Hukou comparing with migrants from rural areas which are the omitted category.

3. The Intergenerational Transmission of Human Capital and Internal Migration

One key advantage of the CHFS 2017 is that we can quantify the impact of the Hukou system on the intergenerational transmission of human capital. The CHFS 2017 measures the college attainment of the household head and the child, where college attainment is measured as having, at least, two years of college education.[12] We observe the educational outcome for for both parents and children for 6256 households in the sample. We estimate logit models that express the college attainment of the child as a function of migration status and parental attainment differentiating between permanent and temporary migrants. In addition, we control for a variety of demographics such as the age of the household head, household size as well as city-tier and age-group fixed effects. Table 3 summarizes our main

[12]The sample consists of children that were between 20 and 40 years old at the time of the survey.

empirical findings.

Table 3: The Intergenerational Transmission of Human Capital: College Attainment

	Full Sample		Excluding Short-term Migrants		Control for Hukou Origin	
	(1)	(2)	(3)	(4)	(5)	(6)
Permanent migrants	-0.0614	-0.0487	-0.0583	-0.0488	0.1260	0.0553
	(0.0184)	(0.0197)	(0.0203)	(0.0216)	(0.0400)	(0.0457)
Temporary migrants	-0.3273	-0.2557	-0.3511	-0.27995	-0.1421	-0.1582
	(0.0138)	(0.0160)	(0.0150)	(0.0177)	(0.0490)	(0.0530)
Household head	0.3286	0.2977		0.2913		0.2883
with college degree	(0.0133)	(0.0149)		(0.0164)		(0.0166)
Tier 2 residence		-0.1074		-0.1072		-0.0551
		(0.0223)		(0.0236)		(0.0363)
Tier 3 residence		-0.1541		-0.1644		-0.0906
		(0.0223)		(0.0240)		(0.0361)
Tier 1 origin					0.2858	0.1865
					(0.0305)	(0.0492)
Tier 2 origin					0.2077	0.1250
					(0.0410)	(0.0502)
Tier 3 origin					0.1406	0.0872
					(0.0409)	(0.0446)
Household characteristics		Y		Y		Y
Age-group fixed effects		Y		Y		Y
Observations	6256	6256	5249	5249	5249	5249
Pseudo R^2	0.0644	0.1496	0.0721	0.1524	0.0816	0.1540

Note: All columns report marginal effects from logit models. The sample is based on the CHFS 2017.

Table 3 documents that migrant children have significantly lower college attainments than children of residents. Column (1) summarizes the results for the basic specification using the full sample, while Column (2) also controls for a variety of demographics and fixed effects. We find that the estimated college attainment gap between children of permanent migrants and children of residents is approximately 5 or 6 percentage points. The gap between children

of temporary migrants and children of residents ranges between 26 and 33 percentage points. Not surprisingly, attainment also decreases by city tier. The gap between children educated in tier 1 cities and children in tier 2 (3) cities is approximately 10 (15) percentage points. We then exclude short-term migrants that have lived in the destination city for less than 5 years. The results for that subsample are summarized in Columns (3) and (4). Overall, we find that our estimates of the attainment gaps are quite similar to the ones reported in Columns (1) and (2). Finally, we control for the Hukou origin which is defined at the province level. The results are shown in Columns (5) and (6). Controlling for the Hukou origin implies that there are no significant differences between permanent migrants and residents. However, the gap between children of residents and temporary migrants is still 16 percentage points which is quite large. We thus conclude that the attainment gap between children of residents and temporary migrants is large and economically important. The gap between children of residents and permanent migrants is much smaller and largely due to differences in origin.[13]

It is natural to ask what channels may contribute to these differences in the intergenerational transmission of human capital. It is important to understand the interaction between local fiscal and migration policies. It is well-known that there are large differences in educational spending across cities in China. In Section 5.2 of this paper, we provided a detailed analysis of local expenditure policies and show that tier 1 cities have expenditures on education that are approximately 3 (4) times as large as those in tier 2 (3) cities and more than 6 times as large as those in rural areas. It is plausible that these differences in educational spending largely account for the persistent differences in educational attainment among children. Local governments are also required to provide free primary and middle school education for migrant children. However, local governments often impose strict rules

[13]Appendix A.4 provides some additional robustness checks such as controlling for city fixed effects and Hukou province of origin fixed effects. Overall, we find that the results are similar to the one reported above.

that prevent migrant children from attending the best local schools. These restrictions are even more severe in high school. Migrant children without local Hukou are not allowed to participate in college entrance exams unless strict requirements are met, even if they can manage to attend a local high school. The Hukou system, therefore, restricts access to educational opportunities for children of temporary migrants which affects investment decisions in human capital, inequality, and social development.[14]

Table 4: Restricted Access to Educational Opportunities

Share of Temporary Migrant Children in Local Public Schools		
Parental Skills	Low-skill	High-skill
Tier 1	71.8	84.3
Tier 2	83.9	87.0
Tier 3	89.1	87.2
Share of Temporary Migrant Children Left Behind		
Parental Skills	Low-skill	High-skill
Tier 1	47.9	19.3
Tier 2	38.7	30.5
Tier 3	42.1	45.0

Note: These statistics are based on the MDMS 2011.

To characterize differences in access to local public goods and educational opportunities we turn to 2011 Migrants Dynamic Monitoring Survey, which provides additional important information about the behavior of temporary migrant households and the constraints that they face. This is a large-scale representative survey of temporary migrants who moved away from the place where they have a Hukou registration for more than 6 months. To match the migration definition in the CHFS 2017, we only use those households in the MDMS 2011 who moved across prefectures. Similarly, we impose the same age restrictions (20-65) for parents and only keep the households with school-age children. These sample restrictions reduce the

[14]The Hukou status also restricts access to health insurance, pension, unemployment insurance, maternity benefits, and housing providence funds, as we discuss in detail below.

sample size to 16,864 households.

Table 4 shows that a significant share of children of temporary migrants is not enrolled in local public schools. Children of low-skill households are less likely to attend local schools than children of high-skill households. Table 4 also reports the proportion of children who are not living with their parents. The fraction of left-behind children of low-skill households ranges between 47.9 percent in tier 1 cities to 38.7 percent in tier 2 cities. For high-skill households, the fraction ranges from 19.3 percent to 45 percent. We conclude that a significant number of temporary migrants leave their children behind with relatives. In summary, the children of migrants have more limited access to educational opportunities than children of residents.

Table 5: Local Public School Access

	(1)	(2)	(3)
Household head	0.035	0.026	0.027
with college degree	(0.021)	(0.020)	(0.20)
Tier 2 residence	0.124	0.103	0.110
	(0.012)	(0.012)	(0.012)
Tier 3 residence	0.184	0.166	0.171
	(0.011)	(0.012)	(0.012)
Intra-provincial migrant		0.020	0.020
		(0.007)	(0.07)
Hukou origin fixed effects		Y	Y
Household characteristics			Y
Observations	16864	16864	16859
Pseudo R^2	0.024	0.024	0.057

Note: All columns report marginal effects from logit models. The sample is based on the MDMS 2011.

We have also estimated discrete choice models that control for additional sources of observed heterogeneity. Table 5 reports the estimates from logit models that predict the likelihood that a children of temporary migrants attends a local public school. Once we control for additional sources of heterogeneity, we find that there are only small differences in access

to local public schools by skill level, approximately two to three percentage points. The most important determinant of public school access is the city of residence. Children of migrants in tier 2 and tier 3 cities are more likely to attend local public schools than migrant children in tier 1 cities. The estimates range between 11 and 17 percentage points. We also compare cross-province migrants to within-province migrants in columns (2) and (3). We find that the differences between cross-providence and within-providence migrants are small, approximately two percentage points.

In summary, we conclude that there are large differences in college attainment across city tiers. These differences are likely to be driven by differences in primary and secondary school quality among cities. Moreover, the college attainment gap between children of permanent migrants and children residents is small. In contrast, the college attainment gap between children of temporary migrants and children of residents is large and economically meaningful. These observations suggest that permanent migrants and residents have almost equal access to educational opportunities within a city, while temporary migrants face some serious restrictions. These restrictions are consistent with the finding that temporary migrants are less likely to enroll their children in public schools and are more likely to face serious barriers at the high school level than permanent migrants or residents. Moreover, temporary and permanent migrants often leave their children behind which may lead to lower human capital accumulation.

4. A Spatial OLG Model

We develop a spatial overlapping generations model with a system of cities to study the impact of local fiscal and internal migration policies on access to educational opportunities,

inequality, and the accumulation of human capital. The model captures the key institutional arrangements of fiscal decentralization and local Hukou policies in modern China. We can therefore perform a comparative static analysis of internal migration policy changes that accounts for general equilibrium effects which are likely to be important in this context.

There is a continuum of individuals each of whom lives for two periods, one period as a child and one period as an adult. A household consists of an adult and a child. At each point in time the economy, therefore, consists of two overlapping generations. As in Bénabou (1996) and Fernandez and Rogerson (1996, 1998) adults make all decisions in our model, i.e. children are passive and do not make any decisions. Hence, we can characterize the dynamic equilibrium of the model as a sequence of static spatial equilibria that are linked by the intergenerational transmission of human capital. We, therefore, suppress time subscripts in our notation.

4.1. Household Types

There are K discrete skill types. In the initial period, each adult is characterized by a measure of skills, denoted by s_k, and a housing endowment denoted by e_{jk}.[15] The fraction of adults with skill k living in city j at the beginning of the period is given by q_{jk}.

4.2. Cities and Hukou Policies

The economy consists of J cities and one rural, less developed area, denoted by location 0. Each location has a local labor and housing market. Let p_j denote the price of a unit of

[15]The housing endowment is in the location in which the adult grew up as a child. In the empirical model, we assume that each type k has the same endowment conditional on j when the economy starts, which is broadly consistent with the initial privatization of the housing stock in China (Zhang, Fan and Mo, 2017).

housing in the local housing market of city j. Similarly, let w_{jk} denote the wage in city j of skill type k. Finally, let ω_j denote an exogenous amenity in location j.

Each local government provides two public goods, educational quality g_j and other local public goods o_j. We model public goods as expenditures per household accounting for congestion within cities.[16] Local public goods are financed by a combination of local revenues: a proportional local income tax with rate t_j^w, revenues from land sales and new housing construction, and intergovernmental transfers from the central government.[17]

Each city has a Hukou policy. We have seen above that some migrants receive the urban Hukou in their destination city, while others do not. Temporary migrants do not have the same access to public goods. We use fiscal wedges to capture the distortions faced by temporary migrants in the economy as suggested by Chari, Kehoe and McGrattan (2007). In particular, we assume that there exists a wedge for educational public goods, denoted by $\Delta_{jk}^g \leq 1$, and a wedge for other public goods, denoted by $\Delta_{jk}^o \leq 1$. Finally, temporary migrants are not eligible for the housing market subsidies, as discussed in detail below. In summary, the Hukou policy in city j is captured by the following parameters of the model: i) the fraction of migrants that receive Hukou, r_{jk}, (ii) the fiscal wedge for educational expenditures, Δ_{jk}^g, iii) the fiscal wedge for other expenditures, Δ_{jk}^o, and (iv) the housing subsidy, s_j^h.[18] We treat the Hukou policy as exogenously given and study the impact of alternative policies that try to increase access to educational opportunities for the children of temporary migrants.

[16] We abstract from non-fiscal congestion externalities in this paper. See, for example, Au and Henderson (2006) and Desmet and Rossi-Hansberg (2013) for models that include non-fiscal congestion externalities into the analysis. We discuss these issues in more detail in the conclusions.

[17] See Appendix A.7 for a detailed discussion of fiscal decentralization and tax sharing agreements in China.

[18] Note that there are no wedges in the labor market, i.e. migrants earn the same wages as residents. Moreover, Hukou status does not affect access to social security since we do not model return-migration and retirement.

Residents, denoted by r, are households that are born in city j and decide to stay in city j. Migrants, denoted by m, are households that are born in location j and decide to move to a different city $l \neq j$, and may bring the children along ($c = 1$) or may not ($c = 0$). Temporary migrants do not obtain local urban Hukou ($hu = n$), while permanent migrants receive local Hukou ($hu = y$).

4.3. Timing of Decisions

Adults can relocate to a city that is different from the city in which they were born as a child. Adults decide whether to stay or move, and whether to bring the child along or leave the child behind. The timing of decisions is as follows:

1. Adult household members make migration decisions given correct expectations of prices, wages, taxes, public goods, and amenities in each city.

2. After households move, they learn whether or not they obtain Hukou status in the destination city.

3. Wages are determined, consumption is realized, housing markets clear, government budgets are balanced, and the achievement of children is realized in each city.

4. Children become adults, inherit housing from their parents, and obtain a skill realization conditional on achievement. Adults die and new children are born.

4.4. The Intergenerational Transmission of Human Capital

The achievement of a child, denoted by a, is defined as the expected skills of the child at the time of the locational decision. This measure of achievement is defined as:

$$(1) \qquad a_{ijk}^{c,hu} = E[s' |\ g_i, g_j, s_k, c, hu] = \sum_{k=1}^{K} s_k\ Pr_{jk}\{s' = s_k |\ g_i, g_j, s_k, c, hu\}$$

The expected skills depend on parental skills, s_k, hukou status, hu, the quality of education in the destination city, g_j, the quality of education in the city they were born, and whether the children move with their parents or not, c.

In our quantitative model, we have two skills levels. s_1 denotes a low-skill worker, and s_2 is a high skill worker. Hence, we need to model the probability of becoming a high-skill worker, i.e. the probability of obtaining a college degree, conditional on observed characteristics. We assume that

$$(2) \qquad Pr_{jk}\{s' = s_2 |\ g_i, g_j, s_k, c, hu\} = \frac{\exp(\delta_{0j} + \delta_1 g_{ijk}^{c,hu} + \delta_2\ s_k)}{1 + \exp(\delta_{0j} + \delta_1 g_{ijk}^{c,hu} + \delta_2\ s_k)}$$

where effective expenditures are given by

$$(3) \qquad g_{ijk}^{c,hu} = \gamma_c^{hu}\ g_i + (1 - \gamma_c^{hu})\ [1_y + (1 - 1_y)\ \Delta_{jk}^{g}]\ g_j$$

and the indicator 1_y is equal to one if the household has Hukou in the destination city and zero otherwise.

Note that for residents, we have assume that $c = 1$ and $hu = y$. Children of residents attend primary and secondary schools in city j. Hence, we have $\gamma_1^y = 0$ and $1_y = 1$, which

implies that $g_{jjk}^{1,y} = g_j$, for all k. The same is true for permanent migrants that bring their children when they move $c = 1$. Hence, we have $g_{ijk}^{1,y} = g_j$ for all $i \neq j$.

For temporary migrants that bring their children along, we have $1_y = 0$. These children spend part of their education in city j and part of the education in city i. Hence, we have $0 < \gamma_1^n < 1$. As a consequence, their effective expenditures are a weighted average of expenditures in city i and city j. We also account for the fiscal education wedge which also depends on skill type. In practice, these children typically have to return to their home province to finish high school and prepare for the college education exam. This often happens after they have finished middle school. In our computational analysis we, therefore, set $\gamma_1^n = 0.25$.

Finally, consider migrants that decide to leave the children behind $c = 0$. These children are educated in city i, and, therefore, we have $\gamma_0^{hu} = 1$. Hence, we have $g_{ijk}^{0,hu} = g_i$ for all k, independently of the Hukou status $hu = y, n$.

We have included city fixed effects in equation (2) to capture differences that are not related to local expenditure on primary and secondary schools. These differences include factors such as heterogeneity in the availability of colleges and universities and the degree of competitiveness of the college entrance exam.[19]

4.5. Preferences

Household utility is defined over the child's expected achievement a, numeraire consumption b, child arrangement c, the quantity of housing services h, noneducational public goods o, and city amenities ω. The utility function is denoted by $U(a, b, c, h, o, \omega)$. The household

[19]It is straightforward to allow for more general achievement functions that allow, for example, for peer effects, as in Epple, Romano and Sieg (2006).

utility is increasing, twice differentiable, and concave in (b, h) for $c = 0, 1$. In our estimated model we use the following specification:

$$U(a, b, c, h, o, \omega) \;=\; \omega \;+\omega_a\, a \;+\; \omega_o\, o \;+\; (h - \underline{h^c})^{\beta^c}\; b^{1-\beta^c} \tag{4}$$

where minimum housing demand is higher when the child lives with the parent ($\underline{h^1} > \underline{h^0}$).

4.6. The Budget Constraint for Residents

A resident with skills k who decides to stay in city j receives labor income equal to w_{jk} and non-labor income equal to z_{jk}. Recall that the tax rate for labor income in city j is t_j^w. The value of the housing endowment is given by $p_j e_{jk}$. The household allocates resources among owner-occupied housing and consumption goods. Let t^b denote the consumption tax rate imposed by the central government. Residents are eligible for housing subsidies, denote by s_j^h. The budget constraint is, therefore, given by:

$$(1 - s_j^h)\, p_j h \;+\; (1 + t^b)\, b \;=\; (1 - t_j^w)\, w_{jk} \;+\; p_j e_{jk} \;+\; z_{jk} \tag{5}$$

The left-hand side of equation (5) is the sum of after-tax consumption expenditures. The right-hand side of equation (5) is the total after-tax household income including asset income from the initial endowment of housing, as well as non-labor income from land rents.[20] Since we assume that non-labor income is primarily generated by agricultural land use, we set $z_{jk} = 0$ for $j = 1, .., J$, i.e. only households that were born in rural areas have agricultural land use rights in our model. As discussed below, migrants from rural areas may lose some

[20]Note that all households own their houses. Children inherit the houses purchased by the parents which then fully endogenizes the law of motion for the initial conditions of the economy.

or all of the land use rights and the associated non-labor income. This lack of well-defined property rights for land in rural areas creates an inefficiency in the allocation of households across space.[21]

4.7. Household Behavior: Residents & Migrants

We solve the decision problem of each household conditional on having chosen a city and then derive the optimal locational choices. A household maximizes utility subject to the budget constraint and the achievement constraint. In our parametric model, we use the Stone-Geary utility function in equation (4). Hence, the demand functions for housing and consumption are given by:

$$
\begin{aligned}
(6) \qquad h^r_{jk} &= \frac{\beta^1}{(1-s^h_j)\ p_j}[(1-t^w_j)\ w_{jk}\ + p_j e_{jk} + z_{jk}] + (1-\beta^1)\underline{h^1} \\
b^r_{jk} &= \frac{1-\beta^1}{1+t^b}[(1-t^w_j)\ w_{jk}\ + p_j e_{jk} + z_{jk} - (1-s^h_j)\ p_j \underline{h^1}]
\end{aligned}
$$

Substituting the demand and achievement functions into the utility function, we obtain the indirect utility of a household that was born in j and stays in j. It is given by:

$$
(7) \qquad V_{jjk} = U(a^{1,y}_{jk}, b^r_{jk}, c=1, h^r_{jk}, o_j, \omega_j)
$$

Next, consider the decision problem of a household that has decided to migrate from city j to city k. The decision problem of a migrant differs from the problem above in the following

[21] Our analysis does not model rural land markets. Instead, we focus on housing markets which are subject to fewer frictions than land markets. Hence, we do not explicitly model the land reallocation risk that migrants face when they leave their land uncultivated (Kung, 1995). In contrast to Ngai, Pissarides and Wang (2019) and Chari, Liu, Wang, and Wang (2021), we also do not model production and consumption of agricultural goods.

ways. First, some migrants move with their children while others leave their children behind. Children that are left behind have a different achievement than children that accompany their parents. Second, some migrants receive the urban Hukou in their destination city, while others do not. Migrants that do not receive Hukou do not have the same access to public goods. Third, migrants that do not obtain local urban Hukou are not eligible for the housing market subsidies. Fourth, migrants do not have housing endowments in the destination city but can sell their housing endowments in the city that they decide to leave.

Finally, we assume that migrants from rural areas (location 0) that leave the children behind retain an ownership stake in the rural location, i.e. they only sell a fraction of their housing endowment when they move to one of the higher tier cities and also retain some of the agricultural income. In contrast, migrants from rural areas that bring the children along sell their full housing endowment and lose all land rents. More formally, define $0 \leq \lambda_k \leq 1$ as the fraction of the endowment that rural households sell when they move and leave their children behind. Note that this fraction may depend on the skill level k. Hence, these households obtain some non-labor income from the retained endowment in location 0.[22]

Hence, there are four types of migrants in our model: i) with Hukou ($hu = y$) and with children ($c = 1$); ii) with Hukou ($hu = y$) and without children ($c = 0$); iii) without Hukou ($hu = n$) and with children ($c = 1$); iv) without Hukou ($hu = n$) and without children ($c = 0$). We can derive the housing demand and achievement functions for each type of migrant.Substituting these demand and achievement functions into the utility function yields the indirect utility functions (net of migration costs):

$$
\begin{aligned}
V_{ijk}^{y,c} &= U(a_{ijk}^{y,c}, b_{ijk}^{y,c}, c, h_{ijk}^{y,c}, o_j, \omega_j) - mc_{ijk} \quad i \neq j, \quad c = 0, 1 \\
V_{ijk}^{n,c} &= U(a_{ijk}^{n,c}, b_{ijk}^{n,c}, c, h_{ijk}^{n,c}, \Delta_{jk}^{o}\, o_j, \omega_j) - mc_{ijk} \quad i \neq j, \quad c = 0, 1
\end{aligned} \tag{8}
$$

[22] Appendix A.5 discusses how we estimate this parameter.

We assume that mobility costs depend on the destination city, skill types, and the mobility status of the children.[23]

The timing assumption implies that migrants find out whether or not they obtain local Hukou after they move. City j gives Hukou status to a fraction of migrants, denoted by r_{jk}. The migrant's expected conditional value function is given by

$$V_{ijk}^{c} = r_{jk}\, V_{ijk}^{y,c} \;+\; (1 - r_{jk})\, V_{ijk}^{n,c} \tag{10}$$

Now that we have characterized all conditional value functions, we can characterize optimal location decisions. Note that each household must decide where to live and whether to bring the child along when moving. In our model there are $J+1$ locations and two child care arrangements for migrants. As a consequence the choice set has $2 \times J + 1$ elements. Let ϵ_{ijk}^{c} and ϵ_{jjk} denote additively separable random utility shocks which are type 1 extreme value distributed. Hence, the probability that a household of type k moves from city i to city j with child arrangement c is given by:

$$P_{ijk}^{c} \;=\; \frac{\exp(V_{ijk}^{c}/\sigma_{\epsilon})}{\sum_{d=0}^{1}\sum_{l\neq i, l\neq 0}\exp(V_{ilk}^{d}/\sigma_{\epsilon}) + \exp(V_{iik}/\sigma_{\epsilon})} \tag{11}$$

where σ_{ϵ} is the scale parameter of the random utility shocks. The probability of staying is:

$$P_{jjk} \;=\; 1 - \sum_{c=0}^{1}\sum_{l\neq j} P_{jlk}^{c}. \tag{12}$$

[23] In our parametric model, we adopt the following functional form specification:

$$mc_{ijk} = mc_{j} + mc_{k}\; 1\{k=2\} + mc_{0k}\; 1\{i=0, k=2\} \tag{9}$$

where $1\{\cdot\}$ is an indicator function. The second term captures the fact that the mobility rate of high-skill households born in rural areas is significantly higher than the observed rates all other types.

Given that we have characterized the households' decision problems, we can now close the model and define the equilibrium for our model. Let us denote the number of resident households living in city j for each skill type k by n^r_{jk} and note that:

$$n^r_{jk} \;=\; q_{jk}\, P_{jjk}. \tag{13}$$

Recall that q_{jk} is the initial share of type k households in city j. The total number of migrants moving to city j for each skill type k with child arrangement c is given by:

$$n^{m,c}_{jk} \;=\; \sum_{l \neq j} q_{lk}\, P^c_{ljk} \;=\; \sum_{l \neq j} n^{m,c}_{ljk}. \tag{14}$$

Define the fraction of migrants of skill k in city j as $n^m_{jk} = n^{m,1}_{jk} + n^{m,0}_{jk}$. Summing across residents and migrants, we can define the number of households of type k living in city j, denoted by $n_{jk} = n^r_{jk} + n^m_{jk}$.

4.8. Housing Markets

The aggregate demand for housing in city j is defined as the sum of the demand by the residents, the migrant households with Hukou, and the migrants without Hukou:

$$H^d_j = H^{dr}_j \;+\; H^{dy}_j \;+\; H^{dn}_j \tag{15}$$

It is straightforward to derive each of these terms. The aggregate supply of housing in city j is defined as the sum of the existing housing stock and new construction:

$$H^s_j = H^{es}_j \;+\; H^{ns}_j \tag{16}$$

The existing housing stock in city j in $j = 1, , ., J$ is given by:

$$H_j^{es} = \sum_{k=1}^{K} q_{jk}\, e_{jk} \tag{17}$$

Accounting for the fact that households that move without children retain $1 - \lambda_k$ of their endowment, the existing housing stock in city 0 is given by:

$$H_0^{es} = \sum_{k=1}^{K} q_{0k}\, e_{0k} - \sum_{k=1}^{K}\sum_{j=1}^{n} q_{0k}\, P_{0jk}^{0}\, (1 - \lambda_k)\, e_{0k} \tag{18}$$

New housing is supplied by the local government in cooperation with some housing developers. We assume that there is an upward sloping housing supply function which captures land supply constraints. In our empirical model, we assume that new housing supply in city j is given by:

$$H_j^{ns}(p_j) = l_j\, p_j^{\eta_j} \tag{19}$$

where l_j is a constant and η_j is the housing supply elasticity in city j. A key assumption of our model is that land and housing market development in a city are primarily driven by migration since residents have a substantial housing endowment in their city.[24]

Housing market equilibrium requires that:

$$H_j^{d} = H_j^{s} \tag{20}$$

[24]In Table 17 of Appendix A.7, we estimate a variety of different land and housing market development models that use Bartik instruments to control for the potential endogeneity of population growth in a city. See also the analysis in Zhang, Fan and Mo (2017). These findings are broadly consistent with our modeling approach and suggest that population growth and migration are important factors that determine land sales and new housing construction.

for all cities.

4.9. City Budget Constraints

Local governments receive revenues from three sources. First, local governments generate own revenues from local taxes, shared taxes, fees, and charges. We model these revenues as proportional to labor income and denote these revenues by T_j^w:

$$T_j^w = t_j^w \left(\sum_{k=1}^{K} n_{jk} \, w_{jk} \right) \tag{21}$$

Second, cities generate revenues from land sales and new housing construction. We denote these revenues by T_j^h. These revenues are proportional to the value of new housing supply:

$$T_j^h = t_j^h \, p_j \, H_j^{ns} \tag{22}$$

Notice that migrants tend to bear a larger burden of this tax than residents, since they do not benefit from local housing endowments. Finally, cities received additional transfers from the central government, denoted by T_j^{tr}. These transfers are financed by a consumption tax. Intergovernmental transfers are given by:

$$T_j^{tr} = \delta_j \, t^b \sum_{j=1}^{J} \sum_{k=1}^{K} n_{jk}^r \, b_{jk}^r + \Big(\sum_{c=0}^{1} n_{jk}^{m,c} \, (r_{jk} \, b_{jk}^{y,c} + (1 - r_{jk}) \, b_{jk}^{n,c}) \Big) \tag{23}$$

where δ_j is the share of the city j. This specification allows us to account for the fact that the central government provides larger transfers to rural areas and lower tier cities. Hence,

total city revenues are given by:

$$T_j = T_j^w \ + \ T_j^h + T_j^{tr} \tag{24}$$

Local governments subsidize new housing purchases of residents and migrants with Hukou. Total government housing subsidies are given by

$$S_j \ = \ s_j^h \, p_j \, (H_j^{dr} + H_j^{dy}) \tag{25}$$

Hence, the net fiscal revenues of cities are given by $T_j - S_j$.

Local governments provide education and other public goods and services. Expenditures on education are given by:

$$\begin{aligned} E_j^g \ &= \ \left(n_j^r + \sum_k n_{jk}^{m,1} r_{jk} \right) \, g_j \ + \ \left(\sum_k (1-\gamma_1^n) \, n_{jk}^{m,1} (1-r_{jk}) \, \Delta_{jk}^g \right) g_j \\ &+ \ \left(\sum_k \sum_{l \neq j} n_{jlk}^{m,0} + \sum_k \sum_{l \neq j} \gamma_1^n \, n_{jlk}^{m,1} (1-r_{jk}) \right) g_j \end{aligned} \tag{26}$$

The Hukou policy affects educational expenditures through two channels: the fraction of migrants that receive Hukou r_{jk} and the fiscal wedge Δ_{jk}^g. The first term captures expenditures for children of residents and migrants with Hukou who brought their children when they moved. The second term captures expenditures for children of migrants without Hukou. We assume that these children only require $(1-\gamma_1^n)$ of expenditures since they often return to the province in which the parents have Hukou to finish high school and prepare for the college entrance exam. The third term reflects expenditures for children whose parents left city j, moved to city l, and either left the children behind with relatives or send them back to complete high school and prepare for the college entrance exam. We assume that the last

type of children require γ_1^n of total expenditures. Note that these children are treated as if they were children of residents. Hence, there are not fiscal wedges for the children left behind or returning home.

Equilibrium requires that education expenditures are equal to the fraction of tax revenues earmarked for that purpose:

$$\zeta_j \left(T_j - S_j\right) \;=\; E_j^g \tag{27}$$

where ζ_j is the share of net tax revenue that is devoted to education. Similarly, expenditures on other public goods are given by:

$$E_j^o \;=\; \left(n_j^r + \sum_k n_{jk}^m r_{jk}\right)\; o_j \;+\; \left(\sum_k n_{jk}^m (1 - r_{jk})\; \Delta_{jk}^o\right) o_j \tag{28}$$

Note that the only difference between equation (26) and equation (28) is that migrants without children also consume other public goods and services. A balanced budget requires that that expenditures for other public goods and services equals net revenue that are earmarked for these purposes:

$$(1 - \zeta_j) \left(T_j - S_j\right) \;=\; E_j^o \tag{29}$$

Migrants also provide a positive fiscal externality to the city since they require lower expenditures, especially on education. One of the key contributions of the empirical analysis below is that we estimate the magnitude of these fiscal externalities.

4.10. Production, Wages, and Agglomeration Externalities

To close the model we need to specify an aggregate production function which depends on the fraction of each skill type in the city. In our empirical model we assume that the production function in city j is Cobb-Douglas with constant returns to scale:

$$Y_j = A_j \, \Pi_{k=1}^{K} \, n_{jk}^{\alpha_k} \tag{30}$$

where A_j denotes total factor productivity.

We can also include agglomeration effects into our model. When households and firms operate in close proximity in cities, efficiency gains primarily arise due to "sharing," "matching," and "learning" as discussed in detail in Duranton and Puga (2004). In our setting, we assume that the productive amenity A_j increases in density. Formally, productive amenities take the following form:

$$A_j = A_{0j} \left(\frac{n_j}{l_j} \right)^{A_{1j}} \tag{31}$$

where l_j is a measure of the fixed land area of the city.[25]

Earnings of skill k in city j are equal to the marginal product of labor:

$$w_{jk} = A_j \, \alpha_k \, n_{jk}^{\alpha_k - 1} \, \Pi_{i \neq k} \, n_{ji}^{\alpha_i} \tag{32}$$

[25] Alternatively, we could assume that the externality depends only on the density of high-skill households as suggested by Moretti (2011). As we explain in detail below, our estimation approach only allows us to identify A_j. As a consequence, our estimated model is consistent with the notion that externalities may be important at the city level. To capture these externalities in our counterfactual analysis we need to make an additional assumption that allows us to decompose A_j into an exogenous and an endogenous component (Coen-Pirani and Sieg, 2019).

Note that migration to the city affects the earnings of residents because of the concavity of the production function. Agglomeration externalities act as multipliers since migration increases the population density and hence the overall productivity.[26]

4.11. Equilibrium

We are now in a position to define a one-period equilibrium of the model:

Definition 1 *Given a transfer policy for the central government* (t^b, δ_j)*, as well as an initial distribution of types and endowments,* (q_{jk}, e_{jk})*, land rents* (z_{jk})*, local tax policies,* (t_j^w, t_j^h, s_j^h)*, local expenditure rules* (ζ_j)*, local Hukou policies* $(r_{jk}, \Delta_{jk}^g, \Delta_{jk}^o)$*, and total factor productivity* (A_j) *for each city* j*, an equilibrium consists of expenditure policies* (g_j, o_j) *and housing prices* (p_j) *in each city, an allocation of households across cities* $(n_{jk}^r, n_{jk}^{m,c})$*, for* $c = 0, 1$*,* $j = 0, .., J$ *and* $k = 1, ..K$*, and earnings* (w_{jk}) *for* $j = 0, .., J$ *and* $k = 1, ..K$*, such that:*

1. *resident and migrants maximize utility subject to the relevant constraints;*

2. *housing markets clear in all communities;*

3. *local budgets are balanced in all communities; and*

4. *earnings are determined by marginal products of labor for each type in all communities.*

[26]Labor market wedges can also be incorporated into the analysis. For example, firms mays pay migrants lower wages than residents holding skills constant. Labor market discrimination lowers the attractiveness of cities for migrants and reduces the overall migration flows. Define a wage wedge $\Delta_{jk}^w < 1$ and assume that lifetime earnings of migrants satisfy:

$$w_{jk}^m = \Delta_{jk}^w \, w_{jk}$$

Since there is no consensus in the literature about the magnitude of these labor market wedges, we do not account for them in our empirical analysis. Some research that has documented the existence of labor market discrimination for migrants are Meng and Zhang (2001) and Demurger et al. (2009).

A dynamic equilibrium for the economy is a sequence of one-period equilibria that are linked by the intergenerational transmission of human capital and the law of motion for housing endowments.

Note that the structure of the model allows us to characterize a dynamic equilibrium period by period since we assume that parents make all decisions on behalf of their children. As a consequence, we can also compute the dynamic equilibrium period by period using a forward iteration algorithm. This structure has the advantage that we can study the long-term transitions of the economy without having to assume stationary or that the economy is on a balanced growth path. Both assumptions may be problematic in the case of China.

Given a specification of all relevant functions of interest, parameter values, and initial conditions, we can compute the expenditure policies (g_j, o_j), housing prices (p_j), and earnings (w_{jk}) that satisfy the housing market equilibrium conditions (20), local budget constraints (27), (29), and first-order conditions of local labor markets (32). There are $(K+3)(J+1)$ unknowns and $(K+3)(J+1)$ equations. Thus, the solution can be found using standard numerical methods.

5. Estimation

5.1. Initial Conditions

The first step of the estimation strategy is to determine the initial conditions of the model. After the founding of the People's Republic of China, all land was nationalized, and all new housing units were owned by the state. Since 1978 China has undergone successive economic reforms. Major urban reforms were initiated in the early 1990s, including the privatization of

public housing. A milestone in the housing reform was the 23rd Decree issued by the State Council in 1998, which stated that work units, mostly state-owned enterprises, were no longer allowed to develop residential housing for their employees (Wu, Gyourko and Deng, 2010). By the end of the 1990s, a private housing market had gradually developed. Hence, we use the state of the economy in 2000 to determine the initial conditions for our model.

One of the nice features of the CHFS 2017 is that it contains a variety of retrospective questions that allow us to characterize the initial distribution of household types. We use this retrospective information together with the observed college achievement of the household head to estimate the initial distribution of skill types in each city. Similarly, we use the 2000 Census to estimate the initial distribution of housing endowments by skill type. Table 6 summarizes the estimated initial distribution of skills and endowments.

Table 6: Initial Conditions

	Share of Skill Type (q_{jk})		Endowments (e_{jk})	
	Low-skill	High-skill	Low-skill	High-skill
Tier 1	3.52	2.11	62	72
Tier 2	9.70	5.31	62	72
Tier 3	8.87	4.29	67	78
Rural	59.90	6.30	80	84

Note that these statistics are based on 2000 Census and the CHFS 2017. Housing endowments are measured in square meters.

Note that tier 1 cities comprised 5.6 percent of the population in 2000. Tier 2 cities accounted for 15 percent of the population. Tier 3 cities had a 13.2 percent share of the total population. The remaining 66.2 percent of the population lived in less developed, rural areas. Not surprisingly, the average skill level is declining by city tier, with tier 1 cities accounting for the largest share of high-skill households. Average housing endowments that resulted

from the initial privatization of the housing stock were fairly uniformly distributed among households in major cities with high-skill households receiving slightly larger housing units than low-skill households. Average initial housing endowments were larger in rural parts of the country than in major cities. However, housing in cities was much more valuable than housing in rural areas.

5.2. Fiscal Capacities and Policy Parameters

The second step of the estimation strategy is to quantify the fiscal parameters of the model. Recall that Chinese cities draw revenues from a variety of sources. First, cities receive transfers from the central government. Second, revenues from tax sharing agreements are quite important since value-added, personal and corporate income tax revenues are shared between local and central governments. Third, cities levy a variety of local taxes, charges, and fees that contribute to own-source revenues. Finally, cities generate a substantial amount of revenues from land development and housing construction. China's City Statistical Yearbook provides statistics that allow us to estimate the relevant revenue shares by city tier. As shown in Table 7, own-source revenues account for 34 percent of total local revenues in tier 1 cities. Note that these revenues include shared personal and corporate income taxes. Land and housing-related revenues account for 35 percent of total revenues. The remaining revenues come from VAT sharing and other central government transfers accounting for 31 percent of the total local revenues in tier 1 cities. Revenue shares of tier 2 cities are similar to those of tier 1 cities. The main difference is that tier 2 cities generate fewer revenues from own-source revenues but obtain higher revenues from land sales than tier 1 cities. Tier 3 cities received 56 percent of their revenues from central government transfers and, therefore, rely more heavily on the central government than tier 1 and tier 2 cities.

Table 7: Revenue Shares and Expenditures by City Tiers

	Tier 1	Tier 2	Tier 3	Rural
Own-source Revenues excluding VAT	34%	24%	16%	7%
Land and Housing Revenues	35%	45%	28%	12%
VAT Revenues & Governmental Transfers	31%	31%	56%	81%
Educational Expenditures per Capita	5,995	2,183	1,553	791
Other Expenditures per Capita	40,447	13,080	8,653	3,485

Note that these statistics are based on the City Statistical Yearbooks, 2013-2017.

Since there are large differences in total fiscal capacity and total revenues, it is not surprising that there are also large differences in expenditures among cities. We can measure the quality of local education using public education expenditures per capita. The data are again provided by China's City Statistical Yearbooks, 2013- 2017, which reports expenditures for both the urban core and the whole prefecture.[27]

Table 7 shows the median educational expenditures and expenditures on other public goods per capita by city tier. Not surprisingly, tier 1 cities have much higher expenditures per capita than tier 2 and tier 3 cities. Note that educational expenditures and expenditures on other public goods in rural areas were, on average, 791 and 3,485 Chinese Yuan per capita respectively. In summary, there are pronounced differences in both educational and other public expenditures among cities and rural areas in China.

We treat revenue policies as predetermined in our model and measure the average income tax rate in each city as the ratio of own-source revenues to local GNP. Table 8 shows that the

[27]We use five-year averages to eliminate the importance of yearly aggregate and idiosyncratic shocks to taxes and expenditures. All the nominal values are deflated with 2017 as the base year. A prefecture is an administrative unit below a province and consists of a city proper (an urban core, similar to a metropolitan area) and a mostly rural area (typically called counties). We proxy rural expenditures using the total expenditures of the whole prefecture minus the expenditures for city proper in a prefecture. We proxy rural expenditures using the total expenditures of the whole prefecture minus the expenditures for city proper in a prefecture.

estimated income tax rate ranges between 2 percent and 9.8 percent. The most developed cities have the highest capacity to generate own-source revenues.[28]

Table 8: Local Government Policy Parameters

	Income Tax Rate	Share of Education Expenditures	Housing Subsidy Rate	Education Expenditure Wedge		Other Expenditure Wedge	
				Low-skill	High-skill	Low-skill	High-skill
Tier 1	0.098	0.156	0.024	0.717	0.843	0.325	0.705
Tier 2	0.058	0.156	0.029	0.839	0.869	0.188	0.505
Tier 3	0.028	0.167	0.038	0.891	0.872	0.143	0.481
Rural	0.020	0.208					

Note that expenditure wedges are estimated based on data from the MDMS 2011. Housing subsidies for residents are estimated based on the CHFS 2017. Income tax rates and the education expenditure shares are estimated based on the City Statistical Yearbooks, 2013-2017, and the 2018 annual report of the Ministry of Finance.

Tax revenues from land sales and new housing construction are proportional to the value of the new housing stock. Using the share of land revenues reported in Table 7, a reasonable estimate of the housing tax rate, denoted by t_j^h, is 40 percent for all cities. The value-added tax was 16 percent in 2018. Since the central and local governments equally share this tax, we set the consumption tax rate of the central government that funds intergovernmental transfers at 8 percent in our model.

The share of expenditures that are allocated to education, denoted by ζ_j, can be estimated by the average ratio of educational expenditures and total expenditures reported in Table 7. Different public good wedges play an important role in our analysis. We measure the educational wedge Δ_{jk}^g based on the share of migrant children in local public schools as

[28]Tier 1 and tier 2 cities attract more firms than tier 3 cities and rural areas in generating corporate income tax revenues. The progressive nature of the income tax system and tax sharing agreement also imply that cities with a larger share of high-income households can generate more income tax revenues.

reported in Table 4. We measure the wedge for other public goods Δ^o_{jk} based on the fraction of migrants who have access to social security or medical insurance as reported in Table 9. Both of these measures are estimated based on a sample of temporary households drawn from the MDMS 2011.

Table 9: Fraction or Temporary Migrants with Access to Other Public Goods and Services

	Housing Providence Fund		Social Security		Medical Insurance	
	Low-skill	High-skill	Low-skill	High-skill	Low-skill	High-skill
Tier 1	3.6	34.6	24.3	66.8	29.9	68.4
Tier 2	3.2	20.8	14.4	46.7	17.4	48.0
Tier 3	1.6	19.2	8.3	38.9	12.2	45.1

Note: These statistics are based on the MDMS 2011.

Despite the fact that all employers in China are required by law to pay social security contributions for their employees regardless of their Hukou status, Table 9 shows that Hukou status matters when it comes to access to social insurance programs. Temporary migrants, however, are often not protected by the law or unwilling to join the social insurance program because of high job uncertainty. Similar access problems arise for medical insurance programs.[29] As a consequence, we find that the wedges for other public goods are larger than the wedges for educational expenditures. Finally, we estimate the fraction of migrants that obtain local urban Hukou in each cities r_{jk} based on Table 1.

[29] All employees are supposed to have access to the Urban Employee Medical Insurance. Also, cities have an Urban Resident Medical Insurance program that primarily covers households with local urban Hukou. Similarly, rural areas offer the Rural Medical Cooperative Insurance program. Many migrants only have access to these programs in their Hukou registration place.

5.3. A Sequential Method of Moments Estimator

Given a characterization of the initial conditions and the policy parameters, we can estimate the remaining parameters of the model using a sequential two-step estimator. In the first stage, we estimate the parameters of the production function and the housing demand function. In the second stage, we estimate the remaining parameters using a nested-fixed-point methods of moments estimator.

The production function is given in equation (30). There are two types of labor in our model: high-skill and low-skill. We allow the share of low-skill labor to be city-specific. Using local wages for each type w_{jk} and the share of labor inputs n_{jk} observed in the CHFS, the parameters of the production function can be estimated using the first-order conditions in equation (32) that characterize competitive wages in each city. In total, we can estimate eight parameters of the production function – namely the TFP parameters (A_j) and the share of unskilled labor (α_{j1}) – using an exactly identified minimum distance estimator.[30]

Similarly, the housing demand function for residents is given by equation (6). The demands for migrants can be derived in a similar way. We can measure the permanent income and housing consumption of migrants and residents households using the CHFS. Hence, we can estimate the parameters of the housing demand function using a method of moments estimator.

In the second stage, we estimate the remaining parameters of the model using a nested fixed-point algorithm. We compute the equilibrium for the model in the inner loop and search over the parameters in the outer loop. Since we condition on observed housing prices, local tax rates, and fiscal wedges in the estimation, the implied equilibrium appears to be unique. The

[30] Assuming constant returns to scale we have $\alpha_{j2} = 1 - \alpha_{j1}$.

moments are based on the net migration flows, the gross migration flows (transition matrix), the college attainment rates of children, and the share of children left behind. Standard errors can be computed using a bootstrap algorithm.

6. Estimation Results

6.1. Parameter Estimates

Our main results are summarized in Table 10 which reports the estimates and estimated standard errors for the parameters of our model. First, consider the estimates of the production function. We find that the TFP estimates are decreasing in city tier as expected. In contrast, the share of unskilled labor is increasing in city tier, with tier 1 cities having the lowest share of unskilled labor.

Second, consider the parameters of the housing demand functions. We find that households with children have a higher level of minimum housing consumption ($\underline{h}$), but are less responsive to changes in income (β). High-skill households have stronger preferences for housing than low-skill households. Overall, our estimates imply that the housing shares are highest in tier 1 cities typically ranging between 34 and 46 percent of permanent income. Migrants with children have shares exceeding 50 percent, which shows that homeownership in tier 1 cities has become rather expensive for migrants. Housing shares in tier 2 (3) cities range between 13 (6) and 22 (12) percent of lifetime income. Housing shares are even lower in rural areas.[31] Not surprisingly, migrants consume much less housing in tier 1 cities than residents. The differences in housing consumption between migrants and residents in all other cities are small. We thus conclude that with the exception of tier 1 cities ownership is still

[31] We follow Wang and Zhang (2014) and set the housing supply elasticity $\eta_j = 2.1$ for all three city tiers.

Table 10: Parameter Estimates and Standard Errors

Parameter	Estimate	Std Error	Parameter	Estimate	Std Error
Utility Function			Housing Demand		
ω_1	0.16	(0.07)	β_0^1	0.085	(0.014)
ω_2	0.33	(0.11)	β_2^0	0.037	(0.009)
ω_3	-1.62	(0.21)	β_1^1	0.045	(0.003)
ω_0	0.00	—	β_2^1	0.011	(0.001)
ω_g	4.76	(0.65)	$\underline{h}_1^0$	19.63	(6.58)
ω_o	5.49	(0.71)	$\underline{h}_2^0$	62.43	(8.23)
σ_ϵ	1.61	(0.15)	$\underline{h}_1^1$	57.98	(1.08)
			$\underline{h}_2^1$	83.42	(1.26)
Production Function			Mobility Cost		
A_1	10.45	(0.36)	mc_1	8.62	(0.82)
A_2	6.93	(0.14)	mc_2	5.91	(0.48)
A_3	5.49	(0.16)	mc_3	3.37	(0.32)
A_0	1.70	(0.07)	mc_k	-0.79	(0.17)
α_{11}	0.43	(0.02)	mc_{0k}	-2.23	(0.36)
α_{21}	0.53	(0.01)	Attainment Function		
α_{31}	0.62	(0.01)	δ_{01}	-3.53	(0.31)
α_{01}	0.90	(0.01)	δ_{02}	-1.63	(0.17)
			δ_{03}	-1.26	(0.10)
			δ_{00}	-1.18	(0.04)
			δ_1	21.95	(1.58)
			δ_2	1.75	(0.11)

Note: estimated standard errors are given in parentheses.

affordable for resident and migrant households.[32]

Third, consider the remaining parameters of the utility function. Table 10 shows that all parameters of the utility function have the expected sign and are estimated relatively precisely. The unobserved amenities do not play a large role in explaining household sorting.

[32]It is not difficult to extend our model and to allow for a more affordable housing option in tier 1 cities for migrants that does not involve ownership. Note that including such a rental option makes migration to tier 1 cities more attractive since housing expenditures shares of migrant households will be lower in such a model than in our baseline model. The lower housing consumption would then also imply that migrants provide lower fiscal externalities than the ones we estimate below. Nevertheless, the fiscal externalities would still be substantial.

As expected, there are significant moving costs. Note that the moving costs capture all other reasons why migrants may not want to move, that we do not explicitly model. The estimates show that it is more costly to move to tier 1 and tier 2 cities than tier 3 cities. High-skill households face lower mobility costs than low-skill households, especially high-skill households from rural areas.

Finally, consider the parameters of the the college attainment function. We find that local expenditures and parental skills are the main predictors of college achievement. The marginal effects of both variables are statistically significant and economically meaningful. Once we condition on local expenditures and parental skills, the fixed effects associated with the city of destination are small. We, therefore, conclude that heterogeneity in the availability of higher-education institutions across city tiers does not play a large role in our analysis once we control for differences in the quality of primary and secondary education.

6.2. Goodness of Fit

Next, we evaluate the goodness of fit of our model. First, consider the fit of the moments that matched in estimation. Table 11 summarizes our main results.

We find that our model matches closely the observed and predicted net migration flows and the share of households who leave their children behind. Table 11 also reports college attendance rates observed in the data and predicted by our model by skill type and city tier. Overall, our model captures these spatial patterns of human capital accumulation well. Human capital accumulation increases as households move to more attractive cities. Moreover, residents tend to have higher college attainment than transitory migrants.

Finally, we show in Appendix A.6 that our model also fits the observed revenue shares,

Table 11: Model Fit

	Allocation				Temporary Migrant Children Left Behind			
	Low-skill		High-skill		Low-skill		High-skill	
	Data	Model	Data	Model	Data	Model	Data	Model
Tier 1	0.056	0.054	0.034	0.034	0.479	0.450	0.193	0.225
Tier 2	0.187	0.186	0.081	0.082	0.387	0.376	0.305	0.400
Tier 3	0.172	0.175	0.053	0.052	0.421	0.436	0.450	0.448
Rural	0.405	0.405	0.012	0.012				
	Wage				College Attendance: Residents			
	Low-skill		High-skill		Low-skill		High-skill	
	Data	Model	Data	Model	Data	Model	Data	Model
Tier 1	3.439	3.492	7.312	7.227	0.768	0.816	0.946	0.962
Tier 2	2.477	2.504	5.084	5.022	0.654	0.666	0.909	0.920
Tier 3	2.187	2.155	4.311	4.418	0.568	0.559	0.874	0.880
Rural	1.093	1.093	3.926	3.940	0.309	0.308	0.702	0.719
	College Attendance: Permanent Migrant				College Attendance: Temporary Migrants			
	Low-skill		High-skill		Low-skill		High-skill	
	Data	Model	Data	Model	Data	Model	Data	Model
Tier 1	0.622	0.471	0.895	0.823	0.355	0.203	0.768	0.720
Tier 2	0.606	0.512	0.898	0.837	0.354	0.400	0.786	0.801
Tier 3	0.541	0.452	0.867	0.819	0.323	0.396	0.725	0.793
	Housing Demand: Residents				Housing Demand: Migrants			
	Low-skill		High-skill		Low-skill		High-skill	
	Data	Model	Data	Model	Data	Model	Data	Model
Tier 1	65	62	80	85	40	43	68	80
Tier 2	72	72	95	90	60	61	91	87
Tier 3	87	91	100	99	85	86	105	107
Rural	130	122	120	126				

Note: Data moments are constructed based on the CHFS 2017.

expenditures policies, and GNP per capita in each city. Note that we do not target these moments in estimation. We, therefore, conclude that our model fits the key dimensions of the data well.

6.3. Estimated Fiscal Externalities

Expanding educational opportunities to migrants without reducing educational quality for residents is likely to require significant tax increases. This need arises because migrants provide large positive fiscal externalities to all major cities. One key advantage of the empirical analysis is that we can estimate the magnitude of these fiscal externalities. Columns A-C of Table 12 report the revenues generated from income, land sales, and consumption taxes for the four different migrant types in our model. Total revenues are reported in Column D. Educational expenditures and expenditures for other public goods are reported in Columns E and F. Housing subsidies are reported in column G. Total expenditures are reported in Column H. Subtracting total expenditures from total revenues then yields our measure of fiscal externalities reported in Column I.

Table 12 suggests that the fiscal externalities reported in the last column are positive for all migrant types. The fiscal externalities are declining by city tier, with tier 1 cities enjoying the highest fiscal externalities. Comparing the externalities for different types of migrants, we find that fiscal externalities are larger for high-skill than low-skill households. While high-skill households require higher expenditures than low-skill households, they pay much higher taxes and consume more housing. The revenue effect dominates the expenditure effect. Households with children generate similar externalities as households without children. The higher schooling expenditures are more or less offset by the higher taxes that households with children pay.

Table 12: Estimated Fiscal Externalities

	Income Tax A	Land Sales B	Sales Tax C	Total Revenue D	Edu Exp E	Other Exp F	Housing Subsidy G	Total Exp H	Total Dif I=(D-H)
Low-skill, no child									
Tier 1	341	432	220	993	0	581	7	588	405
Tier 2	146	143	172	460	0	233	3	236	224
Tier 3	61	100	149	309	0	147	3	150	160
Low-skill with child									
Tier 1	341	1043	64	1448	151	581	16	748	700
Tier 2	146	218	150	514	77	233	4	315	199
Tier 3	61	106	141	308	53	147	3	202	105
High-skill no child									
Tier 1	705	1170	377	2251	0	979	33	1012	1239
Tier 2	292	263	337	891	0	434	10	444	447
Tier 3	124	141	306	571	0	294	9	303	267
High-skill with child									
Tier 1	705	1496	292	2493	184	979	42	1205	1288
Tier 2	292	280	329	901	88	434	11	533	369
Tier 3	124	119	305	548	60	294	8	362	186

Note: All variables are in 1,000 Chinese Yuan and in per capita.

How plausible are our estimates of these fiscal externalities? In Appendix A.7 of this paper we provide additional empirical evidence which supports the magnitude of our estimates. If anything, our estimates may be a lower bound of the true fiscal externalities since there are other externalities that we do not explicitly model in our analysis. For example, social security is administered at the local level in China. Workers and firms contribute to a social security account, which is shared by all households living in the same city. Retired workers obtain pensions that are financed using a pay-as-you-go system. Migrants are, on average, much younger than residents and, therefore, are net contributors to the social security account. Older residents benefit from migrants, because they did not pay much social security taxes when they were young, and experience a windfall gain from the introduction of the pay-as-you-go system. These gains are larger in cities with large migration inflows. Our estimates of the fiscal externalities of migrants do not account for the financing of social security.

7. Reforming the Hukou System

Our analysis of the current system of migration controls has documented that a large number of temporary migrants do not have the same access to local public goods and services as residents and permanent migrants. In particular, children of temporary migrants tend to have access to lower-quality schools than children of residents and permanent migrants. Moreover, many migrant children are left behind and attend lower-quality schools in rural areas and less developed cities. Finally, residents in all major cities enjoy higher levels of public good provision and/or pay lower taxes due to the positive fiscal externalities generated by migrants. It is, therefore, not surprising that Hukou reform has been an important focus of the Chinese Government since Xi Jinping started to serve as general secretary of the CCP in November 2012.

In March 2014, the Central Committee of the CCP and the State Council released a National Urbanization Plan (2014-2020) which emphasized urban Hukou reform as part of a national strategy to increase urbanization. In July 2014, the State Council issued additional Policies on the Reform of Household Registration System that further clarified the plan for full liberalization of Hukou in small and medium cities. It also called for more transparent Hukou requirements in large cities that may not be able to relax Hukou requirements.[33] Most importantly, temporary migrants in small and medium-sized cities were to be given complete access to local public goods including equal education rights for children, affordable housing, basic medical insurance, urban pension fund, and employment benefits. On September 30, 2016, China's State Council released another circular that urged local governments to grant hukou to 100 million temporary migrants by 2020. In particular, small and medium-sized cities were asked to completely remove restrictions on hukou registration. Larger first-tier and second-tier cities were also asked to ease hukou registrations, considering location, occupation, residence, participation in social security, and length of staying in the city. The circular provided some incentives for local government to increase the registration of temporary migrants. Nevertheless, the Hukou reform was largely financed by local governments. While the implementation of these reforms was slow at the beginning, the speed of the reforms accelerated after 2016. According to the Chinese National Bureau of Statistics, the goal of 100 million registrations was accomplished by the middle of 2020.

We use these reforms that were implemented between 2014 and 2020 to guide our policy experiments. In particular, we simulate the impact of policies that extend full residency rights to all migrants in tier 3 cities. Recall that most tier 1 and many tier 2 cities are already so large that it may be difficult to increase their populations. Hence, additional migration to

[33]In addition, rural migrants' rights to land contracts, the use right of self-built home in rural areas, and gaining collective earnings in hometowns were to be protected even if these households obtained an urban hukou in a city.

these cities may neither be feasible nor efficient. We, therefore, keep the current Hukou policies in place in tier 1 and tier 2 cities.[34]

To implement the counterfactual policy analysis, we fix the quality of public goods in all cities at the baseline equilibrium level. We then need to impose some assumptions about how the Hukou reforms are financed. Policy 1 introduces a surcharge on the national consumption tax to finance the increase in transfers from the central government. Policies 2 follows the actual reforms and assumes that the cost of expanding access to local public goods to migrants is primarily born by the local governments in tier 3 cities. It uses a surcharge to the local income tax to finance the additional expenditures. We consider both policies with and without agglomeration externalities.[35]

Table 13 summarizes the main impact of the policy experiments on the migration of households. Both policies open access to public goods in all tier 3 cities, which leads to a significant increase in the overall population share of these cities. In contrast, the number of migrants with and without Hukou stays approximately the same in tier 1 and tier 2 cities.

Low- and high-skill households in rural areas are the primary beneficiaries of these policies. Consider, for example, policy 1 without agglomeration externalities. Our model implies that the number of low-skill migrants from rural to tier 3 cities increases from 133.56 (=42.07+91.49) million to 232.01 million. Similarly, the number of high-skill migrants from rural to tier 3 cities increases from 31.21 (=20.97+10.77) million to 43.38 million. Those are substantial increases in migration flows from rural areas to tier 3 cities. Comparing the effects of Policy 1 to Policy 2, we find that Policy 1 generates larger effects than Policy 2. This follows from the fact Policy 1 distributes the costs of expanding the Hukou system to

[34]We also considered Hukou reforms that included tier 2 cities. These reforms tend to increase aggregate achievement even more but are also much more expensive to finance.

[35]To assess the impact of agglomeration externalities on our outcomes, we set $A_{1j} = 0.4$ for all cities and adjust A_{0j} such that A_j is equal to the estimated baseline value.

Table 13: Equal Access to Local Public Goods: Migration Analysis

	Baseline	Policy 1 (national)		Policy 2 (local)	
Agglomeration		no	yes	no	yes
City		Low-skill Migrants with Hukou			
Tier 1	7.17	6.58	6.04	6.67	6.17
Tier 2	34.97	31.02	26.53	31.92	27.86
Tier 3	42.07	232.01	295.56	221.19	278.40
City		Low-skill Migrants without Hukou			
Tier 1	20.40	18.72	17.18	18.98	17.57
Tier 2	92.20	81.77	69.95	84.14	73.46
Tier 3	91.49	0.00	0.00	0.00	0.00
City		High-skill Migrants with Hukou			
Tier 1	8.96	8.15	6.68	8.40	7.04
Tier 2	23.87	20.25	14.55	21.40	16.06
Tier 3	21.97	43.38	58.20	40.87	54.09
City		High-skill Migrants without Hukou			
Tier 1	10.10	9.19	7.53	9.48	7.94
Tier 2	21.59	18.32	13.16	19.37	14.53
Tier 3	10.77	0.00	0.00	0.00	0.00
Share of Migrant	0.28	0.34	0.37	0.33	0.36
Tax Surcharge	0	0.02	0.02	0.05	0.04

Note: Population numbers are in million. The total population is 1.39 billion.

all households including residents in tier 1 and tier 2 cities as well as residents in rural areas, while Policy 2 places the financial burden of expanding Hukou on the residents in tier 3 cities.

Agglomeration externalities act as a multiplier since the inflow of households increases the population density, which makes tier 3 cities more productive. Overall, we use a fairly conservative estimate of the magnitude of the agglomeration externality here. If we use a larger estimate, we can generate larger multiplier effects than the ones reported in Table 13

Policy 1 requires an increase of the national consumption tax by 2 percent while policy 2 can be financed by an increase in the local income tax of 5 percentage points. We thus conclude that both policies are expensive and require significant tax increases.

Table 14 summarizes the impact of the two policy regimes on college attainment.[36] We find that an additional 11 (10) to 15 (14) million children would receive a college education under policy 1 (2). Not surprisingly the effects are larger when the government used a national consumption tax since this tax imposes a lower tax burden on the tier 3 cities what are the primary destination of the additional migrants. These positive effects arise since the number of children that are educated in tier 3 schools increases substantially while the number of children that are educated in rural schools decreases by almost the same margin. Hence, the net increase in college attainment is largely due to the fact the school quality increases for these migrant children. The attainment effects on children of residents in tier 1-3 cities are negligible. This shows that it is possible to design policies that extend access to higher education for temporary migrants without hurting the educational achievement of all other children. These reforms primarily require an investment in new schools in tier 3 cities. We conclude that the reforms, which mimic the reforms implemented in China in 2014, promise to increase the college attainment of migrant children.

[36]Here we assume that the number of children is half the population size.

Table 14: Number of Children with College Degree

	Baseline	Policy 1 (national)		Policy 2 (local)	
Agglomeration		no	yes	no	yes
City	Children of Low-skill Resident: College Degree				
Tier 1	19.53	19.43	19.34	19.43	19.36
Tier 2	43.77	43.04	42.30	43.15	42.52
Tier 3	30.53	30.09	31.27	29.83	30.98
Tier 0	86.51	74.55	67.33	75.75	69.20
City	Children of High-skill Resident: College Degree				
Tier 1	13.63	13.56	13.42	13.58	13.46
Tier 2	31.62	30.84	29.25	31.06	29.76
Tier 3	17.31	18.37	20.89	17.84	20.27
Tier 0	5.99	5.05	4.04	5.22	4.28
City	Children of Low-skill Migrants: College Degree				
Tier 1	3.76	3.53	3.29	3.55	3.34
Tier 2	27.37	24.45	20.90	25.16	21.94
Tier 3	27.63	54.32	68.96	51.82	65.00
City	Children of High-skill Migrants: College Degree				
Tier 1	7.32	6.69	5.51	6.89	5.80
Tier 2	18.63	15.82	11.35	16.73	12.53
Tier 3	13.27	17.83	24.00	16.79	22.29
	All Children College Degree				
Low	239.10	249.41	253.40	248.69	252.33
High	107.78	108.17	108.47	108.11	108.39
Total	346.88	357.58	361.87	356.80	360.72

Note: Population numbers are in million.

There is an emerging literature that has evaluated the short term impact of the 2014 Hukou reform on migration, local labor market, education and children left behind.[37] These studies show that the 2014 Hukou reform increased migration rates, decreased the proportion of migrants who leave their children behind, and increased the Hukou registration probability. These empirical findings are broadly consistent with the qualitative predictions of our model.

Note that our policy analysis differs from these types of studies in, at least, two important ways. First, we compute the path that the economy would have taken if the proposed Hukou policies had been in place in 2000. We, therefore, do not provide a retrospective analysis of the impact of the reforms implemented in 2014.[38] Second, our model focuses on long-run adjustments over a 30-year period. Our model is, therefore, not well-suited to make short-term predictions necessary to assess the short-term impacts of the 2014 Hukou reforms.

We conclude that reforms of the current Hukou system are feasible, but require significant tax increases. The magnitude of these tax increases is largely driven by the fiscal externalities provided by migrant households. We have documented that these fiscal externalities arise because migrants contribute more local revenues than are needed to finance the public goods and services that they consume in all major cities. Aggregating these fiscal externality measures at the city level, our estimates of the aggregate fiscal externalities range between 6 and 15 percent of total city revenues. Any reform of the current Hukou system increases expenditures on migrant households which then significantly lowers the fiscal externalities. In the limiting case of full residency rights, migrant households still provide some positive fiscal externalities due to the local revenues generated from new land development. Nevertheless,

[37] See, for example, An Qin, Wu and You (2020) and Xu, Wang, Zhang and Hu (2022).

[38] We also do not predict what will happen in China in the next decades after the actual reforms had been fully implemented in 2020. Such an analysis would require additional assumptions about the current distribution of the housing endowments and, more importantly, future productivity shocks and returns to education.

large increases in local and / or national taxes are required to offset the reduction of the fiscal externalities provided by migrant households.

8. Conclusions

We have explored the impact of local fiscal and migration policies on human capital accumulation and inequality in China. Using a combination of data sets, we have documented that children of temporary migrants have not enjoyed the same access to local public schools as children of residents. Moreover, many migrants leave their children behind with relatives in less developed cities and rural areas. We have shown that children of temporary migrants have obtained a lower quality of education than children of residents. Hence, these children accumulate less human capital than resident children. Given these drawbacks of the current system of migration controls, there is a need to study the feasibility and effectiveness of alternative migration policies that offer the potential of decreasing inequality within China while at the same time promoting growth via increasing the aggregate level of human capital in the economy.

To accomplish this goal we have developed and estimated a spatial equilibrium model that is consistent with the institutional features of fiscal decentralization in China and the restrictions imposed by the current Hukou system. Our empirical analysis suggests that it is feasible to accomplish the policy goals that were formulated by China's State Council in 2016 and to provide equal access to local public goods and services for, at least, 100 million migrants. However, the implementation of these policy changes requires significant tax increases and additional intergovernmental transfers to local governments. These tax increases are necessary since migrants provide large positive fiscal externalities which range

between 6 and 15 percent of total local revenues. Large tax increases are, therefore, required to offset the reduction of the fiscal externalities provided by migrant households. Hence, these reforms require a significant redistribution of resources within the economy.

We would like to point out that the Hukou reforms studied in this paper primarily affect transitory migrants that move from rural areas to tier 3 cities. Recall that our estimate of the educational wedge is .71 for low-skill migrants and .84 for high-skill migrants. Hence, children of temporary migrants experience increases in education quality of 41 and 19 percent, respectively, as they obtain full access to primary and secondary schools in tier 3 cities. Moreover, these children experience an increase in school quality of approximately 100 percent compared to children in rural areas in high school. These increases in educational quality are quite significant and improve the overall access to educational opportunities for the migrants to tier 3 cities. However, the subpopulation, that benefits from these reforms, is too small relative to the overall population of China to have a significant impact on the intergenerational correlation of human capital in the economy. Large inequalities in access to educational opportunities persist after the reforms are implemented. For example, education expenditures in tier 1 cities remain four times as high as educational expenditures in tier 3 cities and more than seven times as high as in rural areas. Equalizing some of these differences would undoubtedly have a much larger impact on the intergenerational persistence of human capital.[39]

This paper provides ample scope for future research. In our model congestion arises in the provision of public goods since we measure public goods as expenditures per capita. There may be other forms of congestion that affect the benefits of local amenities that we have not explicitly modeled. Our policy analysis may overstate the benefits of reforming the Hukou

[39] Golley and Kong (2013) provide an empirical analysis of intergenerational mobility in China.

system if these additional congestion costs are sufficiently large to make it undesirable for tier 2 and tier 3 cities to increase their populations. However, the analyses in Au and Henderson (2006) and Desmet and Rossi-Hansberg (2013) suggest that, if anything, most Chinese cities are currently too small. We have restricted our analysis to mobility across city tiers. Future research should estimate model with a larger choice set and focus on mobility among all cities in China.

We have restricted attention to reforms of the Hukou system that are initiated and financed by the central government. Some local governments may have the desire to extend the provision of local public goods and services to temporary migrants. However, it is almost impossible to engage in serious redistribution at the local level due to the negative externalities that arise from migration (Epple and Romer, 1991). The federal government is in a much better position to cope with these negative externalities. Nevertheless, it would be interesting to endogenize local Hukou policies to study how cities respond to financial incentives provided by the central government. Any dynamic game-theoretic analysis is, however, challenging due to the existing non-stationarities in the economic development in China. Moreover, researchers would need to take a stand on the objectives of the cities balancing the welfare of young and old cohorts. It is not obvious, how local Chinese governments make these types of trade-offs. More research is needed to understand these important research questions.

A. Appendix

A.1. Data Sources

Our analysis relies on several large scale data sets including national-wide household and migrants surveys, census, and city statistical yearbooks.

Micro-level household data is from the 2017 China Household Finance Survey conducted by the Research and Survey Center on China Household Finance. The sample is representative at both the national and province levels and covers all provinces, municipalities, and autonomous regions, except Xinjiang and Xizang. The CHFS sample has around 40000 household observations. It collects detailed information about wage, employment, migration experience, household expenditure, and demographics.

We use their detailed information on migration and wage histories to document the pattern of migration and wage dynamics. CHFS data has unique information on the record of Hukou changes from rural to urban and from one location to another. Migrants with Hukou transfer account for 4.73 percent, a considerable proportion of the total population. The transition of Hukou status is an important feature in our analysis.

The Migrants Dynamic Monitoring Survey (MDMS) is conducted by the China Population and Development Research Center. In this data, migrants are defined as those aged 15-59 years who have moved across counties but have no local Hukou and had been living in local cities for more than one month. We call these "temporary" migrants in our analysis since they have not obtained local Hukou.

The MDMS sample was drawn using the stratified multi-stage random sampling method with the Probability Proportional to Size (PPS) approach. The survey covered 348 cities

from all 32 provincial units in mainland China. The sample provides a good representation of migrants with about 200,000 observations from 10,300 neighborhoods in urban or suburban areas that were randomly selected. The questionnaire includes five sections: demographic information including gender, age, marital status, etc.; socioeconomic status including education, income, and occupational status; migration characteristics; public health and medical services and family planning questions.

The census has been conducted by China's National Bureau of Statistics every 10 years. The data consists of precise information about one's Hukou registration place and current residence for the whole population, and thus can provides a precise picture of migration in China in terms of mobility in different regions and its relationship with education and age. The fifth population census in 2000 adopted a new criterion to define migration. The reference period was changed from one year in previous censuses to six months, placing migrants at their current residence. The 2000 census classifies migrants with considerable spatial precision, helping to capture mobility across township/street committee boundaries. However, the census migration questions do not permit a full assessment of the migrant population because the census has no information on Hukou change. We overcome this problem by taking advantage of the migration information in CHFS and MDMS.

City-level data of GDP, fiscal revenue, education, and other public expenditure come from the City Statistical Yearbook from 2000 to 2017. The City Statistical Yearbook is published by the National Bureau of Statistics based on administrative data. The data is digitalized by an online database CEIC.

The aggregate statistics of 2018 fiscal structure data for central and local governments are from the annual financial report from the Ministry of Finance and the websites of local governments. Data of the detailed balance sheets of local government come from a well-known

online data platform WIND.

A.2. Institutional Background: Hukou System

China's current Hukou system was formally established in 1958 as a means of population registration to control internal migration. Individuals who stay in a location that is not their registered residence, need to acquire a temporary residence permit to get limited access to local public goods and services. By design, the Hukou registration system had a profound impact on the economic development of the People's Republic of China. It restricted labor mobility and, therefore, affected the spatial allocation of labor, capital, and other mobile production factors in the economy.

Before the start of China's transition to a market economy in 1978, the central government formulated and implemented the Hukou policy. Local governments played a limited role during that time. Since the 1990s local governments have gradually been given the power to decide the registration rules under the guideline from the central and provincial governments. As a consequence, Hukou has become a critical policy tool for local governments to manage local public finance and city growth, and to attract investment and high-skilled workers.

Currently, the Hukou status of a person is primarily defined by two characteristics: the location and the type. Location refers to the legal address of the registration. There are two types of residential status, which are commonly referred to as rural (agricultural) and urban (non-agricultural) Hukou. Each citizen is registered at birth. The location and the type of a newborn child are determined by either the mother's or the father's Hukou status.

The Hukou system is managed by the local police department at the township level. It is possible to change the Hukou status from rural to urban in most prefectures. However, the

change of residency status is tightly controlled by local governments, especially in tier 1 and tier 2 cities of the country. To accomplish a change in residency status a person must apply to the local police department. A change is only granted if the person meets certain requirements, which are linked to the following categories: investments, tax payments, real estate purchases, employment status, college status, joining relatives, and special contributions. All tier 1 and most tier 2 cities set high criteria for migrants to obtain local urban Hukou. The requirements of these cities have become more stringent over time. In contrast, lower-tier cities tend to have weaker requirements (Zhang, Wang and Lu, 2019).

Based on the institution of Hukou, one can define the concepts of permanent and temporary migration in China. Temporary migrants are individuals whose place of residence differs from their place of registration. Most rural-urban migrants are temporary migrants. Permanent migrants are those who have changed their registration and obtained an urban Hukou in the new city of residence. It is where an individual is registered, rather than the intended duration of stay, that defines an individual as a permanent or temporary migrant. Previous studies mostly focused on temporary migrants. Taking advantage of the data on Hukou changes of individuals, we can account for permanent and temporary migrants to evaluate the impact of Hukou policy changes on migration decisions and educational achievement.

A.3. Fiscal Decentralization and Tax Sharing Agreements

We have shown that Chinese cities primarily rely on three sources of revenue: 1) own source revenues that arise due to local taxes and fees as well as tax sharing agreements with the central government, 2) revenues from land and housing development, and 3) intergovernmental transfers from the central government. As a consequence, the central government plays a large role in determining city finances. To illustrate the importance of tax-sharing agreements

and intergovernmental transfers, it is useful to consider the aggregate budgets of the central and local governments. For the central government, we focus on the general public budget.[40] Table 15 reports the latest publicly available statistics from the 2018 fiscal year compiled by China's Ministry of Finance.

Table 15 shows that the central government spends 32 percent of total expenditures for public goods and services such as national defense, science and technology, public security and education. In contrast, 68 percent of general budget expenditures are earmarked for transfers to local governments. That is a much larger fraction than in most comparable countries.

Central government revenues mainly come from two sources: 1) domestic value-added taxes and consumption taxes (48 percent), and 2) corporate and personal income taxes (36 percent). As we discuss in more detail below, consumption and income taxes are shared between the central and local governments. We thus conclude that an important role of the central government is to collect revenues and to transfer these revenues to local governments.

Table 15 also presents the aggregate budget of local governments in China. We focus on the two most important local budgets: the general public budget and the government-managed fund.[41] The general budget of local governments is financed by local revenues (54 percent), central transfers (39 percent), and transfers from the government-managed fund (7 percent). In addition, local governments receive significant revenues from the government-managed funds, 76 percent of which comes from the sale of land-use rights.

[40]There are three other budgets: 1) the government-managed fund, 2) the state capital fund, and 3) the social security fund. These three funds are relatively small at the central level of government and do not play a role in our analysis. At the local level, the government fund and the social security funds can be substantial. The state capital funds, which are related to state-owned enterprises, are relatively small at the local and central levels compared with the other three funds. The social security fund is mostly managed by local governments. We ignore state capital and social security funds in our analysis since they do not play an essential role in our model.

[41]The third important budget at the local level is the social security fund which accounted for another 7.7 trillion Yuan in expenditures in 2018.

Table 15: Revenues and Expenditures in 2018

Central Government: General Public Budget		
	Total	Share
Total Revenues	8544	100%
– VAT & Consumption Taxes	4138	48%
– Corporate & Personal Income Taxes	3056	36%
– Other Revenues	1350	16%
Total Expenditures	10238	100%
– Central Spending	3270	32%
– Intergovernmental Transfers	6967	68%
Local Governments: General Public Budget		
	Total	Share
Total Revenues	17990	100%
– Local Revenues	9791	54%
– Intergovernmental Transfers	6967	39%
– From Government Fund	1232	7%
Total Expenditures	18819	100%
– Education	3044	16%
Local Governments: Government-Managed Fund		
	Total	Share
Total Revenues	8580	100%
– Land Sales	6509	76%
Total Expenditures	7747	100%
– Urban Development Related	6814	88%

The unit is billion Chinese Yuan.
Data source: annual report of China's Ministry of Finance, 2018.

Tax sharing agreements between the central and local governments are an essential part of fiscal decentralization in China. These agreements are based on fixed sharing rules. The current structure of tax sharing arrangements goes back to a reform of the fiscal system in 1994. Taxes were classified as central, local, and shared taxes. Table 16 illustrates the taxing sharing arrangement in the fiscal year 2018. Central taxes include customs duties, vehicle purchase taxes, and some consumption taxes. The value-added tax is the main shared tax. Note that VAT tax revenues are shared equally between the central and local governments.[42] Personal and corporate income taxes are also shared taxes. The corporate income tax is 25 percent, and the personal income tax ranges between 5 percent and 45 percent. Local governments receive approximately 40 percent of all income taxes. The progressive nature of the income tax system implies that top-tier cities can generate much higher revenues from income taxes than lower-tier cities. Local taxes also include a variety of real estate and property transaction taxes, land use and urban development tax, and other consumption taxes.

Table 16: Tax Sharing Arrangements

	Central	Local	Share of Taxes	Share of GDP
Central Taxes	100%		20.2%	3.8%
Shared Taxes			67.1%	12.6%
– Domestic VAT	50%	50%	35.7%	6.7%
– Corporate Income Tax	63%	37%	20.5%	3.8%
– Personal Income Tax	60%	40%	8.1%	1.5%
Local Taxes		100%	12.6%	2.4%

Data source: annual report of China's Ministry of Finance, 2018.

Equally important are expenditure assignments between the central and local governments. These assignments determine the responsibility of the central and local governments

[42]The current VAT tax rate is 16 percent.

for the provision of certain public goods and services. Not surprisingly, the central government is primarily responsible for national defense, foreign affairs, and national transportation projects. In contrast, local governments are primarily responsible for education, urban development, social security, health, housing, community affairs, and the environment.

A.4. College Attainment: Robustness Checks

Our model attributes the differences in college attainment to the a lack of access to high-quality local public schools for the children of temporary migrants. Another plausible explanation is that the college admission quota is distributed across geography in favor of residents with local Hukou. Hence, children of households holding a local Hukou of a city with abundant universities (e.g. Beijing, Shanghai) face much less fierce competition. Therefore, it is naturally easier for children with Hukou from these cities to attain a college degree, regardless of the quality of the secondary schools. To assess the importance of this channel, we estimated three additional reduced form models of college attainment as robustness checks. The results are shown in Table 17.

Column I shows our preferred specification of our model while Column II reports the estimates for the same model without controlling for cohort fixed effects and individual characteristics. This version is fairly close to the specification of our structural model. In Column III we have added Hukou province of origin fixed effects to the specification. This allows us to check whether China's province-based admission system affects the probability of going to college as suggested by Yang (2021). In Column IV we also control for city fixed effects. This allows us to test whether the children of households holding a local Hukou of a city with abundant universities (such as Beijing or Shanghai) have higher college attainment.

Our findings suggest that the key estimates of the model are robust to these changes in the

Table 17: Marginal Effects of Children College Attainment

	I	II	III	IV
Permanent Migrant	0.055	0.036	0.046	0.026
	(0.046)	(0.045)	(0.047)	(0.051)
Temporary Migrant	-0.158	-0.187	-0.155	-0.168
	(0.053)	(0.0.052)	(0.055)	(0.0.059)
Head College	0.288	0.317	0.287	0.279
	(0.017)	(0.015)	(0.017)	(0.017)
Origin Tier	Y	Y	Y	Y
Destination Tier	Y	Y	Y	Y
Cohort Fixed Effects	Y	N	Y	Y
Hd. Characteristics	Y	N	Y	Y
Origin Province	N	N	Y	N
Origin City	N	N	N	Y
Pseudo R2	0.154	0.123	0.170	0.197
Observations	5249	5249	5244	5133

Note that the sample is based on the CHFS 2017.

model specification. In particular, the estimates for permanent migrants are all statistically insignificant. The estimates for temporary migrants are all negative, statistically significant, and of similar magnitude. We thus conclude that parental skills, migration status, as well as fixed effects for city-tiers of origin and destination are the most important variables explaining college attainment in our sample.

A.5. Agricultural Income from Land Use in Rural Areas

Here, we discuss how to calibrate the ownership shares retained by migrants from rural areas, denoted by λ_k. The CHFS allows us to break down a household's income by source. The upper panel of Table 18 shows our estimates of the fraction of net annual income from agricultural land use for households with different migrations status and skill levels.

Table 18: Share and Level of Income from Agricultural Land Use

Migration Status	Temporary With Child	Temporary Child Left Behind	Permanent All	Resident All
	Agr. Income Share			
Low-skill Migrant	9.0	13.6	3.9	22.8
High-skill Migrant	2.6	2.1	0.46	2.6
	Agr. Income Level			
Low-skill Migrant	2261	3777	4101	8852
High-skill Migrant	1264	1682	889	3086

Note: All households were born in a rural area. All statistics are based on CHFS 2017.

We find that rural residents obtain approximately 23 percent of their income from agriculture, temporary migrant families receive 14 percent from agriculture if they leave their children behind, and 9 percent if they bring their children along. Permanent migrants receive only 4 percent of their income from agriculture. High-skill households only receive a negligible fraction of their income from agriculture, which suggests setting $\lambda_1 = 1$ The lower panel of Table 18 also reports the total annual income from agriculture. It suggests that for low-skill households that move without children $(1 - \lambda_0) = 3777/8852 = 0.43$. Hence, $\lambda_0 = 0.57$.

A.6. Goodness of Fit: Revenues, Expenditures, and GNP

Table 19 reports the goodness of fit of our model for revenue shares, expenditures, and GNP per capital. Note that these moments are not targeted in estimation and thus provide some additional validation tests of our model. Overall, we find that model fits these additional dimensions of the data well.

Table 19: Model Fit: Revenue Shares, Expenditures and GNP

	Revenue Shares					
	Income Tax		Housing Tax		Transfers	
	Data	Model	Data	Model	Data	Model
Tier 1	0.34	0.39	0.35	0.34	0.31	0.27
Tier 2	0.24	0.36	0.45	0.22	0.31	0.42
Tier 3	0.16	0.23	0.28	0.19	0.56	0.58
	Expenditures				GNP	
	Education Exp. per Capita		Other Exp. per Capita		per Capita	
	Data	Model	Data	Model	Data	Model
Tier 1	0.198	0.185	1.335	1.002	4.48	4.85
Tier 2	0.072	0.081	0.432	0.437	3.24	3.27
Tier 3	0.051	0.052	0.286	0.260	2.25	2.69
Rural	0.026	0.022	0.115	0.083	0.98	1.17

Note: The data moments based on either the City Fiscal Yearbook or the China Statistical Yearbook. GNP is measured in million Yuan.

A.7. Fiscal Externalities: Robustness Checks

We have argued that migrants provide large positive fiscal externalities to major cities in China. In this section, we provide some evidence that supports the predictions of our model that migrants also provide positive revenue externalities.

Recall that cities have two main sources of own-source revenues: taxes and revenues from land development and housing construction. First, consider tax revenues which primarily consist of consumption and income tax revenues. Local revenues are generated by tax sharing agreements between the local and central governments. We can use data from the CHFS 2017 to gain some insights into differences in local tax payments by Hukou status. Table 20 reports estimates of income tax payments, consumption patterns, and housing purchases of residents and migrants. Again, we distinguish between temporary and permanent migrants. It reports

regression coefficients in Columns (1) - (2) and marginal effects from logit models in Column (3). Each model controls for a variety of socio-economic characteristics and city fixed effects. Column (1) suggests that migrants pay the same amounts of income tax as residents. Column (2) shows that migrants have slightly lower levels of total consumption than residents, but these differences are largely driven by the fact that migrants have to spend a higher income share on housing. Hence, we conjecture that there are only small differences in consumption tax revenues by residency status. Moreover, our model simulations reported above account for these consumption differences.

Table 20: Differences between Migrants and Residents

	Personal Income Tax	Total Consumption	New Housing Purchases
	(1)	(2)	(3)
Permanent migrants	-34	-4156	0.008
	(233)	(1444)	(0.003)
Temporary migrants	-316	-3271	-0.001
	(214)	(1268)	(0.003)
Household characteristics	Y	Y	Y
City Fixed Effects	Y	Y	Y
Observations	13645	17160	16900
R^2	0.4257	0.2937	0.0231

Note: regression coefficients in (1) and (2), marginal effects from logit in (3). The sample is based on the CHFS 2017.

Second, fiscal revenues from land development and new housing construction can account for around 40 percent of local revenues. Since most residents benefited from the initial privatization of the housing stock in the late 1990s, the additional housing demand, therefore, is largely driven by young residents that did not participate in the initial privatization and older residents that want to increase or upgrade their housing consumption. In contrast, migration has increased the population of many coastal cities which created the need for

new housing construction. Hence migrant flows have driven a significant part of new land development and housing construction. Using the CHFS data, we estimate logit models of new housing purchases. Column (3) in Table 20 suggests that permanent migrants are more likely to purchase new housing in a two-year period than residents.

Finally, we provide some evidence regarding the relationship between land development, new housing investment, and population growth in Chinese prefectural cities. The empirical analysis in this section is based on city statistics from 2008-2016. We focus on four outcome variables that measure new housing supply: the value of new land development, the area of new land development, housing prices, and residential housing investments. The data for housing investments are from the China Statistical Yearbook. Housing prices, land sale areas, and land values are from the CEIC database. Note that the outcome variables differ in the number of missing values which explains the variation in sample sizes. We regress each outcome variable on population size controlling for time fixed effects using a log-log specification. Hence the coefficient of the population variable is identified because of differential changes in population growth among the sample of cities. Since population growth may be endogenous, we also report IV estimates using Bartik instruments in Table 21.

We find that there are strong positive correlations between the different measures of land and housing supply and population growth. Since population growth is mainly driven by migration flows, we view these findings as supportive of our main hypothesis that migrants provide positive fiscal externalities. In Table 21, we also estimate the model using Bartik shock to instrument population growth for possible endogeneity problems caused by unobserved productivity shocks. The IV estimates show a much stronger positive relationship between land and housing measures and population growth.

Table 21: Land and Housing Market Development and Population Growth (2008-2016)

	Land Sale Area		Land Sale Value		Housing Price		Housing Investment	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Population	0.279	2.032	1.208	5.757	0.159	1.196	0.835	3.822
	(0.045)	(0.349)	(0.083)	(0.986)	(0.013)	(0.127)	(0.041)	(0.320)
Observations	1,232	1,122	986	896	2,205	2,011	2,764	2,514
Number of cities	248	228	248	228	280	260	280	260
R^2	0.144	0.140	0.346	0.347	0.249	0.244	0.459	0.463
First Stage		Pop		Pop		Pop		Pop
Bartik Shocks		0.1061		0.0727		0.029		0.0306
		(0.018)		(0.014)		(0.003)		(0.003)
Wald Statistics		33		26		76		99

Notes: The data are from the period 2008-2018; all quantities are in logs. Standard errors are reported in parentheses. The sample is based on the China Statistic Yearbook and the CEIC database.

References

An, L., Y. Qin, J. Wu and W. You, "The Local Labor Market Effect of Relaxing Internal Migration Restrictions: Evidence from China," mimeo, 2020.

Au, C.C. and V. Henderson, "Are Chinese cities too small?" *The Review of Economic Studies*, 73 (2006), 549-576.

Bénabou, R., "Heterogeneity, Stratification, and Growth: Macroeconomic Effects of Community Structure," *American Economic Review*, 86 (1996), 584-609.

Bénabou, R., "Tax and Education Policy in a Heterogeneous-Agent Economy: What Levels of Redistribution Maximize Growth and Efficiency?" *Econometrica*, 70 (2022), 481-517.

Bosker M., S. Brakman and H. Garretsen, "Relaxing Hukou: Increased Labor Mobility and China's Economic Geography," *Journal of Urban Economics*, 72 (2012), 252-266.

Bryan, G. and M. Morten, "The Aggregate Productivity Effects of Internal Migration: Evidence from Indonesia", *Journal of Political Economy*, 127(2019), 2229 - 2268.

Chari, A., E. Liu, S. Wang and Y. Wang, "Property Rights, Land Misallocation, and Agricultural Efficiency in China," *The Review of Economic Studies*, 88 (2021), 1831-62.

Chari, V.V., P. Kehoe and E. McGrattan, "Business Cycle Accounting," *Econometrica*, 75 (2007), 781-836.

Chen, Y. and S. Feng, "Access to Public Schools and the Education of Migrant Children in China," *China Economic Review*, 26 (2013), 75-88.

Coen-Pirani, D. and H. Sieg, "The Impact of the Tax Cut and Jobs Act on the Spatial Distribution of High Productivity Households and Economic Welfares," *Journal of Monetary Economics*, 105 (2019), 44-71.

Demurger, S., M. Gurgand, M., S. Li and X. Yue, "Migrants as Second-class Workers in Urban China? A Decomposition Analysis," *Journal of Comparative Economics*, 37 (2009), 610-628.

Desmet, K. and E. Rossi-Hansberg, "Urban accounting and welfare," *American Economic Review*, 103 (2013), 2296-2327.

Diamond, R., "The Determinants and Welfare Implications of US Workers' Diverging Location Choices by Skill: 1980-2000," *American Economic Review*, 106 (2016), 479-524.

Duranton, G. and D. Puga, "Micro-Foundations of Urban Agglomeration Economies" in *Handbook of Regional and Urban Economics*, (Amsterdam: Elsevier, 2004), 2063-2117.

Epple, D., R. Romano and H. Sieg, "The Intergenerational Conflict over the Provision of Public Education," *Journal of Public Economics*, 96 (2012), 255-268.

Epple, D. and T. Romer, "Mobility and Redistribution," *Journal of Political Economy*, 99 (1991), 828-858.

Epple, D. and H. Sieg, "Estimating Equilibrium Models of Local Jurisdictions," *Journal of Political Economy*, 107 (1999), 645-681.

Fan, Yi, J. Yi and J. Zhang, "Rising Intergenerational Income Persistence in China," *American Economic Journal: Economic Policy*, 13 (2021), 202-230.

Fang, L. and B. Herrendorf, "High-skilled Services and Development in China," mimeo, 2020.

Fernandez, R. and R. Rogerson, "Income Distribution, Communities, and the Quality of Public Education," *Quarterly Journal of Economics*, 111 (1996), 135-164.

Fernandez, R. and R. Rogerson, "Public Education and Income Distribution: A Dynamic

Quantitative Evaluation of Education-Finance Reform," *American Economic Review*, 88 (1998), 813-833.

Fernandez, R. and R. Rogerson, "Equity and Efficiency: An Analysis of Education Finance System," *Journal of Political Economy*, 111 (2003), 858-97.

Golley, J. and S. T. Kong, "Inequality in intergenerational mobility of education in China," *China and World Economy*, 21(2013), 15-37.

Hao, T., R. Sun, T. Tombe and Z. Zhu, "The Effect of Migration Policy on Growth, Structural Change, and Regional Inequality in China," *Journal of Monetary Economics*, 113 (2020), 112-134.

Heckman, J., "China's Human Capital Investment," *China Economic Review*, 16 (2005), 50-70.

Huang, Z., "Peer Effects, Parental Migration and Children's Human Capital: A Spatial Equilibrium Analysis in China," mimeo, 2020.

Kung, J., "Equal Entitlement versus Tenure Security under a Regime of Collective Property Rights: Peasants' Preference for Institutions in Post-Reform Chinese Agriculture," *Journal of Comparative Economics*, 21(1995), 82-111.

Meng, X. and J. Zhang, "The Two-Tier Labor Market in Urban China: Occupational Segregation and Wage Differentials between Urban Residents and Rural Migrants in Shanghai,"

Journal of Comparative Economics, 29 (2001), 485-504.

Moretti, E., "Local Labor Market," in O. Ashenfelter and D. Card, eds,. *Handbook of Regional and Labor Economics*, (Amsterdam: Elsevier, 2011), 1238-1312.

Ngai, R., C. A. Pissarides and J. Wang, "China's Mobility Barriers and Employment Allocations," *Journal of European Economic Association*, 17 (2019), 1617-53.

Piketty, T., Y. Li and G. Zucman, "Capital Accumulation, Private Property, and Rising Inequality in China, 1978-2015," *American Economic Review*, 109 (2019): 2469-2496.

Piyapromdee, S., "The Impact of Immigration on Wages, Internal Migration, and Welfare," *The Review of Economic Studies*, 88 (2021), 406-53.

Tombe, T. and X. Zhu, "Trade, Migration and Productivity: A Quantitative Analysis of China," *American Economic Review*, 109 (2019), 1843-1872.

Wang, Z. and Q. Zhang, "Fundamental Factors in the Housing Markets of China," *Journal of Housing Economics*, 25 (2014), 53-61.

Whalley, J. and S. Zhang, "Inequality Change in China and Hukou Labor Mobility Restrictions," NBER Working Paper 10693, 2013.

Wu, J., J. Gyourko and Y. Deng, "Evaluating Conditions in Major Chinese Housing Markets," NBER Working Paper 16189, 2010.

Wu, W. and W. You, "The Welfare Implications of Internal Migration Restrictions: Evidence from China," mimeo, 2020.

Xu, S., R. Wang, J. Zhang and J. Hu, "Moving Together or Leaving Behind: The Impact of School Enrollment Policy on the Children of Rural Migrants," mimeo, 2022.

Yang, Y., "Place-Based College Admission, Migration and the Spatial Distribution of Human Capital: Evidence from China," mimeo, 2021.

Zhang, H., J. Behrman, S. Fan, X. Wei and J. Zhang, "Does Parental Absence Reduce Cognitive Achievements? Evidence from Rural China," *Journal of Development Economics*, 111 (2014), 181-195.

Zhang, J., J. Fan and J. Mo, "Government Intervention, Land Market, and Urban Development: Evidence from Chinese Cities," *Economic Inquiry*, 55 (2017), 115-136.

Zhang, J., R. Wang and C. Lu,"A Quantitative Analysis of Hukou Reform in Chinese Cities: 2000-2016," *Growth and Change*, 50 (2019), 201-221.