Floating population: migration with(out) family and Chinese economic development*

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Abstract

In developing countries, rural workers who migrate to urban areas face large monetary and non-monetary costs, which gives them an incentive to leave family behind. This option is absent from standard equilibrium models of migration. Using Chinese data from 2000 to 2005, we develop and estimate the first quantitative spatial model in which workers can choose whether to migrate, whether to bring their family, where to go, and how to allocate their consumption across locations. We show that the ability of rural workers to become a "floating population" that consumes partly at origin through remittances was essential for Chinese economic development.

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The literature on developing countries emphasizes both high rural-urban wage gaps, suggesting large individual and aggregate gains from rural-urban migration, and high monetary and non-monetary costs of migration (Gollin et al. 2014, Imbert and Papp 2020, Lagakos et al. 2023). To reduce these costs, many rural migrants leave family dependents behind, a strategy that is particularly attractive when internal migration policies restrict access to public services for migrant families at destination.[1] In China in 2005, the context of our study, the UNICEF (2018) estimated that 59 million (approximately one in five) rural children had been left behind by at least one of their parents by 2015.

Yet, the decision to migrate with or without family is absent from standard economic models of migration, which try to capture the productivity and welfare effects of rural-urban migration (Bryan and Morten 2019, Tombe and Zhu 2019, Lagakos et al. 2023). Quantifying the effect of living conditions and migration policies on the decision to leave family behind, and the effect of migration with and without family on productivity and welfare is challenging because (i) migration decisions respond to economic and policy conditions at origin and destination, (ii) migration flows affect markets at origin and destination, and (iii) existing spatial migration models do not consider family dependents.

To overcome these challenges, we motivate, develop, and estimate a model of family migration in spatial equilibrium. We proceed in four steps. First, we document a number of empirical facts on rural-urban migration in China in the early 2000s, which explain why rural migrants in China are described as a "floating population." We use detailed census data on bilateral migration flows, combined with data on remittances and local consumption of non-tradable goods and services from the nationally representative China Migrants Dynamic Survey (CMDS) and the Longitudinal Survey on Rural Urban Migration in China (RUMiC). We show that rural migrants disproportionately concentrate in high-wage destinations and limit local expenses in these expensive cities by leaving family behind and sending back remittances. These stylized facts suggest that migration choices depend not only on wages and prices at origin versus destination, but also on the relative costs and opportunities of migrating with or without the family.

The second step of our analysis introduces these elements into a quantitative spatial model of location choice. We assume that a rural household is composed of an older and a younger generation, is exogenously born in a location, and can decide to stay or move across a set of urban locations. Our model introduces two novel features in an otherwise standard spatial model: (i) rural households decide whether, *how* (leaving family

[1] A survey of 185 countries shows that 80% of them had policies to reduce rural-urban migration—a fast-growing trend (from 38% in 1996), especially in developing countries (United Nations 2013). They range from land tenure insecurity to registration booklets limiting access to education and health services and under-servicing of migrant settlements (Feler and Henderson 2011, Song 2014, Selod and Shilpi 2021), which impose larger costs on families.

behind or not), and where (which destination) to migrate within a nested structure; and (ii) households optimize their consumption allocation across household members—the old and the young—and across space. In contrast with standard models where all generations move to the city and consumption exclusively takes place at destination, migrant households might decide to leave the younger generation behind and allocate a fraction of their consumption at origin—which increases their incentives to locate in high-wage, high-price destinations. This interaction between the allocation of consumption and the location choice is the key novelty of our theory and a significant quantitative force.

In the third step of our analysis, we estimate the main parameters of the model using plausibly exogenous variation in local prices, wages, and relative migration costs. We first use detailed consumption data to parameterize the consumption allocation across household members, goods, and space. This allows us to derive the price indices and indirect utilities that are relevant to the different options of the location choice program (staying, moving with the family, moving without the family).[2] Second, we use variation in exposure to international trade (Facchini et al. 2019) as an instrument for destination wages to estimate the elasticity of substitution between different locations *conditional on migrating with or without family*. Third, we estimate the elasticity of substitution between migration with and without family using the inclusive value of each migration mode for each origin from the previous step (as in Buggle et al. 2023). We instrument the inclusive value with a predictor of living costs at destination based on geographic constraints to urban sprawl at the periphery of cities, in the spirit of Saiz (2010) and Harari (2020), combined with a gravity structure to capture the "family-friendliness" of migration options across origins. Fourth, we estimate the elasticity of substitution between staying and moving away from origin locations, using exogenous variation in the price of agricultural commodities combined with cropping patterns across origins, following Imbert et al. (2022).[3] As suggested by our stylized facts, we find (i) high substitution across cities, especially for non-family migrants, (ii) a high degree of substitutability across migration modes, and (iii) a lower elasticity of emigration. Overall, this procedure allows us to estimate the three nests—whether, how, and where—of the migration model, an innovation that allows us to recover more realistic bilateral migration costs.[4]

[2]Since we estimate an elasticity of substitution between consuming non-tradables at destination and remitting close to 1, we consider an "overlapping" Cobb-Douglas formulation for preferences. We identify the consumption weights of the Cobb-Douglas utility function using the average consumption allocated to non-tradables and to remittances for households migrating with and without family dependents.

[3]To complete the estimation of the model we also estimate labor demand and land supply elasticity at destination using a shift-share design close to the one developed in Imbert et al. (2022).

[4]We estimate bilateral migration frictions by migration mode—including non-monetary welfare costs, or incompressible expenses induced by a certain living arrangement (e.g., travel or commuting costs) and the associated policy constraints (e.g., access to healthcare)—as the residual that separates our model from the data. This approach follows methods developed in the spatial equilibrium literature (Redding

In the fourth step of our analysis, we use our framework to perform three counterfactual analyses. First we quantify the value of migration without family, by forcing migrants to fully consume at destination. Without the possibility to remit, many rural workers would choose to stay: Rural-urban migration would decrease by 60%, up to 78% in mega cities (above 5 million). As a result, aggregate productivity would decline by 14%. This counterfactual highlights the crucial role of migrants' ability to leave family behind and remit income back home for the Chinese economy. Second, we simulate the effect of a subsidy that would equalize education costs between origin and destination. We show that this subsidy would increase overall migration by 10%, mostly toward otherwise expensive mega-cities. It would also drastically change the composition of migration flows, with a share of family migrants increasing from 19 to 34%. This policy would increase rural residents' (including rural migrants') welfare but decrease urban residents' welfare, due to wage declines in urban areas. By bringing more migrants to productive locations, the policy increases aggregate productivity by 2%. In two further counterfactuals, we show that targeting the subsidy toward smaller cities would reduce these gains to zero, whereas targeting to mega-cities would magnify them. Third, we simulate changes in the non-monetary costs of either family migration only or of both family and non family migration in a way that yields similar increases in migration overall (12%). We show that reducing family-specific migration costs brings welfare gains to rural residents (0.34%) but little productivity gains (0.54%), while reducing costs of family and non-family migration brings larger welfare gains to rural workers (0.41%) and productivity gains (2.19%).

Our main contribution is to provide a novel framework to better understand migration decisions and their effects on productivity and welfare. It includes the decision to bring dependents, which is a key variable of adjustment for households facing large spatial variation in prices and/or policies that reduce migrants' access to public services at destination. We show that the ability for rural workers to become a "floating population" of workers that left their family behind and remitted income at origin was essential for Chinese economic development.

Related literature Our paper contributes to the large literature that explores the nature of frictions to labor mobility in developing countries (e.g., Brandt et al. 2013, Bryan et al. 2014, Ngai et al. 2019, Gai et al. 2021, Adamopoulos et al. 2024, among others), and how these frictions shape aggregate outcomes (Gollin et al. 2014, Bryan and Morten 2019, Tombe and Zhu 2019, Lagakos et al. 2023, Morten and Oliveira 2024). Our paper is closest

and Rossi-Hansberg 2018), which we adapt to a multiple-nest structure (Buggle et al. 2023). We show in Appendix E.3 that estimating different bilateral frictions for migration with and without family is crucial in our setting.

to structural spatial equilibrium models that quantify migration frictions and their effect on aggregate output (Bryan and Morten 2019, Tombe and Zhu 2019, Morten and Oliveira 2024). It is also close to Lagakos et al. (2023), who estimate a structural model where rural households can choose between two types of migration (permanent and seasonal), with different costs and benefits. Our contribution is to develop and estimate a spatial equilibrium model of internal migration with two modes of migration: with and without family, which imply a different allocation of income and consumption across space. The model structure with multiple nests allows for rich substitution patterns between migration modes and destinations.[5] This enables us to consider counterfactuals that go beyond reductions in overall migration frictions and to simulate the effect of education and migration policies that differently affect family and non-family migrants.

Second, our work belongs to the body of research that emphasizes the ties that migrants keep to their origins, through the study of remittances (see Yang 2011, for a review), family left-behind (see Antman 2013, for a review), or temporary migration (see Dustmann and Görlach 2016, for a review). The closest contributions are Lessem (2018), who models the joint life-cycle location choices of spouses to study how wage differentials between Mexico and the U.S. and border enforcement affect the patterns of return migration, and Albert and Monras (2022), who argue that displaced consumption affects the allocation of international migrants across American cities. To our knowledge, neither of these papers, nor the many others surveyed in literature reviews, study how migration frictions may affect family and non-family migrants differently and how the strategic choice to move with or without family affects the spatial distribution of economic activity. Our approach also differs in that most of the previous literature focuses on international migration while we study patterns of internal migration. This context enables us to measure migration flows with and without family between the full set of possible origins and destinations, which is difficult to do in the context of international migration. The Chinese context is important in itself: The UNICEF (2018) estimates that a staggering 59 million children of rural China had been left-behind by at least one parent in 2005, with well-documented negative effects (Li et al. 2015, Démurger and Wang 2016, Fellmeth et al. 2018, Bai et al. 2018, Gao et al. 2022).

Third, our work relates to the large urban economics literature on the role of agglomeration and dispersion forces in disciplining city size (Tabuchi 1998, Au and Henderson 2006, Desmet and Rossi-Hansberg 2013, 2014). For instance, Au and Henderson (2006),

[5]Other papers have used models with multiple nests in the context of international migration. Buggle et al. (2023) study the emigration choice of German Jews fleeing Nazi persecutions using one nest for destination choice and one nest for the choice of leaving Germany. Liu (2023) evaluates the equilibrium response to U.S. immigration policies using a model of international migration in which migrants choose between countries, occupations, and modes of entry.

Desmet and Rossi-Hansberg (2013), and Desmet and Rossi-Hansberg (2014) argue, using system-of-cities models, that (productive) cities are too small in China because of barriers to migration. Our contribution is to point out that migration barriers are not just large, but also biased against family migrants, so that productive cities in China are disproportionately populated by migrants without family. The ability to limit their local expenditures and to send remittances back to the family members left behind explains why, despite migration barriers, China saw the emergence of mega-cities.[6]

1 Data and institutional framework

This section presents the institutional framework, the main data sources, and descriptive statistics about migration patterns and living arrangements in cities. We leave discussions of the empirical strategy and data underlying the identification of the key parameters guiding migration choices to Section 4.

1.1 Migration barriers in China

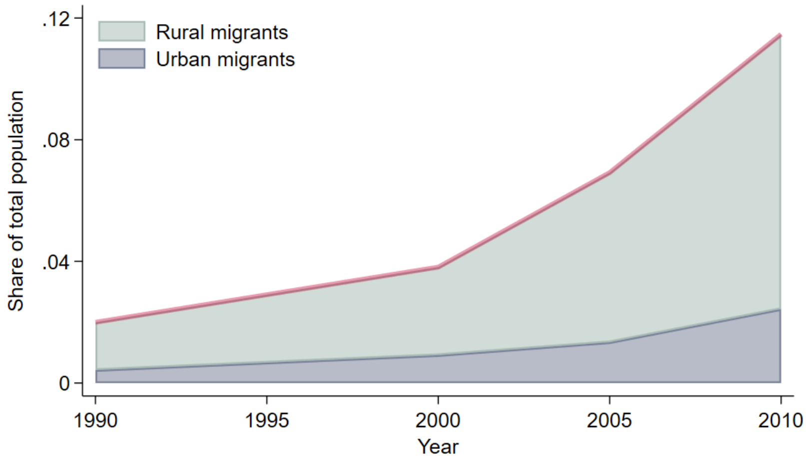
A distinctive feature of the Chinese context is the formal policy restricting internal migration: the *hukou* registration system, introduced in 1958. Between 1958 and the late 1970s, migration was effectively illegal in China unless mandated by the government. In the 1980s and 1990s, with the beginning of the Reform era, migration was tolerated, but essential services such as food provision were still attached to the place of household registration, which severely curtailed individuals' ability to work outside of their places of origin for long periods of time (see, e.g., Zhang et al. 2018). Figure 1 shows that migration between prefectures was limited.

From 2000 onward, our study period, food provision and place of registration became separate, but *hukou* type continued to condition access to public goods. Agricultural *hukou* holders would still have access to land at their registration place, while non-agricultural *hukou* holders would have access to welfare benefits and public services (e.g., enrollment in local schools, healthcare, urban pension plans, and subsidized housing). Due to the growing decentralization of migration policy in the Reform era, this general rule masks considerable variation across locations in terms of *hukou* stringency. In some cities, migrants would need to return to their places of registration for basic services such as education and healthcare or would be charged higher fees at their destination, while access to public services would be more inclusive in others (Song 2014).[7]

[6] A report from the United Nations (2018) identifies 33 cities of at least ten million inhabitants, home to about 12% of the world population, of which 27 were in low and middle income countries and 6 were in China (Shanghai, Beijing, Chongqing, Tianjin, Guangzhou, Shenzhen).

[7] After the end of our study period, in 2014, the central government partly reduced the discretionary

Figure 1. Evolution of the migration rate by *hukou* type.



Notes: This figure represents the internal migration rate in China between 1990 and 2010, using Population Censuses (1990, 2000, and 2010) and the 2005 Mini-Census. A migrant is defined as an individual whose prefecture of residence is different from her prefecture of household registration. "Rural" and "urban" refer to agricultural and non-agricultural *hukou* holders, respectively.

1.2 Migration data

Migration flows Our main data source is the 2005 1% Population Survey (hereafter, "2005 Mini-Census"), which we use to measure migrant flows, returns to labor, and local prices.[8] The sampling frame of the "2005 Mini-Census" is the Public Security Bureau's 2004 population registry and covers the entire Chinese population, regardless of migration status. We use a random 20% extract of the micro-data to characterize each individual's migration situation, based on their current place of residence (the destination), their place of household registration or *hukou* (the origin), their *hukou* type (agricultural or non-agricultural), and their family situation. Information on the date of arrival at destination allows us to create a bilateral prefecture-level matrix of migration flows covering the period 2000–2005. Throughout the empirical sections of the paper, we define a migrant as an individual residing in a different prefecture from their prefecture of registration.[9] According to this definition, 5.6% of the Chinese population in 2005 were internal migrants, most of which (80%) originating from rural areas. Figure 1 puts these

nature of local registration policies and imposed a gradual relaxation of migration restrictions in lower-tier cities (Zhang et al. 2018).

[8]Our analysis also relies on information on population, prices, amenities, and migrant flows from the 1990, 2000, and 2010 Population Censuses, and the "2015 Mini-Census." We mostly use these alternative sources in robustness checks and/or to define baseline characteristics at the local level.

[9]Prefectures are the administrative level between provinces (which are immediately below the central government in the Chinese administrative hierarchy) and counties. There were 345 prefectures in China in 2005. Prefecture boundaries are subject to change; all the data used in this paper are mapped to the 2005 administrative boundaries. In a sensitivity analysis (Appendix B.7), we explore alternative definitions of migration based on the 2005 "Mini-Census" and 2000 Population Census.

rates in perspective using similar data from the 1990, 2000, and 2010 Population Censuses. The migration rate series shows a structural break around 2000, corresponding to China's accession to the WTO (Facchini et al. 2019, Tombe and Zhu 2019), with low and slow-growing migration rates before 2000 and a rapid increase afterward.

Remittances and consumption across locations We capture remittances and the consumption of non-tradables at destination using the Longitudinal Survey on Rural Urban Migration in China (RUMiC 2008–2009, see Akgüç et al. 2014) and the China Migrants Dynamic Survey (CMDS), a nationally representative repeated cross-section conducted by the National Health Commission every year since 2011 (Wang et al. 2021). We use the amount remitted during the past year and divide it by yearly income to obtain an estimate of the share of income remitted by migrants to their households of origin.[10] We similarly define consumption shares of non-tradables at destination, including housing, education, and other services (e.g., medical and transport expenditures at destination).[11]

1.3 Living conditions in cities and rural locations

Wages We use the "2005 Mini-Census" to measure wages in 2005. Information on wages is, however, not available in the 2000 Census; we therefore use average wages from the Statistical Yearbooks to measure returns to labor "at baseline."[12] The yearbooks distinguish between the wage in the "city" proper, i.e., the urban core of the prefecture, and the prefecture as a whole, i.e., including the rural hinterland. We leverage this distinction to measure destination and origin wages differently, using "city" and prefecture wages, respectively.

Rents and housing conditions We use the 2005 Mini-Census to measure the cost of housing and to characterize housing conditions for both migrants and non-migrants in 2005. The data contain a rich housing module, which includes the monthly rent paid, as well as a wide array of housing characteristics. With these data, we create a measure of

[10]The CMDS survey manual prescribes that enumerators include as remittances cash transfers (mailed, wired, or brought back home), in-kind transfers, support for left-behind children, parents, or spouses, and the purchase of various items for household use. However, it does not include investment in businesses or savings for future use at origin (Ashraf et al. 2015); the CMDS measure may therefore provide a lower bound on the share of income that migrants remit. We combine the measure in 2011 with that present in RUMiC (2008–2009) to create a remittance share across 221 destinations (see Appendix A.1).

[11]We provide further descriptive statistics about migration patterns, migrant characteristics, their consumption behavior, and their access to public goods at destination in Appendix A.2.

[12]These data are compiled by the National Bureau of Statistics based on the Reporting Form System on Labor Wage Statistics, the National Monthly Sample Survey System on Labor Force, and the System of Rural Social and Economic Surveys.

rental price at the prefecture level by averaging monthly rent per square meter across all tenants living in private accommodation.

Living arrangements We capture the living arrangements of households in cities by leveraging the household roster module of the 2005 Mini-Census. Our main dichotomy is whether migrants live with any dependent family members at destination or leave them behind in their rural homes. Concretely, we define a family migrant as a household head living with a parent (father, mother, or parents in law) or a child, and the others as migrants without family. We characterize living arrangements in the same way in the CMDS and RUMiC. This measure implicitly assumes that every migrant has either a parent or a child they could bring with them. As an alternative, we use the fertility module presented to every female respondent aged 15–65, which lists all living children and allows us to unambiguously classify mothers as migrants with and without their children. We check that the two measures are strongly correlated, and we provide alternative parameterizations of our model using these different dichotomies.

***Hukou* environment** One of our objectives is to investigate the effect of migration restrictions—their level but also their heterogeneity—on mobility between rural and urban areas and on migrant allocation across destinations. To measure *hukou* stringency, we follow Wu and You (2021) and use census data from 2000 and 2010, which record whether people were born in a different county, whether they were registered locally, and their registration type (agricultural or not). We compute the registration probability as the share of 15–64 year-old work migrants born in another county who were registered locally with a non-agricultural *hukou*: It is low on average and increases only slightly from 9% in 2000 to 12% in 2010.[13]

Amenities Amenities are an important aspect of living conditions in cities. Since they are largely unobservable, we infer them using the structure of the model (Section 4), and assess the validity of our model-based amenity estimates using data on pollution and commuting in 2015—see Appendix A.1 for details about these additional data sources.

1.4 Descriptive statistics

We now provide descriptive statistics about migration patterns in our context.[14]

In Panels A to D of Table 1, we report socio-demographics from the 2005 Mini-Census on urban residents and rural-urban migrants, then separately for migrants with family

[13] In Appendix A.2, we show that registration probability correlates well with indices of *hukou* stringency from Zhang et al. (2018) based on policy documents across 124 Chinese cities. We also use auxiliary survey data to describe what migration restrictions mean for the life of rural-urban migrants, in particular

Table 1. Descriptive statistics.

	Urban non-migrants	Rural-urban migrants All	With family	Without family
Panel A: Demographic characteristics (2005 Mini-Census)				
Age	43.04	31.42	35.93	30.11
Female (head)	0.351	0.358	0.223	0.398
Married	0.872	0.692	0.976	0.609
Number of children	1.447	1.490	1.676	1.430
Number of children (OCP*)	1.138	1.422	1.627	1.357
Panel B: Education (2005 Mini-Census)				
High school (at least)	0.555	0.176	0.135	0.188
College (at least)	0.246	0.020	0.011	0.022
Panel C: Economic characteristics (2005 Mini-Census)				
Income (head, RMB)	1231	1060	1196	1023
Hours worked per week	45.84	55.49	55.26	55.55
Housing share	0.331	0.217	0.236	0.213
Panel D: Living arrangements (2005 Mini-Census)				
Co-inhabitants	2.47	2.85	3.09	2.77
No kitchen	0.091	0.549	0.384	0.596
No toilet	0.189	0.567	0.541	0.575
House ownership	0.789	0.075	0.178	0.045
Panel E: Expenditures (RUMiC)				
Remittance share	–	0.202	0.113	0.280
Non-tradables share (in the city)	–	0.480	0.542	0.424
Panel F: Migration experience (CMDS)				
Age at migration	–	28.56	28.62	28.49
Migration across provinces	–	0.499	0.442	0.562
Panel G: Prospects (CMDS)				
Return migration	–	0.128	0.117	0.157
Hukou conversion	–	0.484	0.497	0.449
Observations (Census)	264,794	59,183	13,327	45,856
Observations (RUMiC)	–	3,931	1,838	2,093
Observations (CMDS)	–	98,916	51,979	46,937

Notes: In Panels A to D, the sample is restricted to household heads aged 15–64 and living in urban areas (2005 Mini-Census). In column (1), we report statistics for urban residents with a local *hukou.* In column (2), we report statistics for people living in urban settings but with a rural *hukou.* Columns (3) and (4) distinguish those having moved with family or not among the latter. Descriptive statistics for *Income (head, RMB)* and *Hours worked per week* are restricted to individuals who reported positive working hours in the past week; *Income (head, RMB)* is monthly income. *Number of children* is available for female respondents (OCP* excludes women who were above 25 when the One-Child Policy was adopted). *Housing share* is based on the predicted outcome from a regression of monthly rent (in log) for respondents renting in commercial housing on prefecture fixed effects interacted with dwelling characteristics. Panel E relies on the Longitudinal Survey on Rural Urban Migration in China in 2008–2009 (see Appendix A): *Remittance share* is the ratio of monthly remittances to monthly income; *Non-tradables share* is the ratio of consumption spent at destination on food, rents, and local (e.g., medical or transport) services to monthly income. The sample in Panels F and G is restricted to household heads aged 15–64 and living in urban areas within the China Migrants Dynamic Survey (CMDS) in 2011. *Migration across provinces* is a dummy equal to 1 if the last migration spell involves crossing a provincial border. *Return migration* is a dummy equal to 1 if the respondent is willing to return to their *hukou* registration place in the future. *Hukou conversion* is a dummy equal to 1 if the respondent is willing to convert their *hukou* to the current destination.

in terms of access to public goods.

[14]We provide additional descriptive statistics about (i) family migration over time, (ii) the geography of immigrant inflows, family migration, and remittances, (iii) the geography of migration restrictions, and (iv) the incidence of return migration in Appendix A.2.

(22.5% of migrants) and without family (77.5% of migrants). Panel A shows that migrants tend to be younger than residents and have more children on average. This is partly due to the One-Child Policy, which allowed rural-*hukou* holders to have a second child when the first was a girl instead of just one for urban-*hukou* holders. Interestingly, migrants who live without family are likely to have children; these children however remain at their location of origin (often with grandparents). Panel B shows that rural-urban migrants are much less likely to have higher education: 18% of migrants have at least a high school degree versus 56% of urban residents. Panel C shows that migrants earn about 15-20% less than urban residents in spite of working much longer hours per week and spend a 34% smaller share of their income on housing.[15] Panel D shows that migrants tend to live in larger households, even when they move without children: They often live in dorm-like accommodation with no kitchen.

We complement this description with data from RUMiC (2008–09), which provide information about expenditures and remittances; and CMDS (2011–12), which provide information on previous and current migration experience, as well as future prospects. In Panel E of Table 1, we report the average share of monthly income devoted to remittances and to non-tradable consumption (food, rents, and local services) in the city. We see that migrants moving with family remit less than those moving without family, they also spend more of their income on non-tradable goods at destination.[16] Interestingly, Panel F shows that migrants with and without family have similar ages at migration but migrants without family are more likely to leave the province. Finally, Panel G shows that few migrants plan to return (an option favored by, on average, only around 13% of all migrants), but many hope to convert their *hukou* to the location at destination if possible (around 49%).[17] Migrants with family are a bit less likely to want to return and more likely to hope to obtain local *hukou*, but differences are small. Overall, we find that, depending on the decision to migrate with or without family, migrants choose different destinations and have different consumption behaviors. We further investigate these differences in the next section.

[15]We derive housing expenditures from rents reported in the "2005 Mini-Census." Migrants and residents do not have the same access to housing markets: Residents often own their dwelling (see Panel D) and have access to subsidized housing; rural migrants typically live in worker dormitories or under more informal rental arrangements at the fringe of cities. This is one reason why we construct a predicted measure of rents, based on common access to commercial housing across groups.

[16]The share of migrants living with family is much higher in RUMiC and CMDS (2011–2012, see Table 1) than in the 2005 Mini-Census. This is not due to a change in migration patterns over time (see Appendix A.2), or to the selected geographic coverage of CMDS or RUMiC. The most likely explanation is that surveys are less able to sample migrants that are less attached to the destination.

[17]One reason why migrants are not *all* willing to convert *hukou* is that there are advantages to holding a rural *hukou* at origin, e.g., land rights (Adamopoulos et al. 2024).

2 Motivating facts

This section establishes a few motivating facts about migrants' location choices, living conditions, consumption patterns, and decision to migrate with or without their family.

2.1 Migrant concentration

To characterize the allocation of migrants across cities, we construct m_c, a measure of migrant concentration relative to urban residents based on census data:[18]

$$m_c = \log\left(\frac{M_c/\left(\sum_d M_d\right)}{R_c/\left(\sum_d R_d\right)}\right),$$

where R_c is the initial population in city c in 2000 and M_c is the number of rural migrants arriving in city c between 2000 and 2005. This measure would be equal to 0 if the allocation of rural migrants were proportional to the resident population, or equivalently, if the immigration rate were constant across cities. Figure 2 shows that this is not the case. Panel (a) displays the relationship between migrant concentration and a measure of (log) nominal monthly wages, w_c, in 2005. The relationship is clearly positive: A 1% increase in the wage is associated with a 2.44% increase in rural migrant concentration.[19] Panel (b) displays the relationship between migrant concentration and a measure of (log) monthly rents in 2005. Again, the relationship is positive: A city with 1% higher rents exhibits a 1.96% higher rural migrant concentration.

2.2 Living conditions in (expensive) cities

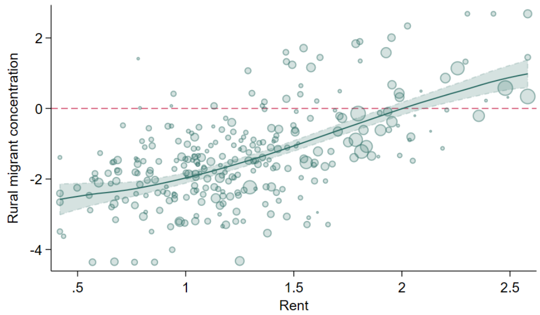
The finding that rural migrants locate in cities with high living costs may seem puzzling, since they are poorer than urban residents. We now investigate *how* rural migrants live in those expensive locations. Panel (a) of Figure 3 shows that rural migrants are about 20 percentage points more likely than urban residents to live without children or parents. Panel (b) shows that they are about 30 percentage points more likely to live in poor quality housing, based on the characteristics of their dwelling (building material, kitchen, bathroom, and toilet type). Importantly, the share of migrants living in precarious conditions strongly increases with housing prices: While rural migrants are as likely as residents to live without family in the cheapest destinations, the difference is around

[18] We discuss migrant concentration using the so-called Zipf law of city size in Appendix B.1.

[19] Appendix B.2 provides more evidence on this relationship. We show that migrants are concentrated in cities where workers work more hours, but are still overly represented in cities with high hourly wages. We also show that rural migrants are concentrated in high-wage, high-rent cities when compared to urban migrants, who may face higher costs of relocating.

Figure 2. Rural migrant concentration, wages, and rents.

(a) Nominal wage



(b) Rent

Notes: The y-axis reports the migrant concentration in city c, m_c. In panel (a), the x-axis reports a measure of (log) monthly wage; in panel (b), the x-axis reports a measure of (log) monthly rent per square meter. Wages and rents are both constructed using the 2005 Mini-Census. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

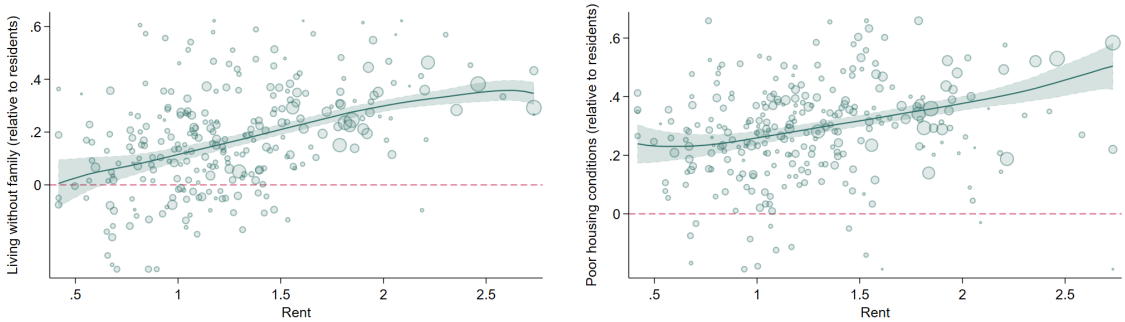
40 percentage points in the most expensive cities; similarly, rural migrants are 20 percentage points more likely to live in low-quality dwellings than residents at the cheapest destinations, and the difference rises to 50 percentage points in the most expensive ones. Hence, rural migrants choose expensive destinations and manage to reduce living costs by moving without family and living in precarious housing conditions.[20]

These differences in living standards (and arrangements) might reflect demographic differences between rural migrants and urban dwellers. In Appendix B.3, we show that rural migrants are younger and less educated than urban residents on average, and more so in high-rent cities. Migrant households and urban residents have similar gender compositions and marriage rates on average, but rural migrants are more likely to be male and single in high-rent cities. These selection patterns do not however explain why migrants are more likely to live without family in expensive cities. Indeed, we can identify mothers from the fertility module of the 2005 Mini-Census, and show that, while they are more likely to live with their children as the rest of the population in cheap locations, they are far less likely to bring them to expensive destinations.[21]

[20] Appendix B.3 provides a sensitivity analysis with other dichotomies for living arrangements, e.g., living with or without any close family members (child, spouse, or parent), with or without children, or with or without spouse. We also study how migrants sort across destinations with different *hukou* stringency, we characterize the dynamics of migration arrangements across cities (Appendix B.5), and we document migrants' intentions and preferences for return migration (Appendix B.6).

[21] The stylized facts reflected in Figures 2 and 3 may be sensitive to our definition of migration. This measure is based on the discrepancy between an individual's place of residence and place of household registration, and thus misses rural migrants who have obtained a local urban *hukou* at destination. In Appendix B.7, we develop alternative definitions based on the 2000 Census and 2005 Mini-Census to show the robustness of the stylized facts to the definition of migration.

Figure 3. Migrants, family, and housing conditions.

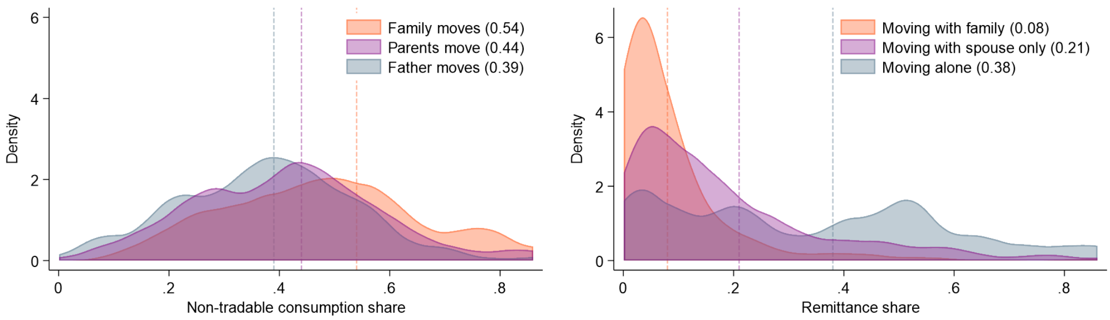


(a) Live without family

(b) Live in low-quality housing

Notes: The x-axis reports a measure of (log) monthly rents constructed using the 2005 Mini-Census. In panel (a), the y-axis reports the difference between the share of rural migrants and the share of urban residents who live without family. In panel (b), the y-axis reports the difference between the fraction of rural migrants and the fraction of urban residents who live in poor housing conditions, based on their dwelling characteristics measured in the 2005 Mini-Census—the index is based on housing material and the types of kitchen, bathroom, and toilet in the dwelling. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

Figure 4. Migrants, remittances, and expenditures on non-tradable goods and services in the city.



(a) "Local" consumption

(b) Remittances

Notes: In panel (a), we report the distribution of non-tradable expenditures at the main place of residence as a share of income (sources: RUMIC, 2008, 2009). In panel (b), we report the distribution of remittances as a share of income; remittances are extracted from RUMIC (2008, 2009) as described in Appendix A.1. In both cases, we distinguish between the subsample of migrants living with family at destination (in orange) versus the subsample of migrants having left their family at origin (in blue).

2.3 Remittances and expenditures on non-tradable goods and services

Rural migrants prioritize high-price locations in which they need to endure difficult living standards. What is the economic rationale for their behavior? Figure 4 shows that rural migrants consume a small share of their income locally, especially when they migrate without their family; the difference across living arrangements in local consumption—as captured by the ratio of expenditures on non-tradable goods and services to income in the city—is around 12 percentage points (panel a). Figure 4 further shows that migrants transfer a substantial fraction of their consumption back to their place of origin (panel b).

Rural workers who migrate without family remit about 28% of their income versus 11% for those living with their family. This transfer of consumption back to origins is large and might explain the high prevalence of migration spells leading to split families: 28% of an urban income is close to a full rural income (see Appendix B.4 for a derivation of the rural-urban wage gap and for a discussion of housing/education expenditures).

These stylized facts explain why rural migrants in China are described as a "floating population." They choose high-wage destinations to maximize nominal income, and they cope with high living costs by leaving their family behind and reducing their consumption of local goods and services, so that they can remit more to their place of origin. In the next section, we develop a spatial equilibrium model of migration decisions that allows migrants to allocate consumption across household members and across locations and to choose between migrating with or without their family.

3 Model

In this section, we introduce a quantitative, spatial model of location choice where rural households take into account the utility of parents and children when choosing where each generation lives and how much they consume.[22]

3.1 Preferences

We assume that the utility of a household χ is given by:

$$U = \mathcal{U}\left(u\left(C^{o}\right), u\left(C^{y}\right)\right) - \bar{u} + \varepsilon\left(\chi\right),$$

where $\mathcal{U}$ aggregates the utility of the older and younger generations, u is strictly increasing and concave, C^{o} represents the consumption bundle of the older generation (denoted with o), C^{y} is the consumption bundle of the younger generation (denoted with y), $\bar{u}$ is a direct welfare cost, which will flexibly capture monetary and non-monetary migration barriers, and $\varepsilon\left(\chi\right)$ is an idiosyncratic taste shock, which we describe below. In our baseline model, we assume that the household utility is a linear combination of utilities across generations:

$$\mathcal{U}\left(u\left(C^{o}\right), u\left(C^{y}\right)\right) = \xi u\left(C^{o}\right) + (1-\xi)\, u\left(C^{y}\right),$$

[22]For simplicity, we assume that urban residents do not move—only rural households are allowed to relocate. We relax the assumption that urban residents are immobile in Appendix C.3. We also assume that there is one type of labor, and we extend the model to multiple labor types in Appendix C.4.

so that household maximization can be decomposed in three separate steps: (i) choosing a living arrangement, (ii) splitting the overall budget across generations, and (iii) choosing a consumption bundle C^g for each generation g. Our baseline model further imposes that $u(C) = \ln(C)$.[23]

A household residing in r chooses between three living arrangements: staying in the rural location, $\ell_o = \ell_y = r$; moving to a certain urban location u but leaving family dependents behind, $\ell_o = u, \ell_y = r$; or relocating the entire family to a city, $\ell_o = \ell_y = u$. This choice shapes their budget constraints through different prices and returns to labor. Indeed, we assume that the consumption basket C is a Cobb-Douglas aggregate of a (perfectly) tradable good and a non-tradable good: A household will thus face different prices, depending on where the different generations live. Letting $\ell = \left(\ell_o, \ell_y\right)$ denote a given living arrangement, we can express the overall household budget constraint as,

$$\mathcal{P}^o(\ell)\, C^o(\ell) + \mathcal{P}^y(\ell)\, C^y(\ell) \leq \mathcal{W}(\ell), \tag{1}$$

where $\mathcal{P}^g(\ell)$ is the price index faced by generation g under living arrangement ℓ, and each living arrangement comes with a different stream of wage, $\mathcal{W}(\ell)$.[24]

3.2 Indirect utility

The indirect utility V associated with living arrangement ℓ is:

$$\ln V(\ell) = \xi u(C^{o*}) + (1-\xi)\, u(C^{y*}) - \bar{u}(\ell) = \ln \mathcal{W}(\ell) - \xi \ln \mathcal{P}^o(\ell) - (1-\xi) \ln \mathcal{P}^y(\ell) - \bar{u}(\ell), \tag{2}$$

which is a function of the wage and a price index, themselves depending on the respective locations of the two generations, and where $\bar{u}(\ell)$ can be thought of as a residual component capturing the welfare cost of migration, of leaving children behind, travel costs, or land (in)security at origin (see, for instance, Brandt et al. 2013, Gollin et al. 2014, Bryan and Morten 2019, Tombe and Zhu 2019, Gai et al. 2021, Adamopoulos et al. 2024).

Our quantitative model further specifies that: $C^o = (C^o_t)^{1-\alpha-\beta}(C^o_n)^{\alpha}(C^o_r)^{\beta}$ and that $C^y = (C^y_t)^{1-\alpha-\beta}(C^y_n)^{\alpha+\beta}$, where: C^g_t is the consumption of the tradable good, C^g_n is the consumption of the non-tradable good for generation g, and C^o_r is a residual consumption of

[23] The baseline model does not explicitly introduce lifecycle considerations, circular migration, or return migration (see, e.g., Lessem 2018), which are limited in our context (see Appendix B.5). We can introduce them with a third sub-utility that represents the utility of the older generation upon retirement, or by interpreting the utility of the younger generation as the future utility stream of the older generation. Another possibility would be to consider both intertemporal choices and different coexisting generations in an overlapping generations framework. We discuss these extensions in Appendix C.2.

[24] $\mathcal{W}(\ell)$ can include the current labor income of the older generation, but also the future labor income of the younger generation, and both quantities can depend on living arrangements. Leaving children behind may harm their educational achievements (Du 2023) and their ability to migrate to cities in the future (Gao et al. 2022). Conversely, human capital accumulation may be more costly in cities than in rural locations.

the non-tradable good for the older generation at origin—which we use to match the fact that even households who migrate with family dependents seem to remit a small fraction of their income. The streams of wages are assumed to be $\mathcal{W}(r,r) = w_r$, $\mathcal{W}(u,r) = \kappa_1 w_u$, and $\mathcal{W}(u,u) = \kappa_2 w_u$, reflecting that (a) parents supply labor inelastically, (b) children do not generate income, and (c) splitting families might lead to a different stream of income than migrating to the city with children, e.g., because of remittance costs or different patterns of working hours across these living arrangements. These hypotheses help us derive the allocation of consumption across the different goods, generations, and locations (see Appendix C.1). Omitting additive constants and assuming that the tradable good is the numeraire, the indirect utility of a household staying in location r is:

$$\ln V_r^s = \ln w_r - (\alpha + \beta) \ln p_r.$$

The same household moving from origin r to destination u, while leaving the children behind, would get the indirect utility:

$$\ln V_{ru}^{m_1} = \ln w_u - \xi\alpha \ln p_u - [\beta + (1-\xi)\alpha] \ln p_r + \ln \kappa_1 - \overline{u}_{ru}^{m_1}.$$

The indirect utility of migrating from r to u with family dependents is:

$$\ln V_{ru}^{m_2} = \ln w_u - [\alpha + (1-\xi)\beta] \ln p_u - \xi\beta \ln p_r + \ln \kappa_2 - \overline{u}_{ru}^{m_2}.$$

These expressions show that bilateral migration costs, $\left\{\overline{u}_{ru}^{m_j}\right\}$, and effective income differences, $\left\{\ln \kappa_j\right\}$, have a similar effect on the common components of household utilities such that one can think of $\left\{\tau_{ru}^{m_j} = \overline{u}_{ru}^{m_j} - \ln \kappa_j\right\}$ as the effective migration costs, which we denote with $\tau_{ru}^{m_j}$ in the rest of the paper.

The previous assumptions on preferences and production imply that migrants who leave family dependents behind have stronger incentives to locate in high-wage, high-price locations. Comparing welfare across these different choices, e.g., the relative utility of migrating without children against staying:

$$\ln V_{ru}^{m_1} - \ln V_r^s = \ln w_u - \ln w_r - \xi\alpha \ln \frac{p_u}{p_r} - \tau_{ru}^{m_1},$$

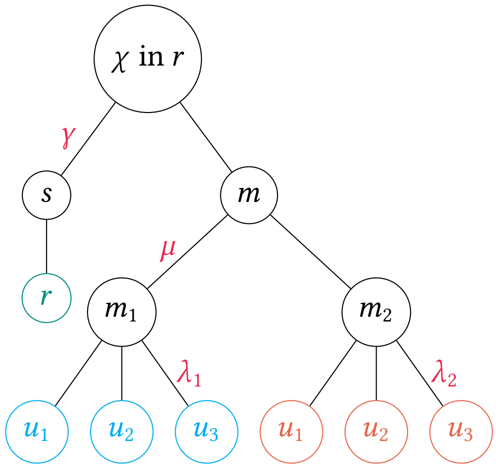
or the relative utility associated with bringing children if migrating:

$$\ln V_{ru}^{m_2} - \ln V_{ru}^{m_1} = -(1-\xi)(\alpha+\beta) \ln \frac{p_u}{p_r} - \left[\tau_{ru}^{m_2} - \tau_{ru}^{m_1}\right],$$

leads to the following lemma, which provides the intuition behind the trade-offs faced by households in choosing their location(s) and living arrangements.

Lemma 1. *Households migrate if real wage differences are high between origin and destination, relative to effective migration costs. When migrating, migrants leave family dependents at origin when the effective migration cost for doing so is relatively low and the difference in the cost of living between rural and urban locations is high—the strength of the latter effect depending on the consumption share allocated to children* $(1 - \xi)$ *and the share of non-tradables in overall consumption* $(\alpha + \beta)$*.*

Figure 5. The nested logit structure.



Notes: The Figure represents the nested structure induced by our assumptions on the distribution of idiosyncratic preferences for relocation, $\varepsilon_{\mathbf{k}}$. The parameter γ is the shape parameter for the upper nest of the generalized extreme value distribution; the parameter μ is the shape parameter for the intermediate nest of the generalized extreme value distribution; and the parameters (λ_1, λ_2) are the shape parameters for the lower nests of the generalized extreme value distribution.

3.3 Location choice

The indirect utility representation allows us to formulate a discrete, nested choice model capturing whether, how, and where households relocate. The program is given by:

$$\max_{\mathbf{k}} \{\ln V_{\mathbf{k}} + \varepsilon_{\mathbf{k}}\},$$

where we rewrite the previous choice of living arrangement as $\mathbf{k}$, a vector capturing whether ($m \in \{0, 1\}$), how ($j \in \{1, 2\}$), and where (u) to relocate. For instance, choosing $\ell = (\ell_o, \ell_y) = (u, r)$ would correspond to migrating ($m = 1$) without family ($j = 1$) to city u. We assume that idiosyncratic preferences for relocation, $\varepsilon_{\mathbf{k}}$, are drawn from a generalized extreme value distribution with a nested structure, organized as follows (see Figure 5 for a graphical representation): The upper nest of the generalized extreme value distribution is about whether the household relocates, and the associated shape parameter is γ; the intermediate nest is about choosing whether to leave family dependents behind or not, and the associated shape parameter is μ; and the lower nests are about location choices with shape parameters (λ_1, λ_2). Given this structure, the probability that household i "j-relocates" from r to u is given by:

$$\pi_{jru} = \left(\frac{V_r^m}{V_r}\right)^{1/\gamma} \left(\frac{V_r^{m_j}}{V_r^m}\right)^{1/\mu} \left(\frac{V_{ru}^{m_j}}{V_r^{m_j}}\right)^{1/\lambda_j}. \tag{3}$$

By the law of large numbers, π_{jru} is also the share of migrants who choose to "j-move" from r to u, which can be decomposed into: the share of households who are born in r and migrate elsewhere, $\left(V_r^m/V_r\right)^{1/\gamma}$; the fraction of households that migrate with living arrangement j among those who migrate, $\left(V_r^{m_j}/V_r^m\right)^{1/\mu}$; and the fraction of those movers choosing city u, $\left(V_{ru}^{m_j}/V_r^{m_j}\right)^{1/\lambda_j}$.[25]

3.4 Production and equilibrium

We now turn to the production side of the economy. First, rural areas produce a freely traded agricultural good following a linear production function $Y_r = Z_r L_r$. Profit maximization implies that $w_r = Z_r$ where w_r is the unit price of labor in rural area r.

Second, we assume that urban areas produce a tradable good that can be freely traded and is produced as follows:

$$Y_u = Z_u L_u^{1-\sigma},$$

where Z_u is productivity, L_u is labor, σ is the elasticity of substitution between factors, and θ is the weight of labor in production.

Profit maximization leads to the following (inverse) labor demand equation,

$$\ln w_u = \ln Z_u + \ln(1-\sigma) - \sigma \ln L_u, \tag{4}$$

where w_u is the unit price of labor in city u.

Third, we assume that the non-tradable good H_u is produced by combining tradable input Y and land—in fixed supply T_u—according to the following production function:

$$H_u = \nu^{-\nu} Y^{\nu} T_u^{1-\nu},$$

where $1-\nu$ captures the importance of land as an input. Profit maximization leads to

[25] The expected value of being born in r, V_r, is given by $V_r = \left[\left(V_r^m\right)^{1/\gamma} + \left(V_r^s\right)^{1/\gamma}\right]^{\gamma}$, where V_r^s is the value of (fully) staying in location r. The expected value of relocating from r is $V_r^m = \left[\sum_{j\in\{1,2\}} \left(V_r^{m_j}\right)^{1/\mu}\right]^{\mu}$; and the expected value of "j-relocating" from r is $V_r^{m_j} = \left[\sum_u \left(V_{ru}^{m_j}\right)^{1/\lambda_j}\right]^{\lambda_j}$.

the following equation:

$$H_u = T_u p_u^{\eta},$$

where $\eta = \nu/(1-\nu)$ is the supply elasticity for non-tradables, and p_u is the unit price of the non-tradable good. This equation captures the standard relation between the supply of housing (or housing services) and housing prices. We can now define an equilibrium:

Definition 1. *The equilibrium is defined by: (a) households decide whether, how, and where to migrate, and migrant flows are given by Equation (3); (b) households decide how much to consume; (c) intermediate producers maximize profits and determine the demand for labor, so that the wage w_u is determined by Equation (4); and (d) markets for the non-tradable good clear to determine the price p_u in each urban location by equating demand and supply.*

3.5 Extensions and reinterpretations of the model

Our baseline model is static.[26] It is however easy to reinterpret the model in a dynamic manner. For instance, we can allow parents to care both about their own utility and the future utility of their children, $\mathcal{U}(u(C^o), u(C^y)) = \xi u(C^o) + (1-\xi)\,\mathbb{E}\,[u(C^y)]$. We can also allow the stream of wages to consist of the older generation's wage and the expected wage of the younger generation, both depending on the location choice. In such extension (E1), we can account for how future wage expectations shape current living arrangements. Higher expected urban wage growth would encourage family migration; conversely, higher expected rural wage growth would discourage migration and induce more migrants to leave their children in the village.

We have, so far, ignored the possibility that rural migrants return to their origins, or that non-family migrants in urban areas eventually manage to bring family dependents to the city. A simple extension of the model with three generations (the old, the mature, and the young) would enable us to discuss family reunification and return migration policies, with a utility function that takes the following form: $\mathcal{U}(u(C^o), u(C^m), u(C^y)) = \xi_o u(C^o) + \xi_m u(C^m) + (1-\xi_o-\xi_m)u(C^y)$. In this extension (E2), we can assume that the household head, when mature, decides on migration options: (i) stay; (ii) migrate as mature with the family dependents and stay in the urban location; (iii) migrate as mature, leaving family dependents behind, and then return when old at origin; and (iv) migrate as mature, leaving family dependents behind, and then reunify the family at destination.

We have also ignored the implications of location choice for human capital accumulation. In extension (E3), we assume that the old generation maximizes the following preferences, $\mathcal{U}(u(C^o), u(C^y), u(C^f)) = \xi_o u(C^o) + \xi_y u(C^y) + \xi_f u(C^f)$, where C^o is the current consumption of the old generation, C^y is the current consumption of the young

[26] This section summarizes a lengthier discussion in Appendix C.2.

generation, and C^f is the future consumption of the young generation. We assume for simplicity that the future consumption of the young generation is linear in their acquired human capital, H, i.e., $C^f = \gamma H$, and that the latter can be chosen by the household. In this alternative model, leaving children behind provides advantages relative to staying or moving with those children: (i) migrating increases the income available to consume and invest in human capital, and (ii) migrants *without children* pay (lower) rural prices for consumption and for investing in the young generation's human capital.[27]

4 Estimation

In this section, we estimate the key parameters of the model: (i) the preference parameters; (ii) the shape parameters of the location choice model (the migration elasticities with respect to conditions at destination, to the mode of migration, and to conditions at origin); and (iii) the two elasticities that govern the response of wages and rents to migrant inflows at destination (the labor demand and housing supply elasticities). The estimation relies on various sources of exogenous variation that we introduce here and describe in greater detail in Appendix D.

4.1 Estimation of the preference parameters

We first discuss how we recover the elements entering the previous indirect utilities—an exercise that we detail in Appendix C.1. With Cobb-Douglas preferences, the optimal allocation of consumption across the different goods and generations implies that a fixed share of income is devoted to each good/generation.[28] In Appendix C.1, we show that observing (a) the total consumption allocated to non-tradables, (b) the remittance shares for households migrating without children, and (c) the remittance shares for households migrating with children is sufficient to recover the relative weight of the old generation (ξ) and the consumption shares (α, β).

The quantities (a), (b), and (c) are described in Section 2.3. Households spend about two thirds of their income on non-tradable goods and services, either in the city or at origin (e.g., $0.54 + 0.11$ for migrants living with family); migrant households transfer 11% back to the origin when migrating with their children; and migrant households transfer

[27] While education quality is probably higher in urban centers than in rural areas, rural migrants do not have free access to urban schools and enroll in informal, low-quality migrant-run private schools or need to incur an array of costly fees (Goodburn 2009, Dang et al. 2020). Hence, the relative educational cost is higher in urban areas for rural children, partly due to *hukou* policies.

[28] We estimate the elasticity of substitution between consuming the non-tradable good across locations in Appendix D.1. We do find limited substitutability in expenses across locations; the elasticity of substitution between consuming at origin and destination is however not too different from 1. For this reason, we opted for a simple Cobb-Douglas structure of preferences in the baseline model.

28% back to the origin when migrating without children. The inclusion of a residual consumption of the non-tradable good at origin for the older generation is motivated by the observation that there are non-negligible remittances observed even when migrating with children. Many households indeed keep older family members at origin, some land, and a house. In Section 5, we further use the allocation of income *within* the set of non-tradable goods and services to estimate the relative weight of education expenditures for children (about 10%, implying that education-related expenditures account for more than two thirds of the non-tradable share $\alpha(1-\xi)$ allocated to the younger generation).

These estimates allow us to identify a unique set of preference parameters ($\alpha = 0.51, \beta = 0.15, \xi = 0.75$), which we use with observed wages and prices across locations to compute real wages associated with the different living arrangements $\{\mathbf{k}\}$.

4.2 Estimation of the location choice model

The location choice model is characterized by three nests and their associated parameters: the lower nest and the associated elasticity of substitution across destinations (λ_1, λ_2); the middle nest, governing how migrants move to cities (μ); and the upper nest, disciplining emigration flows across origins (γ). We estimate these nests sequentially.[29]

The lower nest (λ_1, λ_2) We can write Equation (3) as follows:

$$\ln \pi^c_{jru} = \delta_{jr} + \frac{1}{\lambda_j} \ln V^{m_j}_{ru}, \tag{5}$$

where r is a prefecture of origin, u is a prefecture of destination, and j is the mode of the migration spell (with or without family); and π^c_{jru} is the probability to migrate to u conditional on j-migrating from r. This gravity model has two components: (i) the value of j-migration from r to u, $V^{m_j}_{ru}$, which includes real wages and migration costs; and (ii) the total value of j-migrating from origin r across all destinations, $V^{m_j}_{r}$, which is captured by an origin/mode fixed effect, δ_{jr}.

The identification of (λ_1, λ_2) is challenging. The indirect utility (or the real wage) is affected by migration (a reverse causality that we quantify in Section 4.3); and unobserved destination characteristics, e.g., local amenities, might affect both real wages and immigration flows (omitted variation). We use the distribution of industrial structure before the WTO accession to create an exogenous shifter. More specifically, we construct

[29] Our baseline parameterization relies on a dichotomy of living arrangements including all dependent family members, and on a minimal set of controls. We provide alternative sets of estimated parameters in Appendix Table D.6, where we: (i) estimate the model with a definition of family centered on the presence of children in the migrant's household rather than any dependent; (ii) define living arrangements more tightly by focusing on mothers, for whom we know the location of their *children* (based on a fertility module of the 2005 1% Population Survey); and (iii) add control variables.

migration rates between 2000 and 2005 to measure π^c_{jru}, we use data from the "2005 Mini-Census" on local wages and prices to construct the real wage component of $V^{m_j}_{ru}$, which we instrument with a trade shock computed as in Facchini et al. (2019).

Table 2. The lower nest (λ_1, λ_2).

Migration rate	(1)	(2)	(3)	(4)
Real wage at destination	2.894	11.989	1.124	6.043
	(0.473)	(2.075)	(0.320)	(1.130)
Observations	87,577	87,577	87,577	87,577
Migration mode	$j = 1$	$j = 1$	$j = 2$	$j = 2$
F-stat	-	21.57		13.88

Notes: A unit of observation is a pair of origin/destination prefectures in 2005. The specification uses population weights at origin in 2000. The estimation is a Poisson regression in columns (1) and (3) and a two-stage Poisson regression in columns (2) and (4). Standard errors are reported between parentheses and clustered at the level of destinations. The dependent variable is the (log) emigration rate between 2000 and 2005, computed using the migration module of the "2005 Mini-Census." In columns (1) and (2), the emigration rate is calculated for migrants leaving their family at origin ($j = 1$); the emigration rate is calculated for migrants living with their family at destination in columns (3) and (4) ($j = 2$). The set of controls consists of: (log) population at destination in 2000 and (log) geodesic distance between the origin and destination prefectures. In columns (2) and (4), the (log) real wage is instrumented by a trade shock computed following Facchini et al. (2019)—see Appendix D.2 for: details about data construction and the first stage; and alternative estimates based (i) on different dichotomies for living arrangements and (ii) additional controls.

We present the estimates of λ_1 in columns (1) and (2) of Table 2 and the estimates of λ_2 in columns (3) and (4), which we obtain through a Poisson pseudo-maximum likelihood estimation to take into account the presence of 0s in the migration matrix. Our estimates suggest that a real wage increase of 1% would increase immigration by 12% among non-family migrants and by 6% among family migrants. The elasticity of substitution across alternative destinations is larger among migrants who leave family behind, possibly because they care less about other aspects of living standards at destination.

The estimates of λ_1 and λ_2 can then be used, along with our values for parameters α, β, and ξ, to construct the indirect utilities necessary to estimate the middle and upper nests (following Buggle et al. 2023).

The middle nest (μ) The novelty of our location choice model is to consider the decision of moving with or without family, with implications about the relative sensitivity to conditions at destination. The middle nest of the location choice model implies that the relative incidence of family emigration verifies:

$$\ln\left(\pi^c_{jr}\right) = \frac{1}{\mu}\ln V^{m_j}_r + \iota_j + \theta_r,$$

where π^c_{jr} is the emigration rate of migrants of mode j from origin r, conditional on emigrating from r, ι_j are mode fixed effects, and θ_r are origin fixed effects. The values of migration across different family arrangements ($\ln V_r^{m_j}$) can be retrieved from: (i) the model structure; and (ii) estimates from the lower nest (as in Buggle et al. 2023). In column (1) of Table 3, we report the OLS estimate of $1/\mu \approx 4.2$.

Table 3. The middle nest (μ).

Family migration	(1)	(2)
Relative value	4.245	2.729
	(0.912)	(1.375)
Observations	608	608
F-stat	-	69.38

Notes: A unit of observation is a prefecture of origin r and a migration arrangement j. Standard errors are clustered at the origin level and are reported between parentheses. The specification uses population weights in 2000. The term V_r^m is captured by the addition of origin fixed effects—we also add a migration mode dummy, $\mathbb{1}_{j=2}$. The dependent variable is the emigration rate of migrants of mode j from origin r between 2000 and 2005, computed using the migration module of the "2005 Mini-Census." The explanatory variable is the model-computed value of migration from each origin and family arrangement. In column (2), the instrument is a gravity-based measure, z_{rj}, combining the migration mode with the share of developable land at the fringe potential destinations—see Appendix D.2 for: details about data construction and the first stage; and alternative estimates based (i) on different dichotomies for living arrangements and (ii) additional controls.

The value of moving with or without the family, $V_r^{m_j}$, might be contaminated by measurement error or by omitted variation, for instance, if the lower nest is misspecified or if migrant networks are more extensively used by family migrants, increasing both the probability of family migration and its relative value. To address these concerns, we construct an instrument for the relative value of family migration: intuitively, some origins are closer to cities where the price of local, non-tradable goods are higher for exogenous reasons—a factor that disproportionately reduces the value of migration with family. We find exogenous variation in the price of local, non-tradable goods across destinations by (i) delineating urban areas in 2000 based on satellite imagery and (ii) identifying "non-developable" land within a buffer of potential urban sprawl, s_u (see Appendix D.1). We combine this variation s_u with distance from an origin r to possible destinations u, $\zeta_{ru} = 1/d_{ru}$, in a gravity structure to construct an instrument z_{rj} for the relative value of family migration:

$$z_{rj} = \sum_{u \in U} \zeta_{ru} s_u \times \mathbb{1}_{j=2}.$$

Column (2) in Table 3 presents the IV estimate for μ: a 10% increase in the relative value of moving with the family raises the incidence of family migration by about 27%—which translates into estimates of μ around 0.40.

The upper nest (γ) We use the previous parameters to construct the value of emigrating (V_r^m) relative to the value of staying (V_r^s) and relate it to the relative probabilities of migrating (π_r) and staying ($1-\pi_r$):

$$\ln\left(\frac{\pi_r}{1-\pi_r}\right) = \frac{1}{\gamma}\ln\left(\frac{V_r^m}{V_r^s}\right).$$

In this equation, the value of emigrating V_r^m is a complicated object constructed from middle-nest estimates, which might be affected by measurement error and omitted variation. By contrast, the value of staying V_r^s has a simple representation in terms of (log) real wages at origin, $\ln w_r - (\alpha+\beta)\ln p_r$. We exploit the disparities in real wages induced by different agricultural conditions across origins to isolate exogenous variation in the value of staying: We combine local cropping patterns with innovations in the price of agricultural commodities to capture that origins with highly demanded agricultural products in the early 2000s retained a higher fraction of their population between 2000 and 2005 (as documented in Imbert et al. 2022).

Table 4. The upper nest (γ).

Emigration	(1)	(2)
Relative value of emigration	0.512	1.364
	(0.112)	(0.277)
Observations	304	304
F-stat	-	43.92

Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. The specification uses population weights at origin in 2000. The dependent variable is the relative incidence of emigration between 2000 and 2005, computed using the migration module of the "2005 Mini-Census." In column (2), the instrument interacts cropping patterns in 2000 with the HP-filtered prices of agricultural commodities in 2000 (as in Imbert et al. 2022). See Appendix D.2 for: details about data construction and the first stage; and alternative estimates based (i) on different dichotomies for living arrangements and (ii) additional controls.

We present the estimates of the upper nest in Table 4, which correspond to an elasticity of substitution between staying and migrating of about 1.4. Places that received positive income shocks retain a larger fraction of their population.

The bilateral migration costs (τ) An important factor in the location choice of households is the distribution of bilateral migration costs $\tau(\ell)$, depending on the origin r, the destination u, and the migration mode j. These migration costs can be retrieved from the previous estimates and the model structure, subject to a normalization and without loss of generality (setting such costs to 0 for stayers across any origin r).

These migration costs include travel costs, non-monetary benefits or costs of migrating (including the welfare cost of leaving children behind), and monetary or opportunity costs of living arrangements at destination. One factor behind the distribution of bilateral migration costs is *hukou* policy, which induces significant losses for migrants in the (numerous) destinations with high institutional barriers.[30] We quantify in Section 5 how these frictions shape the extent, nature, and spatial distribution of migration in China.

4.3 Labor demand and housing supply

The last block of the model is production at destination. The (inverse) labor demand elasticity disciplines the response of wages to new arrivals, and the housing supply elasticity disciplines the response of the housing price. To estimate the labor demand elasticity, we use Equation (4) and derive an empirical counterpart as follows. We consider the equation in differences between 2000 and 2005 in order to clean for unobserved, fixed heterogeneity across destinations indexed by u:

$$\Delta \ln w_u = -\frac{1}{\sigma} m_u + \varepsilon_u, \tag{6}$$

where $\Delta \ln w_u$ is the change in (log) wages between 2000 and 2005, $m_u = M_u/N_u$ is the immigration rate during the period. To estimate the elasticity of housing supply, we follow Saiz (2010) and regress the change in (log) rents between 2000 and 2005 on the change in (log) number of households in the same period:

$$\Delta \ln p_u = \frac{1}{\eta} \Delta \ln Households_u + \varepsilon_u, \tag{7}$$

As our model highlights, migrants are responsive to wages and prices at destination, which creates endogeneity concerns for the estimation of both elasticities. To address this concern, we use a shift-share design that closely follows Imbert et al. (2022). More precisely, we instrument immigration in u and changes in households in U using a shift-share that combines shocks to the value of the agricultural portfolio of each origin r based on cropping patterns at baseline and changes in the international price of agricultural commodities (shifts) with the share of migrants from r that went to u at baseline (see Appendix D.2 for more details). We report our preferred estimates for the labor demand and housing supply elasticities in Appendix D.3. The labor demand elasticity is precisely

[30] Appendix D.4 better characterizes the nature of migration costs (τ) and how they relate to actual migration policies by migration mode.

estimated, and close to the one reported in Imbert et al. (2022), $1/\sigma \approx 0.3$. The housing supply elasticity estimate is noisy, but suggests a very high elasticity (3.71), which would be in the top 5th percentile of Saiz (2010)'s estimates for the US.

5 Counterfactuals and discussion

In this final section we quantify the contribution of family with and without migration to rural and urban residents' welfare and to aggregate productivity. In each counterfactual experiment, we implement the same five-step procedure: (i) we translate the experiment into changes to the model parameters; (ii) we compute the counterfactual emigration rates with or without family from each origin to each destination; (iii) we aggregate these flows at the level of each destination to compute counterfactual immigration rates; (iv) we let immigration change urban wages and rents based on estimates from Table D.7; and (v) we recompute the value of migrating to each location and the migration decisions. We repeat these five steps until an equilibrium is reached, i.e., when the maximum deviation of wages and rents across destinations from one iteration to the next is less than 0.1%. We then report migration numbers, the share of family migrants both overall and in mega-cities (above 5 million), the change in rural and urban residents' welfare, and the change in aggregate productivity.

5.1 Displaced consumption via remittances

In counterfactual (1), we shut down the crucial mechanism of displaced consumption by simulating the effect of a prohibitive tax on remittances that forces migrants to consume all their income at destination, irrespective of whether they move with or without their family. We present the effect of this thought experiment in the first panel of Table 5. Without the possibility to remit, migration is overall less attractive: the number of migrants declines from 28.5 million between 2000 and 2005 to around 11.8 millions. The decline is more pronounced for migration without family and towards expensive cities. First, the share of family migrants increases from 19 to 46%—because of the lower reliance of family migrants on remittances and of the high degree of substitution between migration modes. [31] Second, the number of migrants going to large cities sharply decreases, from 14.5 to 3.2 million, with a much larger share of them (55%) going with their family. Third, the welfare of rural-born households (75% of our sample in 2005) decreases by 1.9%, while the welfare of urban-born households increases by 1.7%.[32] Aggregate produc-

[31] Migration without family is still attractive in this counterfactual because family migration is more costly for non consumption-related reasons (e.g. lower amenities or restricted access to public services).

[32] There is a large heterogeneity between residents of smaller cities, whose welfare does not change, and residents of large cities who experience welfare gains of about 5%. We explore the distributional

tivity decreases substantially (-14%), which highlights the economic value of migrants' ability to work in productive cities without paying living costs for their whole family.

Table 5. The role of consumption patterns and migration frictions—counterfactual experiments.

	(1) Baseline	(2) C1	(3) C2a	(4) C2b	(5) C2c	(6) C3a	(7) C3b
Total immigrants (millions)	28.49	11.79	31.49	30.07	30.47	31.41	32.00
% of of family migrants	0.19	0.46	0.34	0.29	0.28	0.35	0.19
Immigrants in cities above 5M (millions)	14.53	3.24	16.11	13.13	17.88	14.21	16.17
% of family migrants in cities above 5M	0.14	0.55	0.31	0.09	0.37	0.19	0.14
Change in rural residents' welfare (in %)	0.00	-1.90	0.35	0.18	0.23	0.34	0.41
Change in urban residents' welfare (in %)	0.00	1.65	-0.39	-0.35	-0.11	-0.47	-0.39
Change in aggregate productivity (in %)	0.00	-13.98	2.19	-0.01	2.68	0.54	2.19

Notes: This Table reports statistics on the extent, nature, and consequences of migration flows in the baseline and in counterfactual experiments (C1: taxing remittances), (C2a: subsidizing education costs), (C2b: subsidizing education costs in non-mega-cities), (C2c: subsidizing education costs only in mega-cities), (C3a: equalizing residual migration costs between family and non family migrants), (C3b: uniform decrease of frictions). The reader interested in additional statistics, i.e., the effect on wages, rents, and the amount that is remitted to rural origins, and in measures of migrant concentration, family migration, and urban winners/losers across cities will find detailed Tables and Figures in Appendix E.1 covering all counterfactual experiments.

5.2 Costs of education for migrants

Many local governments limit migrants' access to public services in general, and to schooling in particular. This can have important effects on the allocation of consumption across generations and across space: Education is a sizable item in a typical household portfolio (around 10% of income), and the "price of a unit of human capital" is high for migrant households in many cities (either because of extra fees or because of the lower-quality of more informal schooling options). Based on our model, we would argue that these policies do not only affect aggregate migration flows, but their nature (family or non-family migration) and direction (where people migrate), with potential important effects on welfare and aggregate productivity.

effects of our counterfactual experiments in Appendix E.1 by showing the difference in the concentration of migrants, immigrant inflows, and welfare gains/losses of urban-born households across cities between the counterfactual and baseline scenarios.

In counterfactual (2a), we implement a subsidy of education costs for the children of rural-born households in urban agglomerations such that they face the same price of a unit of human capital whether they leave children at origin or not. As Table 5 shows, the policy moderately increases aggregate migrant flows from 28.5 to 31.5 million households, but this modest increase hides dramatic changes in migration patterns. First, she share of family migration increases from 19 to 34%. Second, the substitution between migration modes tends to lower the concentration of single migrants in larger cities: the share of family migrants in mega-cities increases from 14 to 31%. Third, the policy has symmetric effects on the welfare of rural residents (+0.35%) and urban residents (-0.39%). However, by bringing more migrants into more expensive, but also more productive cities, the blanket education subsidy increases aggregate productivity by 2.2%.

Part of the rationale for migration restrictions is to avoid congestion of housing and public services in mega cities. From the government point of view, it might make sense to design policies that give incentive for migrant family to settle in medium cities. To test this, counterfactual (2b) implements a targeted subsidy of education costs in all urban agglomerations but the mega-cities above 5,000,000 inhabitants. As Table 5 shows, the policy increases migration overall (to 30 million), and especially family migration (29%), but only in medium-size cities: the targeted subsidy actually reduces the number of migrants in mega-cities (from 14.5 to 13 millions). The targeted subsidy improves rural welfare, but by less than the blanket subsidy because migrants earnings in middle-size cities are lower (see Appendix E for more detail on the distributional impacts). Crucially, since family migrants go to less productive destinations, aggregate productivity does not increase (0.01%).

An alternative government objective could be to attract families in the most productive cities by subsidizing education costs in the mega cities. We simulate the effect of this policy in counterfactual (2c). The total number of migrants increase to levels similar to counterfactual (2b), about 30.5 millions, but the additional flows concentrate on large cities (from 14.5 to 17.9 millions). As a result, the gains in productivity become large, even larger than in the untargeted subsidy case (2.7%). The welfare gains for rural residents are larger, and the welfare losses smaller when the subsidy is targeted at larger than smaller cities.

5.3 Migration frictions

The previous counterfactuals illustrate how consumption choices shape migration patterns. We now study how mode-specific migration frictions $\left\{\tau_{ru}^{m_j}\right\}$ affect migrant households by reducing their utility for a given consumption basket. In counterfactual (3a), we equalize the residual component of utilities between migrating with and without family, i.e., $\tau_{ru}^{m_2} := \tau_{ru}^{m_1}$ for any destination/origin pair (u, r). This counterfactual provides an alternative to experiment (1), which equalizes the consumption component of utilities between moving with or without family. As Table 5 shows, equalizing migration frictions changes the allocation of migrants across migration modes and destinations. First, the share of family migrants almost doubles; the high substitution across migration modes implies that the overall number of migrants only slightly increases. Second, the increase in family migrants is mostly toward cheaper, smaller cities, so that the number of migrants in mega-cities is unchanged. This counterfactual suggests that family-specific migration frictions may increase the number of migrants in the most expensive cities, as the estimated gap between family and non-family migration costs is larger in medium-sized cities.

In counterfactual experiment (3b), we model the effect of reducing frictions for both migration with and without family in the same proportion, corresponding to half of the ratio between them. This change increases the number of migrants a bit further as compared to 3a, but it leaves the composition of migration flows unchanged (19% with family). Importantly, it increases migration to mega-cities in a way comparable to the uniform education subsidy (16 millions), but without changing the composition of migration flows there (14%). The policy increases rural welfare by a bit more than it decreases urban welfare (0.41% vs -0.39%), and increases urban productivity (2.19%).

Taking stock from the previous sections, the quantification of our model shows that the ability of migrants to work in expensive destinations but to consume partly at origin via remittances is instrumental in the large flows of migration observed in China in 2000-2005 and in their contribution to economic growth. We show that policies that make it harder for migrants to public education and public services at destination strongly constrain family migration and impose welfare losses on rural residents, with welfare gains of similar magnitude for the (three times smaller) population of urban residents. We consider different ways to relax these restrictions, and find that education subsidies can be an effective way to increase the share of family migration, which could be targeted towards or away from larger cities, depending on whether governments would want to maximize productivity or decrease congestion of mega cities. A uniform relaxation of migration restrictions across destinations and modes would increase immigration in large cities, with large productivity gains.[33]

[33] This discussion relates to the literature on the fiscal impact of migration. Our approach allows us to discuss how migrants' access to public goods would affect city size (and possibly local expenditures on education and healthcare); it does not, however, consider the equilibrium effect of migrant inflows on local expenditures. Note that migrants do contribute to local finances, directly through individual income tax and indirectly through corporate income tax and value added tax—40%, 40%, and 50% of which, respectively, are redistributed to the local government (Liu 2020). Our findings on the effects of relaxing migration restrictions also relate to the literature on "chain migration" (Cascio and Lewis 2023).

5.4 Discussion

This section summarizes our main findings on: (i) the normative implications of displaced consumption and migration frictions with a focus on their redistributive effects; (ii) model extensions allowing for agglomeration and congestion externalities; and (iii) the quantitative and qualitative insights induced by our precise modeling of migration and consumption choices relative to alternative, standard models of location choice.[34]

Normative implications and redistributive effects The export-led growth in China of the 2000s induced wide disparities in living standards across space—between rural and urban areas, and between booming cities along the coast and cities in the interior. In Appendix E.1, we quantify the welfare implications of the possibility for rural-urban migrants to displace part of their consumption and of migration frictions. We show that the ability to displace consumption acted as a strong progressive force, benefiting a large population of rural households from the hinterlands of booming urban centers at the expense of the residents in such cities. More specifically, it reduced welfare inequalities between urban-born and rural-born households and between residents of different cities; it however increased the welfare disparities across rural-born households, benefiting rural households in the hinterlands of expensive cities. By contrast, equalizing migration frictions across living arrangements (counterfactual 3a) has far more modest welfare implications.

Introducing externalities The heterogeneous growth of cities is possibly disciplined by agglomeration and congestion forces. Our baseline quantitative model only features such forces through the modest (equilibrium) adjustment of labor and housing markets.

In Appendix E.2, we show that agglomeration economies (e.g., through positive production spillovers from rural migrants, as in Combes et al. 2015) or congestion externalities (e.g., through negative spillovers on local amenities) would affect our quantification exercise at the margin. Agglomeration forces imply a slightly larger effect of relaxing migration restrictions on migrant inflows, with more positive welfare implications across the board. Congestion forces have the exact opposite effect. Both externalities have limited bite, because their effects are dwarfed by the other drivers of migration, i.e., the large rural-urban income gaps and the significant bilateral migration costs. The most interesting extension allows for remittances to boost production at origin (as in Pan and Sun 2024, Khanna et al. 2022). This extension increases the social returns to migration, while decreasing its private return. In such a framework, migrants migrate less following the

[34] The reader interested in redistributive effects, the role of externalities, and modeling alternatives can refer to Appendix E.1, E.2, and E.3, respectively.

relaxation of restrictions than with our baseline model, even though the policy would have larger welfare effects, and migration subsidies might be welfare-enhancing.[35]

Sensitivity analysis and alternative migration models In this paper, we develop a location choice model that allows potential migrants to choose whether to migrate or not, how to migrate, and where, and to transfer part of their consumption across household members and across space. In Appendix E.3, we illustrate the quantitative and qualitative insights gained through the adoption of those two novel features by estimating three alternative models: (1) a multinomial model of location choice (as in Bryan and Morten 2019, Tombe and Zhu 2019); (2) a nested model where rural households can decide whether to migrate or not, and where; and (3) a nested model adding the possibility for migrants to remit (as in Albert and Monras 2022). In all these models, we treat family and non-family migrants as two separate populations, thus estimating separate elasticities. We show that these alternative models produce misspecified migration costs and severely underestimate the impact of relaxing migration barriers on the *composition* and direction of migration flows. Even the closest model to ours—model 3—would not capture the substitution across migration modes and the changes in the allocation of migrants across space due to changes in the nature of migration flows.

6 Conclusion

This paper offers a new perspective on migration. While most of the literature has studied how migration costs, sometimes induced by policy, deter migration, we identify a novel impact of such migration barriers. They do not only limit the extent to which people migrate, but also how they migrate. One important reason is that many migrants have families; they can adjust their migration patterns and how they redistribute the proceeds of migration across members and across locations. Typically, migrants face a decision between moving with their families to less expensive locations and moving without their families to expensive, productive locations and remitting a significant share of their earnings.

We make this argument in the context of China, where internal migration policies limit the extent to which rural families can fully migrate to urban areas so that rural

[35] In Appendix E.2, we focus on productivity and amenity spillovers. We could also augment our model with alternative policy-relevant channels based on elasticities to immigration estimated in the literature, e.g., future income losses for left-behind children (Gao et al. 2022), the provision of non-traded services (Cortes 2008), criminality (Abramitzky et al. 2023), or slums (Marx et al. 2013). Particularly interesting applications would allow for externalities that are specific to the migration mode. For instance, from Figure 3, we would expect non-family migration to lower demand for housing quality in destination cities, which may be seen as a negative externality.

migrants are described as a “floating population”. We motivate, develop and estimate a spatial equilibrium model where migrants choose whether, how (with or without family), and where to migrate. Our counterfactual simulations suggest that consumption costs and migration barriers targeted at families did little to reduce the influx of rural migrants into the largest, most congested urban destinations.

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Floating population: migration with(out) family and Chinese economic development

Online Appendix

A Data description

This section provides complements to Section 1: (i) a brief description of our data; and (ii) a lengthy discussion of the allocation of migrants, barriers to migration, and split families across space and over time.

A.1 Living conditions in cities

Apart from data on wages, housing rents, living arrangements, and housing characteristics that we obtain from the "2005 Mini-Census" and describe at length in Section 1, we further capture living conditions in cities using data on remittances and consumption patterns from household surveys, data on pollution from satellite images, commuting data from the "2015 Mini-Census", and additional wage data for years other than 2005 from Statistical Yearbooks. We leave the description of additional data used for identification purposes to Appendix D.

Remittances and consumption across locations We use the Longitudinal Survey on Rural Urban Migration in China (RUMiC, 2008–2009) and the China Migrants Dynamic Survey (CMDS, 2011) in order to measure remittances and the consumption of non-tradables at destination. Both surveys target migrants, which is reflected in their sampling and questionnaires. They do differ, however, in their coverage and quality: CMDS is nationally representative, but the questionnaire is less exhaustive than RUMiC; by contrast, RUMiC only covers 15 cities, but its questionnaire is extremely detailed and tailored to capture the migrant experience in China.[36] For instance, the question about remittances in CMDS can be translated as "The total amount of money you gave to your hometown in the past year", while the same question in RUMiC is divided into several sub-questions: "The total net value of money and commodities brought or remitted back to your hometown this year", to which displaced education fees and other "children-raising" fees can be added. As a result, remittances constructed in CMDS tend to be smaller than those in RUMiC. We thus adjust remittances from CMDS across 221 destinations to match those in RUMiC for the overlapping 14 destinations.

RUMiC presents the advantage of decomposing consumption and investment across 20 categories, which we exploit to shed light on the consumption of non-tradables for migrants living under different arrangements. Finally, RUMiC provides us with two questions, which we do not use for estimation but which lend support to the main hypothe-

[36] Given the absence of a sampling frame, RUMiC selects migrant respondents as follows: (i) they randomly sample enumeration areas within each city, (ii) they list all workplaces within these areas, (iii) they collect information on the number of staff and the number of migrant workers from each workplace, and (iv) they randomly select migrant workers to participate in the survey (Meng and Manning 2010).

ses underlying our quantitative approach: (i) “If you were still in your home village, how much do you estimate you could earn every month?”, allowing us to produce a measure of the rural-urban wage gap (see Appendix B.4, and the associated reference in Section 2.3); and (ii) “What is the main reason why your children do not live with you?”, offering as main reasons “high living cost in city”, “high cost of attending school/kindergarten”, “school or kindergarten cannot be found here”, or “education in hometown is better than here”.

Pollution and commuting Pollution data come from TEMIS satellite images and cover the period 1997–2015 with a 20-25 km resolution. We map raster data on NO_2 concentration, which captures industrial and exhaust gas pollution, to Chinese prefectures to create pollution concentration measures at the prefecture × year level. These measures can be interpreted as a proxy for air quality. We also compute average commuting times at the prefecture level from a random 20% micro extract of the 2015 1% Population Survey. These data allow us to proxy for congestion.

Statistical Yearbooks We use aggregate data compiled by the National Bureau of Statistics based on the Reporting Form System on Labor Wage Statistics, the National Monthly Sample Survey System on Labor Force, and the System of Rural Social and Economic Surveys to extract measures of wages at baseline, in 2000.

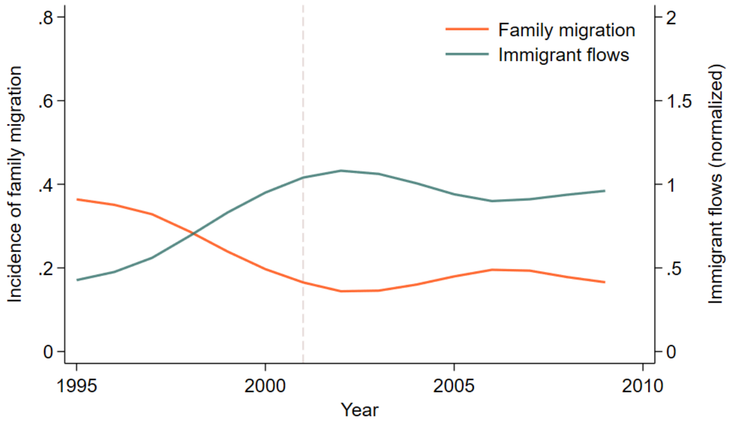
A.2 Descriptive statistics

In this section, we provide complements to the main descriptive statistics discussed in Section 1.4.

Migrant inflows and family migration over time Figure A.1 shows the composition and magnitude of migrant inflows to urban areas between 1995 and 2010. Migrant inflows accelerate around the time of WTO accession, coinciding with other reforms contributing to pushing migrants from rural hinterlands into growing metropolitan areas. After 2000–2001, urban areas experience a steady increase of population, but, more importantly for our purpose, the composition of migrant inflows appears to be stable over time: About 20% of new immigrants to cities are moving with their family.

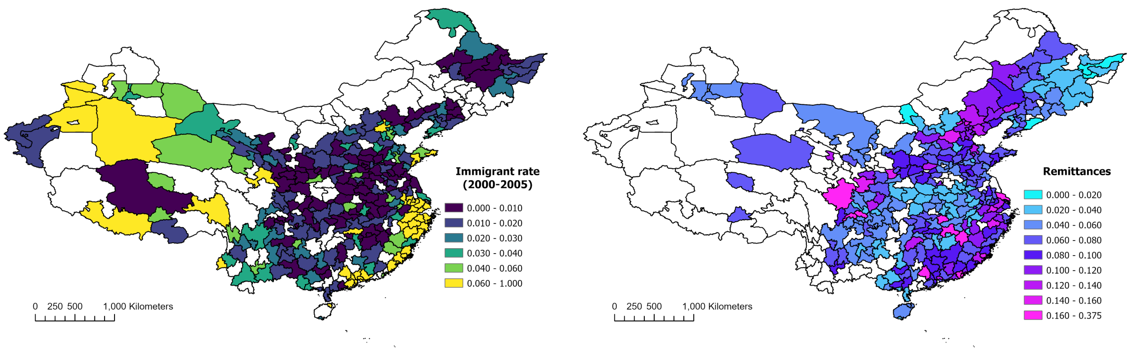
Migrant inflows and remittances across space Figure A.2 displays the geography of migration to cities in China: the allocation of immigrants across space in 2005 in panel (a), and the remittance share across destinations in panel (b). Ignoring the Western, less populated areas, we see that migrants tend to go to large cities (Beijing, Shanghai)

Figure A.1. Migrant inflows and family migration over time.



Notes: This figure shows the composition and magnitude of migrant inflows to urban areas between 1995 and 2010 using Population Censuses (2000, and 2010) and the "2005 Mini-Census." A migrant is defined as an individual whose prefecture of residence is different from her prefecture of household registration. The definition of family migration follows that of our baseline specification (a migrant living at destination with at least a parent or a child). The dashed line indicates the WTO accession of China in 2001. Note that there are two differences with Figure 1: Migration incidence is captured here by yearly flows; migrant flows are normalized by contemporary population in cities and set equal to 1 in 2000.

Figure A.2. Migrant inflows and remittances across prefectures in 2005.



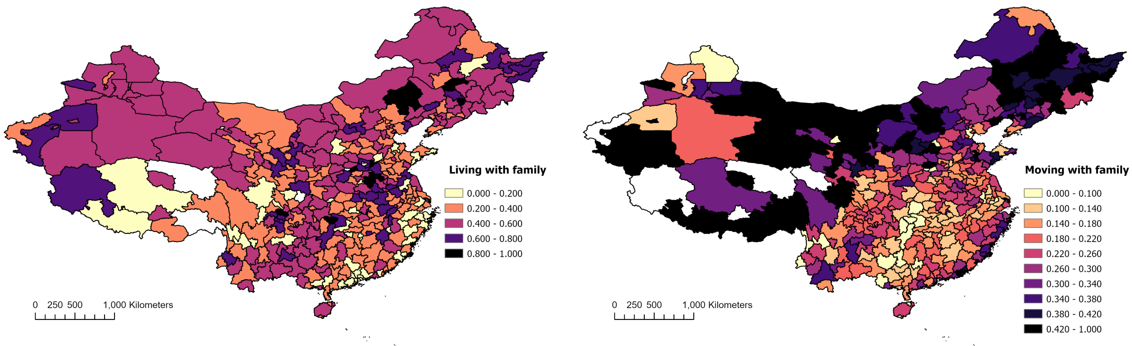
(a) Immigration rate (b) Remittance share

Notes: Panel (a) displays the share of rural-urban immigrants in the 2005 1% Population Survey or "2005 Mini-Census" across urban prefectures. We restrict the sample to urban locations and define rural-urban immigrants as rural-*hukou* holders at those urban locations. Note that the Western regions appear to have large immigrant shares, mostly because those are less populated areas. Panel (b) displays the share of income devoted to remittances across destinations (from CMDS, 2011–2012).

and to the new exporting centers: Tianjin, Fuzhou, and Shenzhen/Guangzhou in the South. From these favored destinations, migrants appear to remit larger fractions of their income (panel b of Figure A.2).

Migration patterns Figure A.3 shows that migration patterns strongly vary across space. First, the spatial distribution of migrants living with family across destinations

Figure A.3. Migration patterns across destinations and origins in 2005.



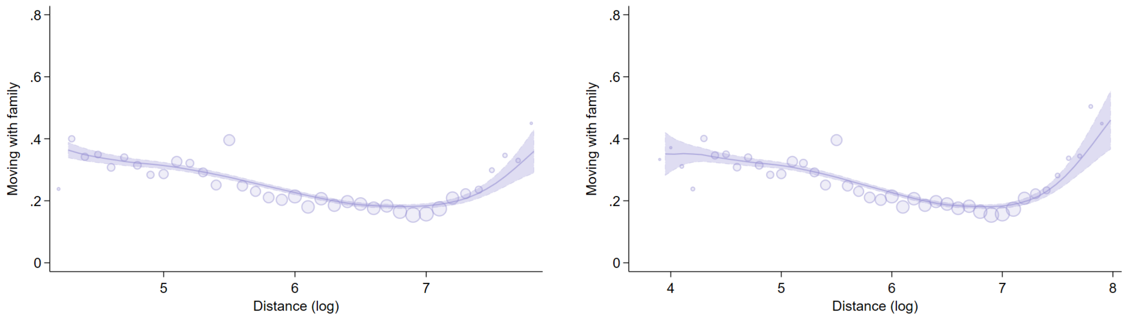
(a) Living with family (destination)

(b) Moving with family (origin)

Notes: Panel (a) shows the variation in migration arrangements across destinations (share of immigrants living at destination with family). Panel (b) shows the variation in migration arrangements across origins (share of emigrants moving with family).

(negatively) correlates with immigrant incidence and with the propensity to remit back to origins: In large cities and new exporting centers, migrants are also less likely to live with family—see panel (a). Second, the previous observation, coupled with the gravity of migration flows, induces spatial disparities in the share of migrants having moved with family from different origins and thus with the incidence of family members left behind by the main breadwinners—see panel (b). These geographic differences are very marked and illustrate a strong spatial heterogeneity in migration patterns across Chinese cities.

Figure A.4. Migration patterns and distance in 2005.



(a) Distance

(b) Travel time

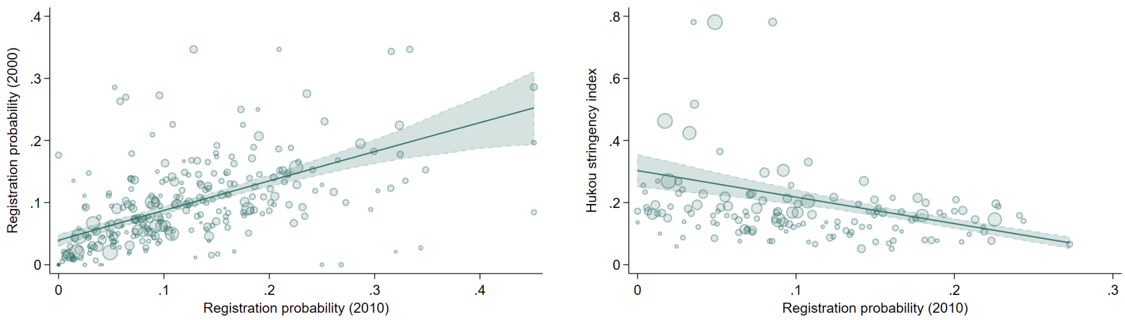
Notes: Panel (a) shows the variation in migration arrangements (share of immigrants living at destination with family) across migration spells implying different geodetic (as the crow flies) distances between origins and destinations. Panel (b) uses instead an indicator of distance based on travel time through the transportation network.

The gravity of migration flows has two distinct implications for the decisions of families to move jointly or remain split between two locations: (i) the proximity to congested locations with strong barriers to family migration induces a higher incidence of split families, for a given distance, as shown in panel (b) of Figure A.3; and (ii) the distance between origins and destinations does predict some of the incidence of the different migration patterns (see Figure A.4). In fact, the former effect is most predictive of family migration: Most population lives in Central China and along the coast, not so far from typical migration destinations, such that the higher incidence of family migration from very distant prefectures (see the right tails in Figure A.4) does not represent more than 1% of all migration spells.

Migration barriers One crucial factor underlying the allocation of migrants and their families across space is the stringency of local barriers to migration (see Section 1.1). In this section, we first describe and compare available measures to capture such barriers. We then show how they reflect migrants' experiences at destination. Finally, we discuss the spatial distribution of *hukou* stringency across cities.

In the counterfactuals that quantify the effects of migration policies (see Section 5.3), we proxy the local regulatory environment affecting immigration with the probability of *hukou* conversion. To create this proxy, we follow Wu and You (2021) and use data from the 2010 Population Census to compute the share of migrants between 15 and 64 years old, having moved for work-related reasons, and born in another county, who were registered locally with a non-agricultural *hukou*. This gives us a city-level measure of the probability for immigrants to convert their household registration at destination; we denote it by r_u.

Figure A.5. Measures of the *hukou* environment.

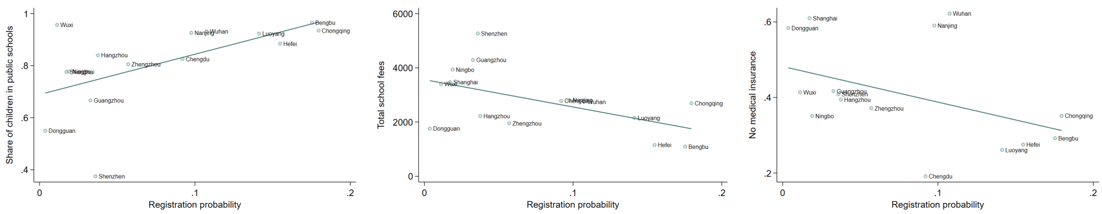


(a) Registration probability, r_u (b) *Hukou* index, h_u

Notes: Panel (a) shows the correlation between the census-based measures of local household registration probability for 2000 and 2010, following Wu and You (2021). Panel (b) shows the correlation between the pre-2014 *hukou* stringency index developed by Zhang et al. (2018) and the household registration probability for 2010. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

We compare this measure of the *hukou* environment with alternative proxies in Figure A.5. Panel (a) plots the registration probability in 2000 against that in 2010 (our main measure), using the 2000 Population Census. We see that the two measures are strongly, positively correlated, which illustrates the presence of inertia in local legislation, despite the fast growth of immigration in that period (see Figure 1). Nonetheless, the majority of prefectures lie below the 45-degree line, which implies that many prefectures eased restrictions on *hukou* conversion between 2000 and 2010. This measure of the *hukou* environment is however a complex equilibrium object, as it is based on observed, and therefore selected, immigration. In panel (b), we correlate our measure of registration probability in 2010 with the composite index from Zhang et al. (2018), denoted by h_u. This index relies on a coding of legislation and policy documents to quantify how easily migrants can obtain local household registration at destination rather than on observed migration and conversion probability. The two measures are strongly negatively correlated, which suggests that they do capture the leniency and stringency, respectively, of the local *hukou* environment.

Figure A.6. Access to public goods and the *hukou* environment.

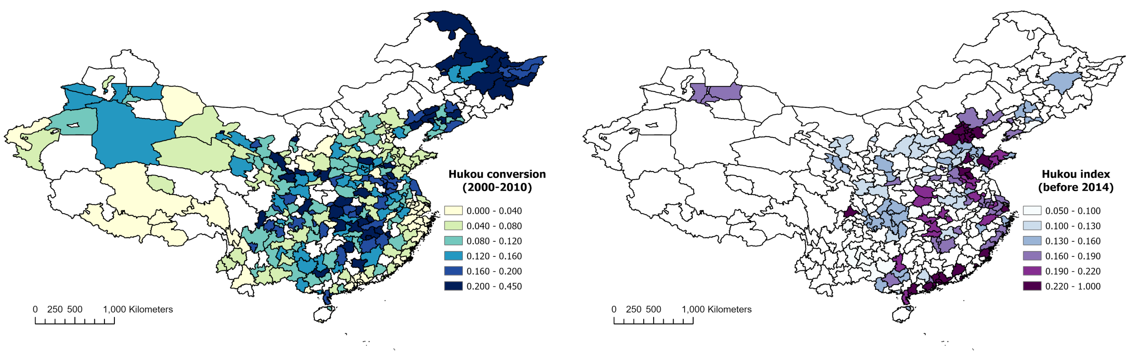


(a) Access to schools (b) School fees (c) Medical insurance

Notes: This figure shows the correlation between measures of access to public goods from RUMiC (2008) and our measure r_u of the leniency of the *hukou* environment, i.e., the city-level *hukou* conversion probability computed from the 2010 Population Census, following Wu and You (2021). A dot is a prefecture of destination. The lines are regression fits estimated with ordinary least squares. "Share of children in public schools" is the share of migrant households' children who attend public schools, conditional on living at destination. "Total school fees" includes tuition fees, the cost of food, the cost of remedial classes taken at schools, and other fees (e.g., school uniform); it excludes sponsorship, boarding, and selection fees. "No medical insurance" is the share of immigrant household heads who do not have any medical insurance. Similar correlations hold with the alternative measure of *hukou* environment h_u from Zhang et al. (2018).

An important caveat of both census- and legislation-based measures is that they rely on *hukou* conversion, which remains a rare event for rural migrants, in particular for the average—low-income, low-education—migrant. Cities typically condition local registration on migrants' meeting a set of stringent criteria, e.g., investing more than one million RMB in an enterprise or having a college degree. In Figure A.6, we leverage the RUMiC (2008) survey of rural-urban migrants, which constitutes a representative survey of migrant workers and their households in 15 cities in nine provinces, to investigate whether our *hukou* environment measure is a good proxy for the experiences of rural migrants at destination, i.e., for their access to public goods. We display in Figure A.6 correlations using the census-based registration probability measure—noting that we find similar correlations (of opposite sign) with the legislation-based *hukou* stringency index. The left panel shows the correlation of the probability for migrants' children (conditional on living at destination) to attend public schools with the *hukou* environment at destination. We see that cities that are characterized by a more lenient stance on migrant *hukou* conversion are indeed less likely to restrict migrants' access to public goods. The middle panel shows that, conditional on going to school at destination, migrants' children pay lower school fees in more liberal *hukou* environments. Migrants have limited access to healthcare in urban China: The right panel shows that immigrants in more stringent *hukou* environments are much less likely to have medical insurance.

Figure A.7. Migration barriers across prefectures.

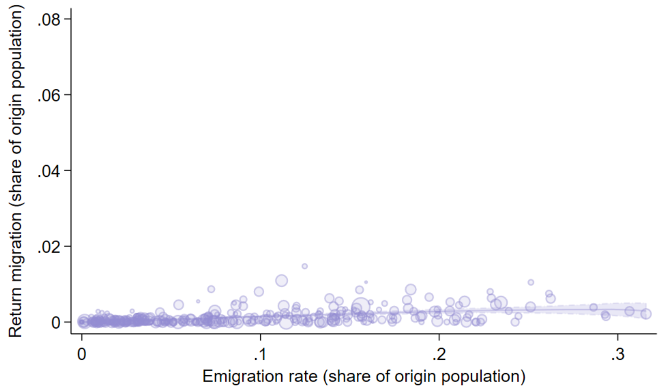


(a) *Hukou* conversion (2010)   (b) *Hukou* index (before 2014)

Notes: Panel (a) shows the variation in *hukou* conversion, r_u—a measure constructed following the procedure developed in Wu and You (2021). Panel (b) uses the composite index capturing the difficulty with which migrants could obtain a local urban *hukou* before 2014, h_u (Zhang et al. 2018).

We finally shed some light on the spatial distribution of barriers to internal migration in Figure A.7 with the measure of *hukou* conversion from the 2010 Census in panel (a) and the composite index capturing the ease with which migrants could obtain a local urban *hukou* before 2014 (Zhang et al. 2018) in panel (b). Migration barriers coincide more or less with the allocation of economic growth during the Reform period. Indeed, the extent to which prefectures constrain access to public services depends on the expected fiscal deficits and (historically) on possible food shortages if they were to allow for migration. Such deficits are thus tied to expected migration (very correlated with local growth prospects) and to fiscal balance and food reserves. In Section 5.3, we exploit the latter to isolate exogenous variation in the allocation of migration barriers across space.

Figure A.8. The incidence of return migration.



Notes: This Figure compares the number of migrants having departed from their origins after 2000 (x-axis) with the number of those having returned between 2004 and 2005 (y-axis) across prefectures.

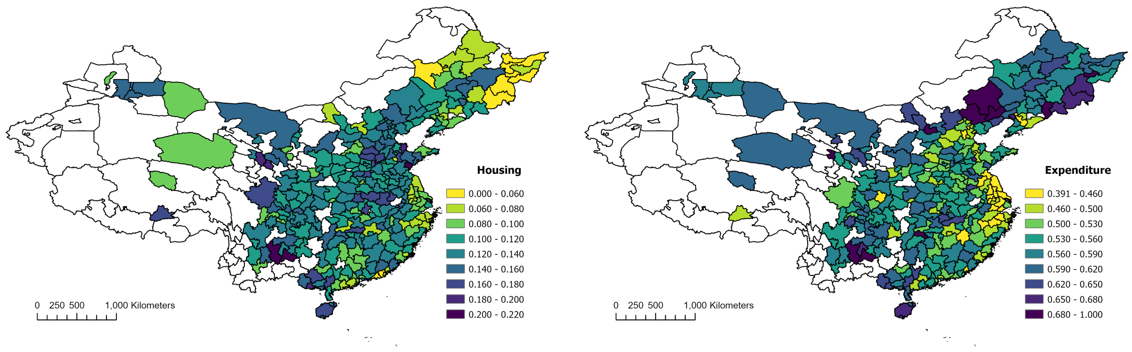
Return migration An intriguing feature of rural-urban migration in China, given the institutional constraints to settling in cities, is the low incidence of return migration. One factor could be the lack of non-agricultural employment opportunities in rural hinterlands (in spite of the effect of remittances documented in Pan and Sun 2024). We quantify the incidence of return migration in Figure A.8, where we compare the number of migrants having departed from their origins after 2000 to the number of those having returned between 2004 and 2005. In rural areas where about 10% of the rural population left during this period, only about 0.3% returned.[37] We further discuss return migration and the prospects of movers in Appendix B.6, where we show that most of them would prefer to stay at destination even when currently leaving the family behind.

Robustness and alternative definitions We finally discuss a few robustness checks. We first provide a sensitivity analysis of Figure A.2 by displaying alternative measures of (displaced) consumption in Figure A.9. We first extract the share of income devoted to housing in panel (a) and find that favored destinations, where migrants appear to remit larger fractions of their income, are also places where they spend less on housing. They do not only spend less on housing: They consume less as a whole. We indeed show in panel (b) of Figure A.9 that the ratio of consumption to income is lower in the most-favored destinations.

In the paper, we use a baseline dichotomy to characterize migration spells and we distinguish migrants living with family (i.e., with at least one parent or child) from mi-

[37] Imbert et al. (2022) further studies the patterns of return migration in the “2005 Mini-Census,” e.g., allowing them to infer the extent of return migration between 2000 and 2005. The conclusion remains that return migration is one order of magnitude lower than migration flows.

Figure A.9. Consumption of non-tradables and expenditure shares of migrants across space.



(a) Housing share (b) Expenditure share (excl. remittances)

Notes: Panel (a) displays the share of income devoted to housing expenditures across destinations (from CMDS, 2011–2012; the measure includes the employer contribution if housing is provided by the employer). Panel (b) displays the ratio of expenditures (from CMDS, 2011–2012; excluding remittances) to income.

grants living without family at their destination. In practice, there are many different arrangements, some involving the migration of one spouse only, others involving both parents—thus leaving children with their grandparents. In Table A.1, we replicate Table 1 and report four other splits of the data: one that distinguishes migrants living with children from those living without children; one that distinguishes female migrants living with children at destination from having left their children at origin (thereby focusing on females with children only, using the fertility module of the "2005 Mini-Census"); one that distinguishes migrants living with any relative from those living without relatives; and one that distinguishes migrants living with a spouse from those living without a spouse. The findings are quite consistent with our baseline dichotomy. Interestingly, we find that migrants who move *alone* are the ones with the largest number of co-residents: They indeed tend to live in dorms or in shared, low-quality accommodation.

Table A.1. Descriptive statistics—living arrangements.

	Children		Children (f)		Spouse		Relatives	
	With	Without	With	Without	With	Without	With	Without
Panel A: Demographic characteristics								
Age	36.08	30.12	35.61	35.40	35.20	29.86	35.13	28.97
Female (head)	0.220	0.397	1.000	1.000	0.095	0.467	0.188	0.471
Married	0.987	0.609	0.992	0.988	0.999	0.566	0.961	0.515
Number of children	1.691	1.428	1.687	1.605	1.433	1.499	1.592	1.437
Number of children (OCP*)	1.643	1.354	1.643	1.530	1.333	1.436	1.508	1.379
Panel B: Education								
High school (at least)	0.133	0.188	0.129	0.105	0.151	0.186	0.146	0.196
College (at least)	0.011	0.022	0.010	0.007	0.014	0.022	0.014	0.024
Panel C: Economic characteristics								
Income (head, RMB)	1,196	1,024	1,186	969	1,175	1,012	1,154	1,000
Hours worked per week	55.32	55.53	55.31	56.11	55.83	55.34	55.61	55.41
Housing share	0.232	0.213	0.226	0.234	0.162	0.230	0.199	0.224
Panel D: Living arrangements								
Co-residents	3.106	2.779	3.281	2.203	2.747	2.893	2.673	2.967
No kitchen	0.388	0.594	0.385	0.541	0.465	0.583	0.444	0.618
No toilets	0.545	0.573	0.544	0.613	0.593	0.556	0.576	0.561
House ownership	0.174	0.047	0.172	0.071	0.115	0.059	0.130	0.039
Panel E: Location characteristics								
City income (RMB)	711	862	715	822	762	857	754	879
Observations	12,952	46,231	9,999	15,388	17,234	41,949	23,525	35,658
	0.218	*0.782*	*0.393*	*0.607*	*0.291*	*0.709*	*0.397*	*0.603*

Notes: The sample is restricted to household heads aged 15–64 and living in urban areas (2005 1% Population Survey). In columns 1 and 2, we distinguish those having moved with children or not (for women with children in columns 3 and 4); in columns 5 and 6, we distinguish those having moved with a spouse or not; and in columns 7 and 8, we distinguish those having moved with any relative or none. Descriptive statistics for *Monthly income (RMB)* and *Hours worked per week* are restricted to individuals who reported positive working hours in the past week. *Number of children alive* is available for female respondents (OCP* excludes females who were above 25 when the One-Child-Policy was adopted). *Housing share* is based on the predicted outcome from a regression of monthly rent (in log) for respondents renting in commercial housing on prefecture fixed effects interacted with various characteristics of the dwelling.

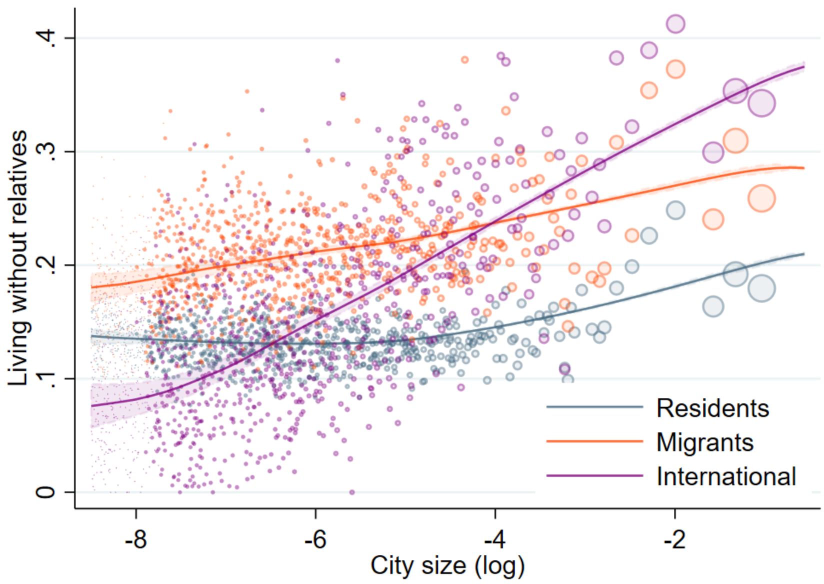
B Complements to the empirical analysis

This section presents some motivational evidence discussed in the introduction and provides complements to Section 2.

B.1 Rural-urban migration across countries

We argue that the patterns observed in China have some similarities with the patterns observed across multiple countries.

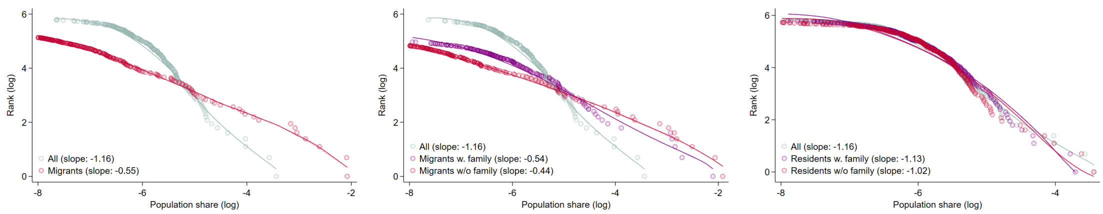
Figure B.1. Living without relatives in urban settings (residents, rural-urban migrants, and international migrants).



Notes: This Figure relies on 149 censuses extracted from IPUMS, for which we observe administrative units at the second level, the location of respondents (rural or urban settings), their migration status (inferred from their location at birth or 10 years prior to the interview), and their living arrangement at destination. The y-axis is the propensity to live without relatives at destination (i.e., alone or in a couple, but without children). The lines are local polynomial fits, where each observation is weighted by population. The dots represent the average across 1,000 bins of (log) relative city size. The relative city size is calculated as the city size divided by the total population across urban areas within a given census wave. The countries covered are: Argentina, Benin, Bolivia, Brazil, Cambodia, Cameroon, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Ghana, Greece, Guatemala, Guinea, Haiti, Honduras, India, Indonesia, Iran, Iraq, Israel, Kyrgyz Republic, Lesotho, Malawi, Malaysia, Mali, Mauritius, Mexico, Mongolia, Mozambique, Myanmar, Nepal, Nicaragua, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Senegal, Sierra Leone, South Africa, Thailand, Togo, Uganda, United States, Uruguay, Venezuela, Vietnam, Zimbabwe.

Living without family Figure B.1 uses data on 149 censuses and 55 countries extracted from IPUMS to show that migrants—defined as having moved to their destination in the past 10 years or inferred from their location at birth in a few censuses—are more likely to live without family than residents. In a selection of these censuses, we do observe a fertility module such that we can verify that it is not related to having children or not, but to the decision to leave the latter in rural areas. Figure B.1 also shows a gradient in the likelihood to live without family as a function of city size: migrants are less likely to live with relatives in larger cities. Finally, these patterns are (much) stronger for international migrants (purple curve).

Figure B.2. The concentration of migrants across Chinese cities.



(a) Migrants and residents (b) Migrants with children (c) Residents with children

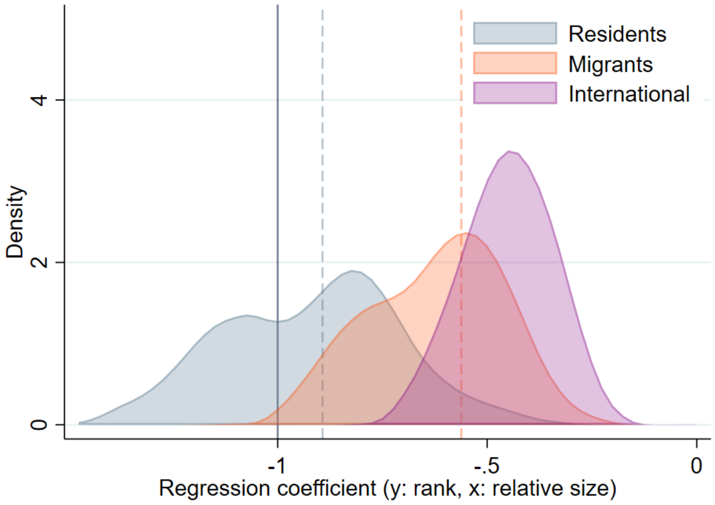
Notes: The x-axis reports (log) population by type (all, migrants, etc.) across prefectures using the "2005 Mini-Census"—note that we normalize the population by type to sum to 1 across all prefectures. The y-axis reports the associated (log) rank of these prefectures. Considering M_c, the rural migrants in city c, $m_c = M_c/(\sum_d M_d)$, and $\log R(m_c) = \alpha + \beta \log(m_c)$, the Zipf law conjectures that $\beta = -1$.

The concentration of migrants across cities We now document the extent to which migrants, especially when they move without family, concentrate in a few cities. To do so, we rely on the so-called Zipf law of city size, which conjectures that (log) population should be linearly related to the associated (log) rank and that the coefficient of such a linear relationship should be -1.

Panel (a) of Figure B.2 shows this relationship *in China* for all urban dwellers (green dots and line) and computed with rural migrants only (red dots and line). While the Zipf law of city size appears to hold for all urban dwellers, rural migrants are (much) more concentrated than the average urban dweller: The (relative) size of the migrant population is three times as large in the most populated city relative to the average urban dweller (panel a). Panel (b) of Figure B.2 shows that migrants without family are even more concentrated—a gradient that is far less obvious when looking at urban dwellers with a local, urban *hukou* (panel c).

The high concentration of migrants in a few cities is not a specific trait of China. In Figure B.3, we show that migrants are more likely to concentrate in larger cities than residents in many contexts other than China—international migrants being even more concentrated than rural-urban migrants. The dashed lines show that China is close to the modes of the distributions.

Figure B.3. The concentration of migrants across cities in other contexts.

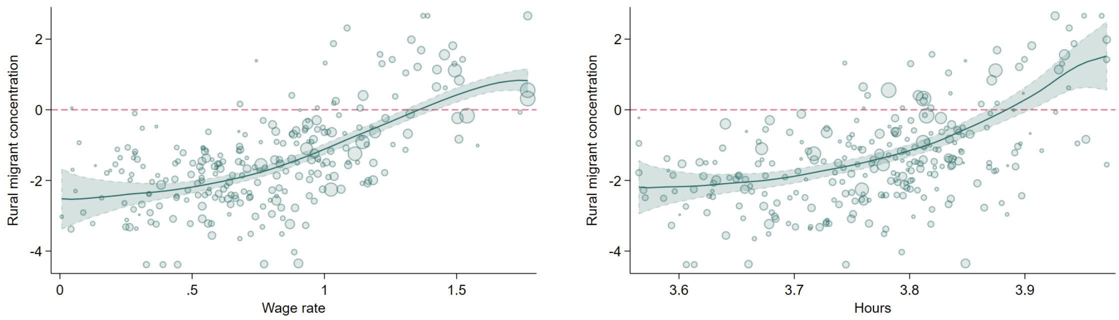


Notes: This Figure reports the distribution of the Zipf estimates, i.e., the coefficient of a regression between (log) population and the (log) rank of cities. The analysis relies on the same 149 censuses extracted from IPUMS, for which we observe administrative units at the second level (see Figure B.1). The dashed lines show the position of China in the corresponding distributions. The countries covered are: Argentina, Benin, Bolivia, Brazil, Cambodia, Cameroon, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Ghana, Greece, Guatemala, Guinea, Haiti, Honduras, India, Indonesia, Iran, Iraq, Israel, Kyrgyz Republic, Lesotho, Malawi, Malaysia, Mali, Mauritius, Mexico, Mongolia, Mozambique, Myanmar, Nepal, Nicaragua, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Senegal, Sierra Leone, South Africa, Thailand, Togo, Uganda, United States, Uruguay, Venezuela, Vietnam, Zimbabwe.

B.2 The sorting of migrants across cities

Our motivating evidence in Section 2 documents that migrants sort into cities where monthly wages are high.

Figure B.4. Rural migrant concentration, hourly wage, and hours worked.

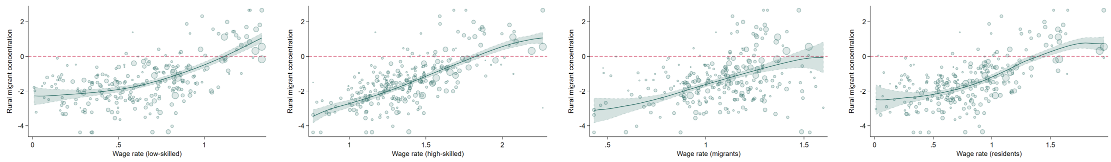


(a) Hourly wage (b) Hours

Notes: The y-axis reports the migrant concentration in city c, m_c, as defined in Section 2. In panel (a), the x-axis reports the (log) hourly wage rate; in panel (b), the x-axis reports a measure of (log) number of hours worked during a normal week. Hours and wages are constructed by aggregating individual responses from the 2005 1% Population Survey. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

Wage rates and hours In Figure B.4, we decompose this finding into two distinct effects: (i) migrants sort into cities where wage rates are high (i.e., the wage adjusted by the number of hours worked during a normal week); and (ii) migrants sort into cities where workers work longer hours. The latter effect is not negligible as workers in "highest-wage" locations appear to work 25-30% more than in the "lowest-wage" locations.[38]

Figure B.5. Rural migrant concentration and various measures of wages.



(a) Low-skilled (b) High-skilled (c) Migrants (d) Residents

Notes: The y-axis reports the migrant concentration in city c, m_c, as defined in Section 2. The x-axis reports different measures of (log) monthly wages constructed using the "2005 Mini-Census": (i) low-skilled average wages in panel (a) based on all workers without a high-school degree; (ii) high-skilled average wages in panel (b) based on all workers with a high-school degree; (iii) migrant wages in panel (c); and (iii) resident wages in panel (d).

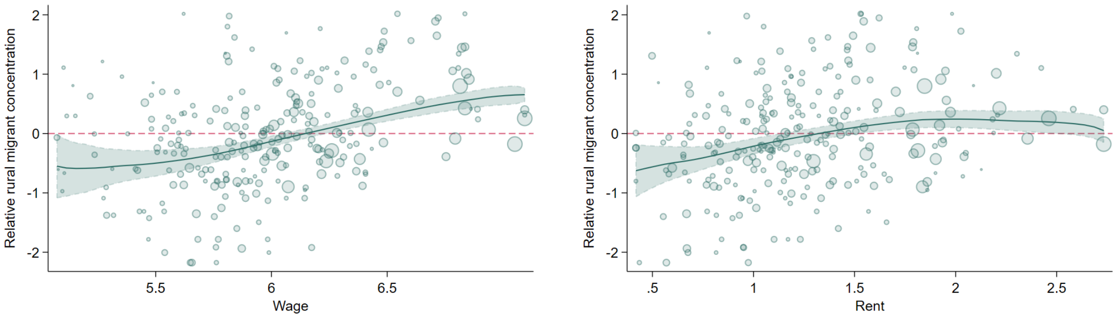
Alternative measures of wages In Figure B.5, we further probe the relationship between migrant concentration and returns to labor by extracting four different measures of wages from the "2005 Mini-Census": a measure of low-skilled wage in panel (a); a measure of high-skilled wage in panel (b); a measure of the average wage earned by rural migrants in panel (c); and a measure of the average wage earned by residents in panel (d). These measures are strongly correlated with each other and thus deliver a very similar message: Rural migrant concentration is higher where wages are higher.

Urban migrants Rural migrants may face lower mobility costs than urban residents when they relocate *across cities*: The latter are already settled and benefit from access to services that would be lost if they were to move to other urban settings (e.g., with higher returns to labor). One corollary of this observation is that urban migrants should be less numerous and their location choices should differ quite markedly from rural migrants'. To document this fact, we construct a measure of relative migrant concentration in city c, rm_c, as follows,

$$rm_c = m_c - \log\left(\frac{U_c / \left(\sum_d U_d\right)}{R_c / \left(\sum_d R_d\right)}\right) = \log\left(\frac{M_c / \left(\sum_d M_d\right)}{U_c / \left(\sum_d U_d\right)}\right),$$

[38]One explanation could be that the substitution effect dominates the income effect for the low-income workers of our context. Another likely explanation is a compositional effect, both in terms of available occupations and in terms of worker characteristics. For instance, migrants typically work longer hours and tend to be over-represented in these high-wage locations.

Figure B.6. Relative migrant concentration and living conditions in cities.



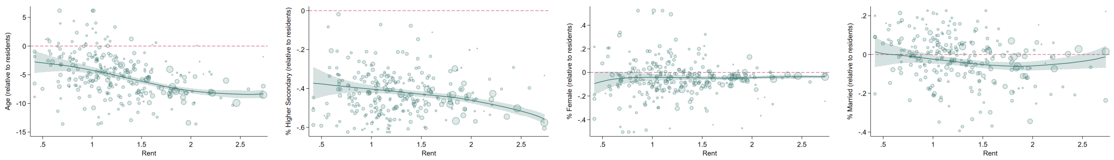
(a) Nominal wage

(b) Rent

Notes: The y-axis reports the relative migrant concentration in city c, rm_c. In panel (a), the x-axis reports the (log) monthly wage; in panel (b), the x-axis reports a measure of (log) rents. Rents and wages are constructed by aggregating individual responses from the 2005 1% Population Survey. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

where U_c denotes the number of urban migrants in city c arrived between 2000 and 2005. This measure would be equal to 0 if migrants were allocated in the same fashion, independently of their registration type (rural or urban). In panel (a) of Figure B.6, we display the relationship between this relative concentration and nominal wages, and we find that rural migrants seem to sort into high returns to labor, and even more so than urban migrants. A percent increase in the nominal wage is associated with a 0.5 percent increase in the relative share of rural migrants. Panel (b) shows the same relationship with our measure of rents.

Figure B.7. The selection of migrants relative to residents in expensive cities.



(a) Age

(b) Education

(c) Gender

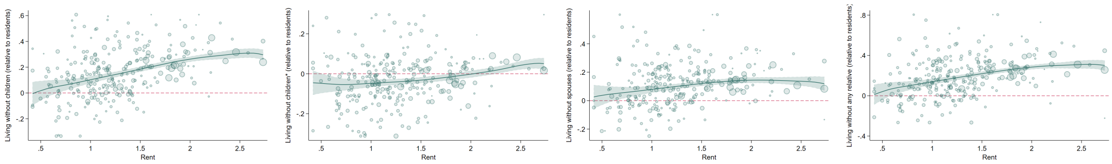
(d) Marriage

Notes: The x-axis reports a measure of (log) monthly rents constructed using the “2005 Mini-Census.” In panel (a), the y-axis reports the difference between the average age of rural migrants relative to that of urban residents. In panel (b), the y-axis reports the difference between the proportion of migrants and the proportion of urban residents who have at least higher secondary education. In panel (c), the y-axis reports the difference between the fraction of migrants and the fraction of urban residents who are female. In panel (d) the y-axis reports the difference between the fraction of migrants and the fraction of urban residents who are married.

B.3 The selection of migrants across cities

Selection along other characteristics We have shown in Section 2 that the selection of rural migrants differs from that of residents across cities subject to different living conditions. For instance, migrants are much less likely to live in decent housing conditions and with children in high-wage/rent locations. In Figure B.7, we further document the selective sorting of migrants across destinations, compared to urban residents. We find that: migrants are younger, and even more so in expensive locations (panel a); migrants are much less likely to have completed high school (panel b); there is no clear gradient between migrant gender and rents, although migrants are slightly more likely to be male (in relative terms) in expensive locations (panel c); and likewise we do not find a strong relationship with marriage status, although migrants are slightly less likely to be married than residents in locations that are more expensive (panel d).

Figure B.8. Migrants and family—sensitivity analysis.

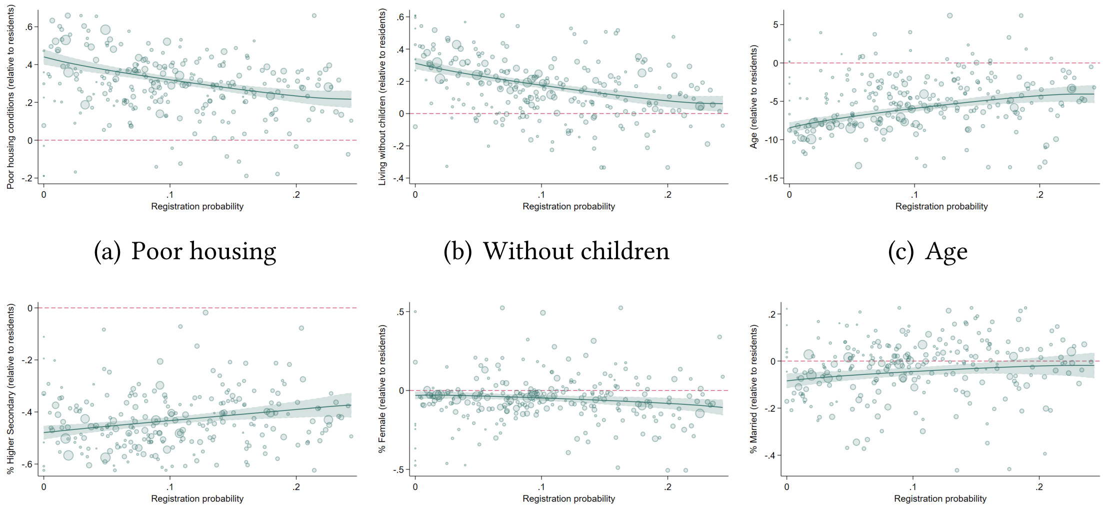


(a) Without children (b) Mothers w/o children (c) Without spouse (d) Without relatives

Notes: The x-axis reports a measure of (log) monthly rents constructed using the "2005 Mini-Census." In panel (a), the y-axis reports the difference between the fraction of rural migrants and the fraction of urban residents who live without their children; in panel (b), we restrict the sample to females declaring having children. In panel (c), the y-axis reports the difference between the fraction of rural migrants and urban residents who live without spouses. In panel (d), the y-axis reports the difference between the fraction of rural migrants and urban residents who live without any relatives. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

Other measures of living arrangements There is some evidence that migrants with different characteristics sort into different cities. In our main discussion (Section 2.2), we mostly focus on the *choice* of moving with or without family and how it interacts with location choices. We now provide a sensitivity analysis in Figure B.8. We first replace living with/without family by living with/without children in panel (a). Second, the evidence presented in Figure B.7 may suggest that expensive cities attract mostly non-family migrants because migrants who do not have dependent children (unmarried migrants) or who are traditionally less involved in childcare (male) sort into such cities, which would threaten our main interpretation. To test this, we focus on women who have children and consider the probability that they bring them to expensive destinations. Panel (b) of Figure B.8 shows that rural migrant mothers are 8-10 percentage points more likely to live with their children as urban resident mothers in the least expensive locations, but that they are 8 percentage points less likely to bring their children in the most expensive destinations. Panel (c) shows the relative probability to live without a spouse across destinations. Panel (d) broadens the definition of family to living with any relative and shows similar patterns: Rural migrants are more likely to live without any relatives in the most expensive locations, while they are as likely as residents to live with relatives in inexpensive cities.

Figure B.9. The selection of migrants relative to residents across cities with different local restrictions.



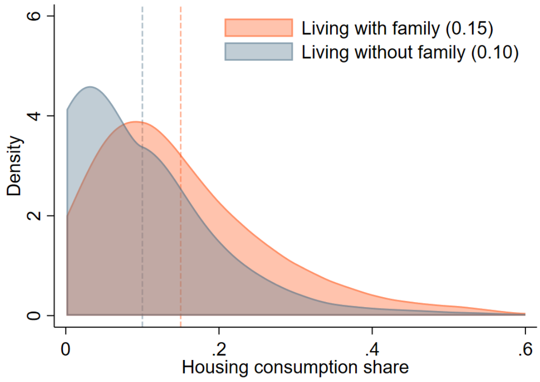
(a) Poor housing (b) Without children (c) Age

(d) Education (e) Gender (f) Married

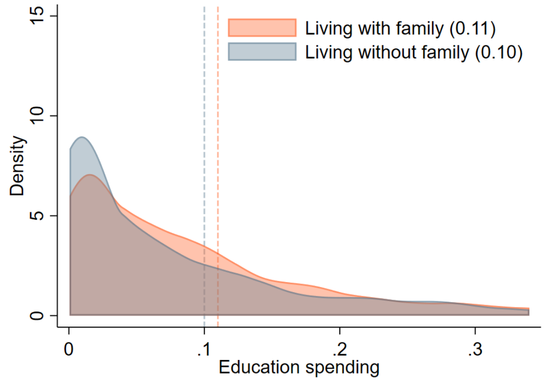
Notes: The x-axis reports the probability for rural migrants to convert their *hukou* registration, as computed from the 2010 Census. In panel (a), the y-axis reports the difference between the fraction of rural migrants and the fraction of urban residents who live in poor housing conditions, based on their dwelling characteristics measured in the "2005 Mini-Census." In panel (b), the y-axis reports the difference between the share of rural migrants and the share of urban residents who live without children. In panel (c), the y-axis reports the difference between the average age of rural migrants relative to that of urban residents. In panel (d), the y-axis reports the difference between the proportion of migrants and the proportion of urban residents who have at least higher secondary education. In panel (e), the y-axis reports the difference between the fraction of migrants and the fraction of urban residents who are female. In panel (f) the y-axis reports the difference between the fraction of migrants and the fraction of urban residents who are married. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

Selection along *hukou* restrictions We finally provide some evidence about the selection of migrants and migration patterns across cities with different registration restrictions. To do so, we rely on our main measure of *hukou* stringency from the 2010 Census: the share of migrants between 15 and 64 years old, who moved for work-related reasons and were born in another county, and who were registered locally with a non-agricultural *hukou* (in the manner of Wu and You 2021). We then replicate Figure 3 and Figure B.7, but replacing the x-axis with the *hukou* conversion probability measure. As apparent in panels (a) and (b) of Figure B.9, living arrangements between migrants and residents are much closer in locations where *hukou* restrictions are milder (and the probability to convert *hukou* registration is higher). The gap in education remains however very large, irrespective of migration restrictions at destination (panel d).

Figure B.10. Migrants and expenditures on housing and education.



(a) Housing expenditures at destination



(b) Education expenditures

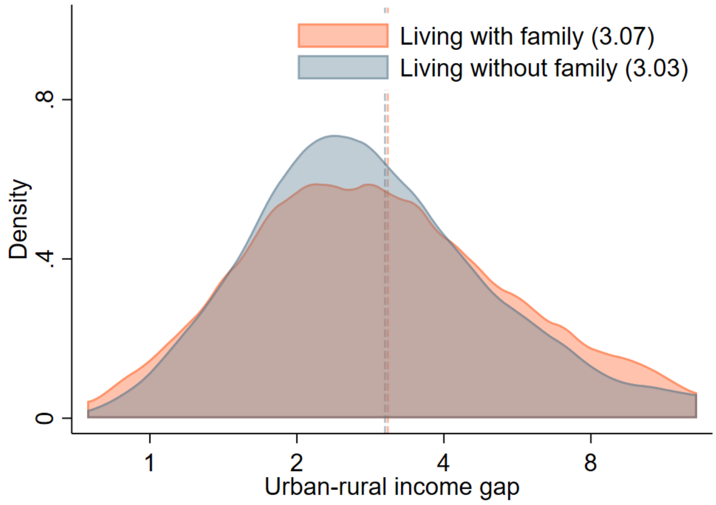
Notes: In panel (a), we report the distribution of housing expenditures as a share of income and at destination (source: RUMIC, 2008–2009). In panel (b), we report the distribution of education expenditures (whether incurred at destination or origin, and including all possible additional fees or non-school educational expenditures) as a share of income. In both cases, we distinguish between the subsample of migrants living with family at destination (in orange) versus the subsample of migrants having left their family at origin (in blue).

B.4 Remittances, expenditures, and the rural-urban wage gap

In Section 2.3, we document the income share spent by migrants on remittances, distinguishing migrants living with family and migrants living without. The former are found to remit less. We now provide complementary evidence on the migrant experience across living arrangements based on the Longitudinal Survey on Rural Urban Migration in China (RUMiC, 2008–2009).

Remittances and expenditures on non-tradables In panel (a) of Figure B.10, we report the distribution of housing expenditures at destination for workers who migrate without family against those moving with their family. We find that about half of the gap in expenditures on non-tradable goods and services across living arrangements can be explained by housing. In panel (b), we rather focus on education expenditures, comparing the expenditures incurred at destination, mostly, for migrants moving with their family to the expenditures incurred at origin for migrants leaving their family behind. Expenditures are quite similar, illustrating that most migrants bringing their children leave them in informal, non-expensive schools of lower quality.

Figure B.11. Migrants and the hypothetical rural-urban wage gap.



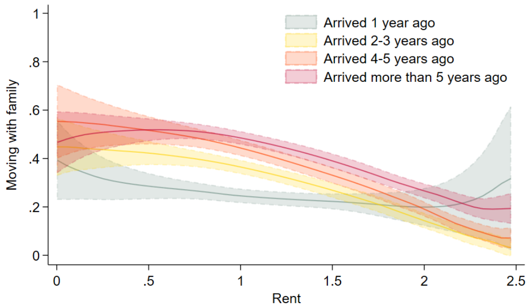
Notes: This Figure displays the distribution of a hypothetical rural-urban wage gap constructed from the actual income earned by migrants at their destination and a hypothetical income at origin. The latter is reconstructed using the following question: “If you were still in your home village, how much do you estimate you could earn every month?”. We distinguish between the subsample of migrants living with family at destination (in orange) versus the subsample of migrants having left their family at origin (in blue). The x-axis is represented on a logarithmic scale.

The rural-urban wage gap In Figure B.11, we shed light on the main factor behind the extent of rural-urban migration: the rural-urban wage gap, counteracting the living costs at destination and the utility cost of leaving children behind. We exploit a hypothetical question in the Longitudinal Survey on Rural Urban Migration in China asking about the income that migrants would get had they remained in their home village. We find that such a gap is similar for migrants choosing different living arrangements: Migrants earn more than three times the rural wage. Accordingly, remittances of about 30% of an urban wage, as we document in Section 2.3, are almost a full rural wage.

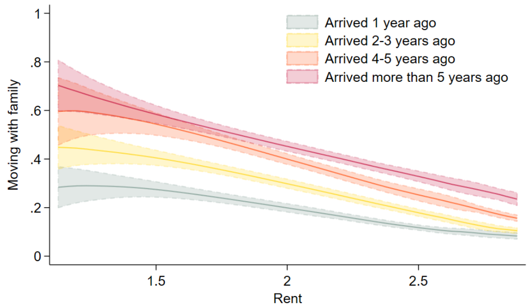
B.5 The dynamics of migration arrangements across cities

Our main evidence presented in Section 2 ignores any dynamic adjustment of migration arrangements over the life cycle of migrants. We provided some insight about the (stable) composition of migrant inflows in Appendix A.2. We now shed light on dynamic adjustment of migration arrangements throughout the migration spell. Figure B.12 displays the incidence of family migration as a function of the time since arrival (at destination) in 2005 (panel a) and in 2010 (panel b). One concern could be that split migration, e.g., leaving children behind, is a temporary arrangement that does not outlive the time for migrants to accumulate resources and knowledge at destination. In short, migrants might just take longer to bring their family to expensive cities. We do not find evidence

Figure B.12. Living with children throughout the migration spell.



(a) Living with children (2005)

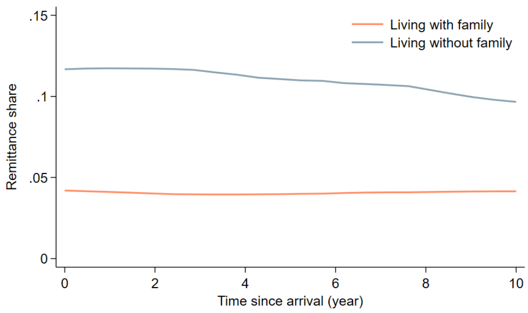


(b) Living with children (2010)

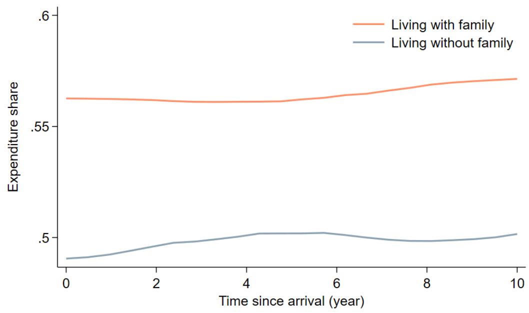
Notes: The x-axis reports a measure of (log) monthly rents constructed using the "2005 Mini-Census." The y-axis reports the share of migrants living with family at destination (in 2005 for panel a, in 2010 for panel b). The lines are local polynomial fits, where each observation is weighted by population: The green line is computed for migrants having arrived one year prior to the census (after 2004 in panel a, after 2009 in panel b); the yellow line is computed for migrants arrived between 2 and 3 years prior to the census; the orange line is computed for migrants arrived between 4 and 5 years prior to the census; and the red line is computed for migrants arrived more than 5 years prior to the census.

for such adjustments. If anything, time appears to matter in inexpensive cities, and the gradient of migration arrangements with prices at destination tilts even further after 4-5 years.

Figure B.13. Remittances throughout the migration spell.



(a) Remittances



(b) Expenditures

Notes: The x-axis reports the time since arrival for migrants interviewed in CMDS (2011). In panel (a), the y-axis reports the remittance share for migrants living with family at destination (orange line) and migrants living without family (blue line). In panel (b), the y-axis reports the ratio of expenditures (excluding remittances) to income for migrants living with family at destination (orange line) and migrants living without family (blue line).

Figure B.13 displays the consumption patterns of migrants with and without family as a function of the time since arrival. While there is some adjustment throughout the migration spell, the gap between migrants with and without family remains large and stable (or converging very slowly), whether we capture it through remittance behaviors (panel a) or through consumption at destination (panel b).

Figure B.14. Future prospects across migration spells.

(a) Return migration (b) *Hukou* conversion

Notes: The x-axis reports a measure of (log) monthly rents constructed using the "2005 Mini-Census." In panel (a), the y-axis reports the average willingness to return (from CMDS) for migrants who live with their children (orange) and migrants living without children (blue). In panel (b), the y-axis reports the average willingness to convert *hukou* at destination (from CMDS) for migrants who live with their children (orange) and migrants living without children (blue). A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

B.6 Prospects, return migration, and *hukou* conversion

In Figure B.14, we document the heterogeneity in prospects for migrants living across different destinations and with or without family. More specifically, we exploit questions about the willingness to return for migrants interviewed in the China Migrants Dynamic Survey (CMDS) and questions about the willingness to convert *hukou* to the destination location (irrespective of the requirements for doing so).

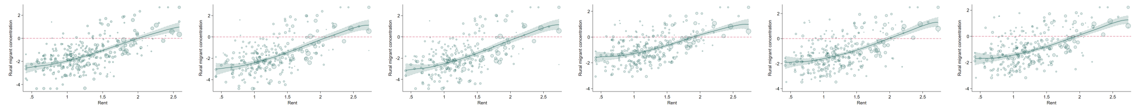
We find that the share of migrants willing to go back to their origin locations is small (see panel a): About 16% of migrants living without family are willing to return versus 11% of migrants living with family at destination. About 40% of migrants are willing to have their *hukou* converted to their destination locations, a prospect that is quite unlikely around 2000 but becomes more realistic with the gradual changes in registration policies (culminating in the 2014 reforms). This evidence rationalizes that we do not consider a dynamic model allowing, among other mechanisms, for return migration.

B.7 A sensitivity analysis of migrant definitions

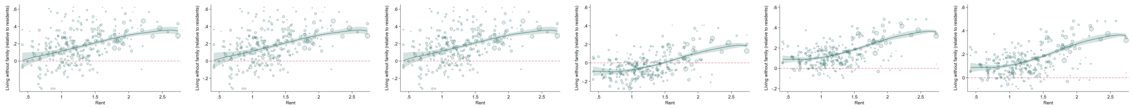
Our measure of migration relies on discrepancies between the place of household registration and the place of residence. The possibility for (some) migrants to change their *hukou* and register at destination means that such a measure misallocates a few rural-urban migrants as urban residents; and the large underrepresentation of migrants in inexpensive cities visible in Figure 2 might be partly due to a higher *hukou* conversion probability.

In this section, we use additional information from the 2005 and 2000 censuses to

Figure B.15. Rural migrant concentration—alternative migration definitions.



(a) Rent (pref., *Hukou*, 2005) (b) Rent (prov., *Hukou*, 2005) (c) Rent (prov., birth, 2005) (d) Rent (pref., *Hukou*, 2000) (e) Rent (prov., *Hukou*, 2000) (f) Rent (prov., birth, 2000)



(g) Fam. (pref., *Hukou*, 2005) (h) Fam. (prov., *Hukou*, 2005) (i) Fam. (prov., birth, 2005) (j) Fam. (pref., *Hukou*, 2000) (k) Fam. (prov., *Hukou*, 2000) (l) Fam. (prov., birth, 2000)

Notes: The x-axis reports a measure of (log) monthly rent per square meter. Rents are constructed using the "2005 Mini-Census" in 2005 or the 2000 Census in 2000. In panels (a) to (f), the y-axis reports the migrant concentration in city c, m_c—see Section 2.1. In panels (g) to (l), the y-axis reports the difference between the share of rural migrants and the share of urban residents who live without family. The different panels vary the migration measure along three dimensions: province- vs. prefecture-level, based on the 2005 1% Population Survey or the 2000 Population Census, and *hukou*- vs. birthplace-based definitions of migration. A bubble is a prefecture of destination and is weighted by its urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

create alternative measures of migration and check the robustness of our stylized facts. Our baseline measure of migration relies on the following ingredients: (i) the discrepancy between the current place of residence and the place of household registration; (ii) information on the *hukou* type; and (iii) information on the year of migration (within the past 5 years). In what follows, we leverage (iii) and complement it with data on the place of birth (in 2000) or on the place of residence 5 years before the census (as a proxy for the place of birth, which is not available in 2005).[39] Since these alternative measures of migrants' origins are recorded at the province rather than at the prefecture level, we also reproduce our main stylized facts considering only (*hukou*-defined) migration spells across provincial boundaries. Figure B.15 reproduces part of Figures 2 and 3, using these alternative migration definitions. The alternative migration definitions vary the date at which migration flows are constructed (2005 as in the baseline, or 2000 using the 2000 census), the level at which they are constructed (prefecture-level as in the baseline, or province-level) and the way migrants are identified (*hukou*-based definition as in the baseline, versus a birthplace-based definition of migration). Across all cases, we observe gradients nearly identical to our first stylized fact. Similarly, the level and steepness of the fitted polynomials may change slightly, but our second stylized fact remains robust to the change of migration definitions.[40]

[39]The latter is an acceptable proxy of birthplace or the place of *hukou* registration before conversion if step migration is limited. Imbert et al. (2022) show that this was indeed the case in 2000–2005 in China.

[40]In unreported results, we confirm that Figure 2 (a), and Figure 3 (b), are robust to such changes.

C Complements to the model

This section provides complements to Section 3 with: the derivation of indirect utilities and consumption patterns across goods and generations; and a three-step discussion of various model extensions.

C.1 Migration, living arrangements, and consumption bundles

Consumption across generations and across goods We suppose that the consumption bundles for the old generation and the young generation are defined as:

$$C^o = \left(C_t^o\right)^{1-\alpha-\beta} \left(C_n^o\right)^{\alpha} \left(C_r^o\right)^{\beta},$$

and that:

$$C^y = \left(C_t^y\right)^{1-\alpha-\beta} \left(C_n^y\right)^{\alpha+\beta},$$

where C_t^g is the consumption of the tradable good, C_n^g is the consumption of the non-tradable good for generation g, and C_r^o is a residual consumption of the non-tradable good for the older generation at origin. The latter is introduced to best capture that all migrant households remit back to the origin, as illustrated in Section 2.3. In this subsection, we omit the subscript associated with the living arrangement, ℓ.

Under the assumptions that the sub-utilities of the old and the young are additive and separable, the overall household program can be decomposed into the following steps. First, the household chooses a consumption bundle C^g for each generation and for a given expenditure E^g, e.g.,

$$\max_{C_t^o, C_n^o, C_r^o} \left(C_t^o\right)^{1-\alpha-\beta} \left(C_n^o\right)^{\alpha} \left(C_r^o\right)^{\beta}$$

subject to $P_t C_t^o + P_n C_n^o + P_r C_r^o \leq E^o$. Second, the output of the previous program can be used to define a price index $\mathcal{P}^g$ such that $\mathcal{P}^g C^g = E^g$, and the household allocates expenditures across generations such as to maximize:

$$\max_{C^o, C^y} \xi u\left(C^o\right) + (1-\xi)\, u\left(C^y\right)$$

subject to $\mathcal{P}^o C^o + \mathcal{P}^y C^y \leq \mathcal{W}$. Third, the previous computations provide us with a consumption bundle across goods and across generations, and an indirect utility $\ln V = \xi u\left(C^{o*}\right) + (1-\xi)\, u\left(C^{y*}\right)$, which can be expressed as a function of prices. With the latter, one can solve for the discrete, nested choice model described in Section 3.3.

The choice of consumption bundles $\{C^g\}_{g\in\{o,y\}}$ leads to the following price indices:

$$\mathcal{P}^o = \left(\frac{P_t}{1-\alpha-\beta}\right)^{1-\alpha-\beta}\left(\frac{P_n}{\alpha}\right)^{\alpha}\left(\frac{P_r}{\beta}\right)^{\beta}, \quad \mathcal{P}^y = \left(\frac{P_t}{1-\alpha-\beta}\right)^{1-\alpha-\beta}\left(\frac{P_n}{\alpha+\beta}\right)^{\alpha+\beta},$$

and the following consumption allocations:

$$P_tC_t^o = (1-\alpha-\beta)E^o, \quad P_nC_n^o = \alpha E^o, \quad P_rC_r^o = \beta E^o,$$

$$P_tC_t^y = (1-\alpha-\beta)E^y, \quad P_nC_n^y = (\alpha+\beta)E^y.$$

The allocation of expenditures across generations implies that $E^o = \xi\mathcal{W}$ and $E^y = (1-\xi)\mathcal{W}$. These equations, combined with Equation (2), allow us to derive the expressions used in Section 3 for indirect utilities.

Indirect utilities To derive indirect utilities, we need to specify the household budget across the different living arrangements. We assume that the streams of wages are given by $\mathcal{W}(r,r) = w_r$, $\mathcal{W}(u,r) = \kappa_1 w_u$, and $\mathcal{W}(u,u) = \kappa_2 w_u$. Assuming that the tradable good is the numeraire, i.e., $P_t = 1$, and omitting constants, we can combine the previous calculations to derive the indirect utility of a household staying in location r:

$$\ln V_r^s = \ln w_r - \ln p_r.$$

The same household moving from origin $r \in R$ to destination $u \in U$, while leaving the children behind, would get the indirect utility:

$$\ln V_{ru}^{m_1} = \ln w_u - \xi(\alpha+\beta)\ln p_u - (1-\xi)(\alpha+\beta)\ln p_r - \left(\tau_{ru}^{m_1} - \ln\kappa_1\right).$$

The indirect utility of migrating from r to u with all family dependents is:

$$\ln V_{ru}^{m_2} = \ln w_u - (\alpha + (1-\xi)\beta)\ln p_u - \xi\beta\ln p_r - \left(\tau_{ru}^{m_2} - \ln\kappa_2\right).$$

Expenditure shares and preference parameters In order to derive the allocation of household members across space, we need to estimate the set of preference parameters and recover the relative weight of the old generation (ξ) and the consumption shares (α,β). In this subsection, we show how observing (i) the total consumption allocated to non-tradables, (ii) the remittance share for households migrating without children, and (iii) the remittance share for households migrating with children is sufficient to identify a unique set of parameters (α,β,ξ).

First, with a structure of "overlapping" Cobb-Douglas preferences, the optimal allocation of consumption across the different goods and generations implies that a fixed share of income is devoted to each good/generation. Both generations allocate a share $\alpha + \beta$ of their respective budget to the non-tradable good, such that the overall share of income allocated to the non-tradable good is $x = \alpha + \beta$, irrespective of the location of such consumption. In RUMiC (see Section 2.3 for an illustration of the underlying data), we find that households spend two thirds of their budget on the consumption of localized goods and services, either at destination or origin ($x = 0.66$).

Second, assuming that remittances only cover the consumption of the non-tradable good, migrant households transfer a share $y = \beta + (1 - \xi)\alpha = 0.28$ back to the origin when migrating without their children and a share $z = \xi\beta = 0.11$ when migrating with their children (see Section 2.3, where we display the distribution of remittance shares by living arrangement). Overall, the previous equations form the following system:

$$\begin{cases} x = \alpha + \beta \\ y = \beta + (1 - \xi)\alpha \\ z = \xi\beta, \end{cases}$$

which can be inverted to get $\alpha = x - z/(1 - (y - z)/x) = 0.51$, $\beta = z/(1 - (y - z)/x) = 0.16$, and $\xi = 1 - (y - z)/x = 0.75$.[41]

C.2 Extensions and reinterpretations of the model

A dynamic reinterpretation of the model While we have introduced a model where the location choice is static, it is easy to reinterpret the model in a dynamic manner. For instance, we can assume that $\mathcal{U}(u(C^o), u(C^y)) = \xi u(C^o) + (1 - \xi)\,\mathbb{E}\,[u(C^y)]$, i.e., parents care about their utility and the expected, future utility of their children. Similarly, we can assume that $\mathcal{W}_r = w_r + \beta\mathbb{E}(w_r)$, $\mathcal{W}_{ru} = \kappa_1 w_u + \beta\mathbb{E}(w_r)$, and that $\mathcal{W}_u = \kappa_2 w_u + \mathbb{E}(w_u)$. These equations mean that the stream of wages is equal to the older generation's wage and the expected wage of the younger generation, both depending on the location choice. Under this reinterpretation, we gain additional insights: Higher expected urban wages encourage family migration; instead, higher expected rural wages discourage migration overall and tilt migration toward migrants moving without family.

A model with return migration and family reunification We have, so far, ignored the possibility that rural migrants return to their origins, or that non-family migrants in

[41] In these calculations, we assume that households do not remit amounts that will serve the consumption of the tradable good at origin. An alternative approach would consider that remittances do include such expenses, in which case the respective formulae are: $\alpha = x - z/(1 - (y - z)) = 0.52$, $\beta = z/(1 - (y - z)) = 0.14$, and $\xi = 1 - (y - z) = 0.83$.

urban areas manage to bring family dependents to the city. A simple extension of the model can accommodate these ideas. For that, however, we need to think about three generations: the old, the mature, and the young. We can assume that the household head, when mature, decides on migration options. Furthermore, we can assume a utility function that takes the following form: $\mathcal{U}(u(C^o), u(C^m), u(C^y)) = \xi_o u(C^o) + \xi_m u(C^m) + (1 - \xi_o - \xi_m)u(C^y)$. In this case, we can consider four potential migration decisions: (i) stay; (ii) migrate as mature with the family dependents and stay in the urban location; (iii) migrate as mature, leaving family dependents behind, and then return when old at origin; and (iv) migrate as mature, leaving family dependents behind, and then reunify the family at destination. Each of these options will come with a different stream of income. The insights we obtain from these extended models are, however, very similar to the ones already discussed. The gain is that the extended model allows us to discuss family reunification and return migration policies.[42]

A model with human capital accumulation A final alternative is to explicitly model human capital accumulation. In this interpretation, we assume that the choice is static—the old generation maximizes the following preferences:

$$\mathcal{U}(u(C^o), u(C^y), u(C^f)) = \xi_o u(C^o) + \xi_y u(C^y) + \xi_f u(C^f),$$

where C^o is the current consumption of the old generation, C^y is the current consumption of the young generation, and C^f is the future consumption of the young generation.[43] We assume for simplicity that the future consumption of the young generation is linear in their acquired human capital, H, i.e., $C^f = \phi H$. In this alternative model, the household faces a budget constraint in the present period, and of the following form:

$$\mathcal{P}^o C^o + \mathcal{P}^y C^y + QH \leq \mathcal{W},$$

where prices $\mathcal{P}^o$, $\mathcal{P}^y$, and Q depend on where the old and young generations live. If the household stays, all prices are at the origin. If the old generation moves without the young generation, $\mathcal{P}^o$ is at destination and $(\mathcal{P}^y, Q)$ are at origin. If the household moves as a unit, all prices are at destination. We assume that: $\mathcal{W} = w$, which is the wage at origin if the household stays and the urban wage in city u if the old generation moves.

Under these assumptions, the household will choose consumption baskets and hu-

[42] Having multiple periods could allow us to consider the role of credit constraints. For instance, credit constraints may encourage non-family migration in ways that are similar to high education costs in cities.

[43] Descriptive statistics extracted from RUMiC (2008–2009) indicate that $\xi_o \approx 0.70$, $\xi_y \approx 0.20$, and $\xi_f \approx 0.10$, which is based on the fact that education expenditures are stable across living arrangements at around 10% of the household income.

man capital accumulation under the different living arrangements as follows:

1. Expenditure on consumption and education of the young, for households who stay at origin:

$$\ln\left(\frac{p_r C_r^y}{w_r}\right) = \ln \xi_y, \quad \ln\left(\frac{Q_r H_r}{w_r}\right) = \ln \xi_f$$

2. Expenditure on consumption and education of the young, for households who leave kids at origin:

$$\ln\left(\frac{p_r C_r^y}{w_u}\right) = \ln \xi_y, \quad \ln\left(\frac{Q_r H_r}{w_u}\right) = \ln \xi_f$$

3. Expenditure on consumption and education of the young, for households who migrate with the kids:

$$\ln\left(\frac{p_u C_u^y}{w_u}\right) = \ln \xi_y, \quad \ln\left(\frac{Q_u H_u}{w_u}\right) = \ln \xi_f$$

One can see that leaving children behind provides advantages relative to staying or moving with those children: (i) migration allows the household to allocate a much higher income across the different consumption pots, and (ii) migration *without children* allows the household to face origin prices when choosing the consumption (price p_r) and human capital accumulation (price Q_r) of the young generation. For instance, one can derive the relative gain in human capital accumulation for households who migrate without their children as:

$$\ln\left(\frac{H_r}{H_u}\right) = -\ln\left(\frac{Q_u}{Q_r}\right),$$

where the latter plays a similar role as our previous κ's in that it creates an education-driven wedge between the indirect utilities across living arrangements of movers.

While education quality is probably higher in urban centers than in rural areas, rural migrants do not have free access to urban schools and end up entering low-quality public schools or informal, migrant-run private schools (Chen and Feng 2013). In short, we find that $Q_u > Q_r$ for rural children and the gap to be strongly linked to *hukou* policies.

C.3 Model with urban to urban migration

In our baseline model, we assume for simplicity that urban residents are immobile. In practice, there is some urban-urban migration in China, even if, as Figure 1 makes clear, it is much less important than rural-urban migration.[44] In this section, we expand our model so that urban residents are mobile across locations, which allows us to determine the initial allocation of urban residents as a function of location fundamentals and model parameters.

Urban residents decide where to live based on the following utility function:

$$\ln V_u = (1-\alpha-\beta)\ln C_t + (\alpha+\beta)\ln C_n,$$

subject to a budget constraint,

$$C_t + p_u C_n \leq w_u,$$

where we use the same notation as the main text. In this context, utility maximization results in the following indirect utility for each individual i with origin u and destination $v \in U$:

$$\ln V_{uv}^m + \varepsilon_{iuv} = \ln w_v - (\alpha+\beta)\ln p_v - \tau_{uv} + \varepsilon_{iuv}.$$

This maximization problem results in the following share of workers across locations:

$$\frac{N_{uv}}{N_u} = \left(\frac{V_{uv}^m}{V_u^m}\right)^{1/\lambda},$$

where $\frac{N_{uv}}{N_u}$ is the probability for inhabitants of u to migrate to v, conditional on migrating to any other city in U. In this case, the marginal mover between any two urban locations is indifferent across locations, as is normal in spatial equilibrium models.

We can use this labor supply equation together with the Cobb-Douglas version of the labor demand equation to solve for the initial distribution of urban residents across locations, which, in the baseline model, we took as exogenous:

$$w_u = w(Z_u, N_u)$$

and:

$$p_u = p(T_u, N_u).$$

Hence, we can substitute these two equations into V_u^m to obtain that:

$$V_u^m = \left[\sum_u \left[w(Z_u, N_u)/p(T_u, N_u)^{\alpha+\beta}\right]^{1/\lambda}\right]^{\lambda}.$$

[44]The fact that there is not much urban to urban mobility around the year 2000 in China, as documented in Figure 1, probably reflects the fact that the gain from moving is much lower for urban residents than for rural ones, rather than limits to mobility.

These equations define a system of U equations and U unknowns ($N_u, \forall u \in U$) that uniquely determines the distribution of urban residents N_u as a function of fundamentals $\{Z_u, T_u\}$ and the main elasticities of the model, as formally shown in Allen and Arkolakis (2014). Note that we can even get closed-form solutions for the distribution of urban residents as a function of fundamentals.

C.4 Model with multiple skills

In our baseline model, we assume, for simplicity, that there is only one labor type. In practice, labor may be heterogeneous. We discuss here how to incorporate multiple factor types at destination in a framework that follows Amior and Manning (2021), and we investigate how this affects the local labor and housing markets.[45]

Local production As in the main text, we assume that tradable output in location u is produced with the following production function:

$$Y_u = Z_u \left[(1-\theta) K_u^{\frac{\sigma-1}{\sigma}} + \theta L_u^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}},$$

where Z_u is the local (exogenous) productivity, K_u denotes capital or land, the parameter σ denotes the elasticity of substitution between labor and the other factor, but labor, L_u, is now a composite of different types of workers that can be expressed as:

$$L_u = \left[\sum_e \theta_e (L_{ue})^{\frac{\sigma_e-1}{\sigma_e}} \right]^{\frac{\sigma_e}{\sigma_e-1}}.$$

This production function allows us to apply the results of Amior and Manning (2021), assuming that each factor can be decomposed between urban residents and (rural) migrants as $L_{ue} = N_{ue} + M_{ue}$. Defining the fraction of urban residents and migrants in each (e, u) cell as $\nu_{ue} = N_{ue}/N_u$ and $\mu_{ue} = M_{ue}/M_u$, the labor aggregate can be written as a function of aggregate labor across types:

$$L_u = F(N_{ue} + M_{ue}, \forall e) = \left[\sum_e \theta_e (\nu_{ue} N_u + \mu_{ue} M_u)^{\frac{\sigma_e-1}{\sigma_e}} \right]^{\frac{\sigma_e}{\sigma_e-1}} = F(\nu_{ue} N_u + \mu_{ue} M_u).$$

Defining $\mathcal{L}(M_u, N_u) = F(\nu_{ue} N_u + \mu_{ue} M_u)$ and holding the immigrant distribution across

[45]Considering multiple skills is probably more important from the perspective of recipient locations than from sending rural communities. It is quite natural to think that, in urban locations, there are many highly qualified jobs that are different in nature than jobs that require fewer/other types of skills.

factor types fixed, an inflow of migrants results in the following:

$$\frac{\partial \mathcal{L}(M_u, N_u)}{\partial M_u} = \sum_e \mu_{ue} \frac{\partial F_e(N_{ue} + M_{ue}, \forall e)}{\partial M_{ue}}.$$

The effect of a migrant shock will be the weighted average of the effect of migrants to each factor type. Under perfect competition in the labor market, this can be interpreted as the average effect on wages in the location.

Hence, the counterfactuals that we performed should be interpreted as holding the distribution of migrants across skill types fixed in each location.

Local housing markets Having multiple factor types also affects the housing market. With multiple skills, there are multiple wage levels. These different wage levels enter the demand for housing, which is reflected in the market clearing condition of the housing sector:

$$T_u p_u^\eta = \sum_e \frac{w_{ue}}{p_u} \left[(\alpha + \beta) N_{ue} + \Gamma M_{ue} \right].$$

We can rewrite this expression as:

$$\ln p_u = \frac{1}{1+\eta} \ln \left[(\alpha + \beta) N_u \left(\sum_e w_{ue} v_{ue} \right) + \Gamma M_u \left(\sum_e w_{ue} \mu_{ue} \right) \right] - \frac{1}{1+\eta} \ln T_u,$$

where Γ is the effective income share allocated to the non-tradable good by migrants. In turn, this expression can be rewritten as:

$$\ln p_u = \frac{1}{1+\eta} \ln \left[(\alpha + \beta) N_u \bar{w}_u^N + \Gamma M_u \bar{w}_u^M \right] - \frac{1}{1+\eta} \ln T_u.$$

This expression takes into account that the average wage of urban residents and immigrants may be different because natives and immigrants may be differently distributed over factor types. The intuition is that an immigrant inflow will increase the demand for housing, thereby putting upward pressure on housing prices. At the same time, however, the immigrant shock may affect wages in the city, which in turn, affects the demand for housing. Which of these two forces dominates is, in general, ambiguous.

D Complements to the model estimation

This section provides complements to Section 4: (i) we estimate an elasticity of substitution between consuming at origin and at destination to rationalize our Cobb-Douglas preferences; (ii) we identify the shape parameters of the location choice model and describe how we extract exogenous variation in the relative value of emigrating with family; (iii) we estimate the labor demand and housing supply elasticities; and (iv) we shed light on the distribution of bilateral migration costs.

D.1 Elasticity of substitution between origin and destination

This section estimates elasticities of substitution between consuming the non-tradable good across locations. As we will see, the estimates encourage us to simplify the analysis and assume a Cobb-Douglas structure of preferences in the baseline model. We estimate the following empirical relationship between the average (log) expenditure share on remittances in city u, $\ln(\mathcal{E}_u)$, and local housing prices, p_u, constructed respectively from the China Migrants Dynamic Survey (2011) and the "2005 Mini-Census":

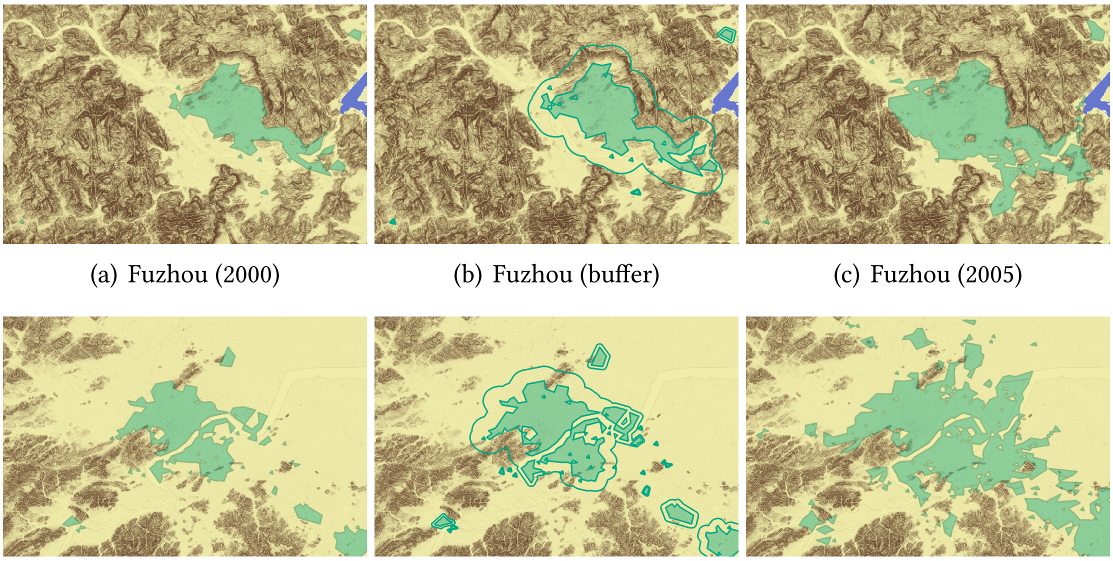
$$\ln(\mathcal{E}_u) = a + b \ln p_u + e_u,$$

where the estimate b would be related to the elasticity of substitution between consuming the non-tradable good across locations ("$b = \rho - 1$"). An issue with estimating the previous equation is that the residual, e_u, might capture migrant composition and unobserved local amenities, inducing an endogeneity concern with omitted variation jointly affecting prices and expenditure shares.

Exogenous variation in housing supply We exploit exogenous variation in housing supply across destinations to predict variation in the price of non-tradables (proxied by the price of housing services). To do so, we identify the shape of cities before our episode of mass migration, and we characterize topography in their immediate hinterlands.

We proceed in three steps. In a first step, we draw on the identification of impervious areas by the Beijing City Lab in 2000 to identify the urban extent of each city within a given prefecture. In a second step, we construct a city-specific buffer, the extent of which is calibrated to ensure that all cities grow proportionally and homogeneously in all directions (Harari 2020). In a third step, we identify water coverage and the local ruggedness within this buffer of potential urban sprawl. In our baseline strategy, we calculate the share of non-developable land within this land stretch for city u, s_u, by classifying a pixel of 30m × 30m as "non-developable" if the average slope is above 5 degrees. Figure D.1 provides insight about the construction of the instrument and the

Figure D.1. An example of our procedure with Fuzhou and Hangzhou.



(a) Fuzhou (2000) (b) Fuzhou (buffer) (c) Fuzhou (2005)

(d) Hangzhou (2000) (e) Hangzhou (buffer) (f) Hangzhou (2005)

Notes: The delineation of impervious areas, as identified from Landsat satellite imagery, is provided by the Beijing City Lab—see https://www.beijingcitylab.com/—and impervious areas are indicated as plain green areas (2000 in panels a-b and d-e, 2005 in panels c and f). The green line in panels b and e corresponds to urban sprawl, as predicted by a uniform growth across cities and within cities in all directions.

variation that it induces across urban areas. Fuzhou and Hangzhou are two historical cities. As shown in panels (a) and (d) of Figure D.1, they markedly differ in constraints to their expansion before mass migration: Fuzhou is in a valley along the Min River and is surrounded by steep hills (especially in the north), while Hangzhou is located in a plain with a few scattered hills. Fuzhou would need to build on a very large share of "non-developable" land if it were to expand in all directions and as much as the average Chinese city (panel b). Hangzhou, on the other hand, would face very limited constraints (panel e). In 2005, we find indeed that Fuzhou experienced an unbalanced urban sprawl concentrated toward the south, while Hangzhou sprawled massively in every direction.

Elasticity of substitution between consuming at origin and destination We use the previous instrument, i.e., the share of developable land at the fringe of cities, to identify the elasticity of substitution between consuming at origin and destination. We rely on the following specification:

$$\ln(\mathcal{E}_u) = a + b \ln p_u + \mathbf{X}_u \beta + e_u,$$

where u is a city, $\ln(\mathcal{E}_u)$ is the average (log) expenditure share on remittances, and p_u is the average rent, inferred from CMDS (2011) and from the "2005 Mini-Census," respec-

Table D.1. Elasticity of substitution between consuming at origin and destination—first-stage.

	Rent (log)
Share of non-developable land	1.314
	(0.349)
Share of non-developable land × TFP	0.974
	(0.511)
Observations	199

Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. The specification uses population weights in 2000. The dependent variable is the (log) rent, computed using the housing module of the "2005 Mini-Census." The (log) rent is instrumented by (i) the share of non-developable land as induced by local geography around city borders in the baseline period (an instrument based on the work of Saiz 2010, Harari 2020) (2000-2005) and (ii) its interaction with manufacturing Total Factor Productivity in 2000 (Imbert et al. 2022). The set of controls consists of: manufacturing Total Factor Productivity in 2000; and (log) population in 2000.

tively. We use our previous geographical variation to construct two instruments: (i) s_u, the share of non-developable land as induced by local geography around city borders in the baseline period, and (ii) its interaction with (log) manufacturing Total Factor Productivity in 2000 (Imbert et al. 2022). The specifications reported in Table D.2 thus include (log) manufacturing Total Factor Productivity in 2000 and (log) population at destination as separate controls. Table D.1 shows the first-stage estimates.

Table D.2. Elasticity of substitution between consuming at origin and destination.

Remittance share (log)	(1)	(2)
Rent (log)	0.245	0.243
	(0.213)	(0.200)
Observations	199	199
Migration mode	$j = 1$	$j = 2$
F-stat	8.74	8.74

Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. The specification uses population weights in 2000. The dependent variable is the (log) expenditure share spent on remittances (CMDS, 2011) and the explaining variable is the (log) rent, computed using the housing module of the "2005 Mini-Census." In column (1), the expenditure share on remittances is calculated for migrants leaving their family at origin ($j = 1$); and the expenditure share on remittances is calculated for migrants bringing their family at destination in column (2) ($j = 2$). The (log) rent is instrumented by (i) the share of developable land as induced by local geography around city borders in the baseline period (2000-2005), an instrument based on the work by (Saiz 2010, Harari 2020), and (ii) its interaction with manufacturing Total Factor Productivity in 2000 (Imbert et al. 2022). The set of controls consists of: manufacturing Total Factor Productivity in 2000; and (log) population in 2000.

The estimates of b are reported in Table D.2, using the sample of migrants leaving their family at origin in column (1) and migrants living with family at destination in column (2). Our estimates are consistent with an average elasticity $\rho = (b+1) \in [0.8, 1.6]$ centered around 1.25, i.e., close to (and not statistically significantly different from) 1. There is some limited substitution between consuming at destination and at origin, and high housing prices induce migrants to displace more of their consumption to rural hinterlands—which is consistent with our findings about living conditions in expensive cities (see Section 2).[46]

D.2 Estimation of the location choice model

The location choice model of Section 4.2 is characterized by three nests and three associated specifications.

The lower nest (λ_1, λ_2) and its gravity structure In Section 4.2, we estimate a simple model of location choice across destinations for workers migrating with and without family (see Table 2). The identification of the lower nest relies on a productivity shifter that impacts real wages at destination, i.e., the trade shock induced by accession to the World Trade Organization (Facchini et al. 2019). The latter is a Bartik-style instrument at the prefecture level capturing the reduction in trade policy uncertainty faced by Chinese exporters of different sectors to the United States.

Table D.3. The lower nest (λ_1, λ_2)—first-stage.

Value at destination	(1)	(2)
Trade shock	1.420	1.245
	(0.306)	(0.334)
Migration mode	$j = 1$	$j = 2$
Observations	87,577	87,577

Notes: A unit of observation is a pair of origin/destination prefectures in 2005. The specification uses population weights at origin in 2000. Standard errors are reported between parentheses and clustered at the level of origins. The dependent variable is the value at destination calculated for migrants leaving their family at origin ($j = 1$, column 1) and for migrants bringing their family at destination in columns (2) ($j = 2$). The set of controls consists of: (log) population at destination in 2000 and (log) geodesic distance between the origin and destination prefectures. The explanatory variable is a trade shock computed following Facchini et al. (2019).

[46] The identification assumption is that local geography at the fringe of cities only affects expenditures on housing through local housing prices, and that it does so more acutely in highly productive cities. One concern is that local geography could affect the type of housing arrangements (dorms, informal housing, etc.) and that local housing prices might be contaminated by such a variation. In unreported robustness checks, we further correct for housing arrangements in the construction of local housing prices without finding any significant differences in our final estimates.

We provide the first-stage specification underlying the estimations of the lower nest in Table D.3. The trade shock is a strong predictor of real wages across destinations—irrespective of living arrangements and the manner in which real wages are computed (i.e., how the composite price index, $\mathcal{P}$, weighs local non-tradable goods at destination versus at origin).

The middle nest (μ) The middle nest of our nested structure can be identified through the decision of moving with or without family, given the value of migrating with and without the family from each origin r, $V_r^{m_j}$. More specifically, the value of family migration across origins r can be written as follows:

$$\ln\left(V_r^{m_j}\right) = \ln\left(\left[\sum_{u\in U}\left(V_{ru}^{m_j}\right)^{1/\lambda_j}\right]^{\lambda_j}\right).$$

We use the parameters $(\alpha, \xi, \beta, \lambda_1, \lambda_2)$ and the residual migration costs $(\tau_{ru}^{m_j})$ from the lower nest estimation to compute the value of migrating with and without the family from each origin r, $V_r^{m_j}$ following Buggle et al. (2023). These values combine the composite attractiveness of destinations for migrants with or without family ($V_{ru}^{m_j}$), which contain many different, unobservable factors. Our baseline strategy is to identify the parameter μ using,

$$\ln\left(\pi_{jr}^{c}\right) = \frac{1}{\mu}\ln\left(\frac{V_r^{m_j}}{V_r^{m}}\right),$$

where π_{jr}^{c} is the emigration rate of migrants of mode j from origin r, conditional on emigrating from r.

The value of moving with or without the family, $V_r^{m_j}$, might be contaminated by measurement error or by omitted variation, for instance, if the lower nest is misspecified. In our baseline strategy, we rely on exogenous price variation in nearby cities to extract differential variation in the composite value $V_r^{m_j}$ for migrants moving with or without family. Our approach consists in extracting a backward-looking, exogenous predictor of local prices, which would differentially affect family migrants and non-family migrants through their heterogeneous reliance on local non-tradable goods. To this end, we use the "non-developable" land within a buffer of potential urban sprawl in 2000, s_u, constructed in Appendix D.1, which strongly affects housing prices. We combine this variation s_u with the distance from an origin r to possible destinations u, $\zeta_{ru} = 1/d_{ru}$, in a gravity structure to construct an instrument, z_{rj}, for the relative value of family migration:

$$z_{rj} = \sum_{u\in U}\zeta_{ru}s_u \times \mathbb{1}_{j=2}.$$

Table D.4. The middle nest (μ)—first-stage.

	Value of family migration
Exposure to living standards (z_{rj})	-1.260
	(0.151)
Observations	608

Notes: A unit of observation is a prefecture of origin r and a migration arrangement j. Standard errors are clustered at the origin level and are reported between parentheses. The specification uses population weights in 2000. The dependent variable is the model-computed value of migration from each origin and family arrangement. The explanatory variable is a gravity-based measure based on the share of developable land at the fringe of cities at destination, s_u (see D.1 for a description of the construction of s_u). The set of controls consists of a set of origin and mode fixed effects.

We provide the first-stage specification underlying the estimations of the middle nest in Table D.4. The gravity-weighted pressure on local prices at destination is a strong predictor of the relative value of family migration.

The upper nest (γ) The identification of the upper nest (γ) of the location model relies on the following equation:

$$\ln\left(\frac{\pi_r}{1-\pi_r}\right) = \frac{1}{\gamma}\ln\left(\frac{V_r^m}{V_r^s}\right).$$

We consider the following empirical counterpart:

$$\ln\left(\frac{\pi_r}{1-\pi_r}\right) = a + b\ln\left(\frac{V_r^m}{V_r^s}\right) + \varepsilon_r,$$

where V_r^m is the value of migrating from location r:

$$\ln V_r^m = \ln\left[\sum_{j\in\{1,2\}}\left(V_r^{m_j}\right)^{1/\mu}\right]^{\mu},$$

and V_r^s is the real wage in origin location r:

$$\ln V_r^s = \ln w_r - (\alpha+\beta)\ln p_r.$$

We instrument the relative value, $\ln V_r^m/V_r^s$, with exogenous shocks to agricultural productivity across possible origins by combining international commodity prices with local cropping patterns (in the manner of Imbert et al. 2022). We first collect Agricultural Producer Prices data (APP, 1991–2016) from the FAO: The data report producer prices at the farm gate in each producing country. For any given crop, we aggregate these country-specific prices into a yearly, international producer price as a weighted average across countries using the baseline share in crop-specific exports as the country/crop weight.[47] We then clean these (log) international producer prices from long-run trends by applying a HP filter (see Imbert et al. 2022) and isolating the residual, d_{ct}, for any given year t and commodity c.

Table D.5. The upper nest (γ)—first-stage.

	Relative value of emigration
Agricultural revenue shock	-7.506
	(1.133)
Observations	304

Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. The specification uses population weights at origin in 2000. The dependent variable is the relative value of emigration. The instrument interacts cropping patterns in 2000 with the HP-filtered prices of agricultural commodities in 2000 (as in Imbert et al. 2022).

These international commodity prices affect agricultural hinterlands differently, depending on local cropping patterns. We exploit this intuition and combine international prices with the revenue share of crop c at origin r in a shift-share design. More specifically, we need the following ingredients to construct a revenue share for each crop: (i) a measure of output (e.g., as measured in tonnes) across locations; and (ii) a price per tonne. We construct a measure of output by multiplying local harvested areas in 2000 (a measure "in acres") with a local predicted yield (a measure "in quantity per acre"). The harvested areas are provided by the World Census of Agriculture 2000, and the predicted yield is constructed within the Global Agro-Ecological Zones project. Nesting these measures within Chinese prefectures requires some geographic approximation that is best described in Imbert et al. (2022). We weigh this predicted output in 2000 by the baseline commodity price in 1980 to construct a revenue share for each crop, α_{cr}, orthogonal to later deviations in international prices. Letting d_c denote the previous price residual at a period of interest, our agricultural productivity shock, ω_r, will be defined as:

$$\omega_r = \sum_c \alpha_{cr} \times d_c.$$

[47] We focus on the following 21 crops (commodities): banana, cassava, coffee, cotton, fodder crops (barley), groundnut, maize, millet, other cereals (oats), potato, pulses (lentil), rapeseed, rice, sorghum, soybean, sugar beet, sugar cane, sunflower, vegetables (cabbage), tea, and wheat. The international price of these commodities is disciplined by World demand and World supply, and China is a large World supplier for a few crops. The most obvious one is tobacco, where China is the leading producer and one company enjoys a local monopoly; we thus exclude tobacco from our agricultural productivity measures.

The estimates reported in Table 4 rely on a two-stage specification where we instrument the relative value of migration with ω_r. We provide the first-stage specification underlying the estimations of the upper nest in Table D.5. The agricultural shock from Imbert et al. (2022) is a strong predictor of the relative value of migrating across origins ($\ln V_r^m/V_r^s$).

Table D.6. Alternative estimation of the location choice model.

Parameters	λ_1	λ_2	μ	γ
Children	11.774	5.836	3.253	1.326
	(2.058)	(1.109)	(1.123)	(0.268)
	[21.53]	[13.86]	[71.63]	[44.20]
	89,886	88,442	608	304
Mothers	9.849	6.144	5.698	0.866
	(1.733)	(1.161)	(1.380)	(0.357)
	[21.55]	[13.87]	[44.20]	[43.83]
	83,828	87,000	566	283
Controls	11.881	6.024	3.094	1.287
	(2.070)	(1.132)	(1.135)	(0.299)
	[21.53]	[13.86]	[67.76]	[39.59]
	89,886	88,442	608	304

Notes: This table reports alternative estimates for the location choice model, based on two alternative definitions of living arrangements (*Children*: migrants without versus with children at their destination, *Mothers*: female migrants leaving children behind versus those with their children at their destination) and a procedure with additional control variables (*Controls*, adding the population at origin for the estimation of all nests, and the land supply shifter at origin for the middle and upper nests). The first two columns report estimates from the lower nest (λ_1, λ_2), as in columns (2) and (4) of Table 2. The third column reports the estimate from the middle nest (μ), as in column (2) of Table 3. The fourth column reports the estimate from the upper nest (γ), as in column (2) of Table 4. Standard errors are reported between parentheses, first-stage F-statistics are reported between square brackets, and the number of observations is reported in the last rows. See Section 4.2 for a description of the empirical specifications.

Alternative estimation procedures Our baseline estimation of the location choice model, discussed in Section 4.2 and in this Appendix, relies on a dichotomy of living arrangements including all dependent family members. For instance, a working-age migrant living with at least one of their retired parents at destination would be counted as migrating with family, even if they left children behind. In this section, we consider alternative estimates for the location choice model, based on two alternative definitions of living arrangements (*Children*: migrants without versus with children at their destination, *Mothers*: female migrants leaving children behind versus those with their children at their destination) and a procedure with additional control variables (*Controls*, adding the population at origin for the estimation of all nests, and the land supply shifter at origin for the middle and upper nests). The estimates, reported in Table D.6, remain close to our baseline parametrization.

D.3 Labor demand and housing supply at destination

Table D.7. Labor demand and housing supply elasticities.

	Δ Log Wage		Δ Log Rent	
	(1)	(2)	(3)	(4)
Immigration Rate	-0.232	-0.304		
	(0.052)	(0.164)		
Δ Log Households			-0.039	0.271
			(0.109)	(0.574)
Observations	289	289	289	289
Controls				
F-stat	.	14.14	.	8.26

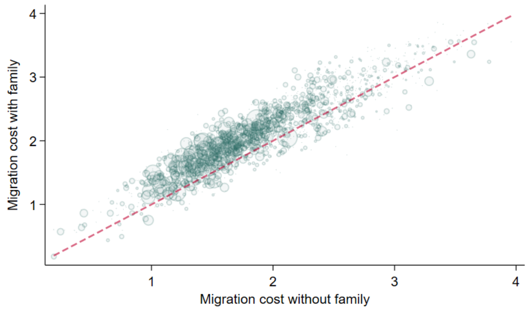
Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. In columns 1 and 2 the dependent variable is the change in log average wages paid by manufacturing firms between 2000 and 2005 (as in Imbert et al. 2022) and the explanatory variable is the immigration rate between 2000 and 2005 from the "2005 Mini Census". In columns 3 and 4 the dependent variable is the change in log average rents per square meter between 2000 and 2005, and the explanatory variable is the change in the log number of households, both computed using Census 2000 and the "2005 Mini-Census". In columns 2 and 4 the explanatory variables is instrumented using a shift share instrument that combines agricultural shocks between 2000 and 2005 in all rural origins and the share of migrants from each origin who lived in that destination in 2000 (as in Imbert et al. 2022).

The identification of the production block of the model requires exogenous variation in migrant inflows to estimate their effect at destination. In the spirit of the shift-share procedure developed in Imbert et al. (2022), we combine the exogenous shocks to rural incomes in each prefecture of origin that we used for the estimation of the upper nest of the location choice model (shifts) with the share of migrants coming from each origin in 2000 (shares):

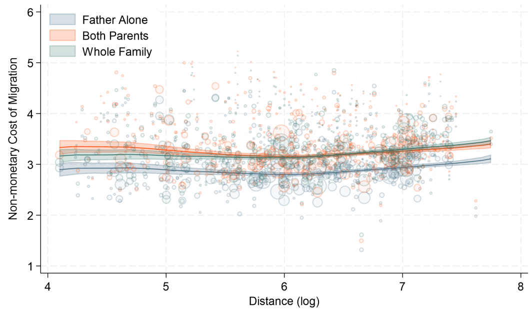
$$z_u = \sum_{r \in R} \zeta_{ru} \omega_r,$$

Table D.7 presents OLS regressions of changes in wages on the immigration rate (column 1) and the IV estimate (column 2). We use -0.3 as our estimate of the inverse labor demand elasticity. In columns 3 and 4, we regress changes in rents per square meters on the change in the number of households. The OLS estimate in column 3 is small and insignificant. The IV estimate in column 4 has the expected sign but a large standard error: the magnitude suggests a very large labor supply elasticity (3.71) which would put it in the top 5th percentile of Saiz (2010) estimates (Dayton-Springfield, Ohio).

Figure D.2. Bilateral migration costs and distance.



(a) Overall distribution



(b) Geographic distance

Notes: Panel (a) plots the bilateral migration costs for family migration (y-axis, $\tau_{ru}^{m_2}$) against the bilateral migration costs for non-family migration (x-axis, $\tau_{ru}^{m_1}$). Panel (b) plots these bilateral migration costs against the (log) distance between origin r and destination u. The lines are local polynomial fits.

D.4 An interpretation of migration costs

The distribution of migration costs We first shed light on the distribution of bilateral migration costs for family migration ($\tau_{ru}^{m_2}$) and non-family migration ($\tau_{ru}^{m_1}$) in panel (a) of Figure D.2 and their relationship with (log) distance between origins and destinations in panel (b). We find that migration tends to induce high costs, and such costs are higher when destinations are distant from origins (panel b). These findings reflect the relatively low incidence of migration given the rural-urban wage gap and the observed geographic gravity in movements across Chinese prefectures.[48]

The role of migration policies One component of the previous costs is the result of migration policies. Migration policies are influenced by various factors that are imperfectly observed and might directly enter the choice of potential migrants (e.g., the tightness of local labor markets, the quality of local public goods, or the state of local finances). We exploit the level of grain reserves before 2000 as in Zhang et al. (2020), g_u, to isolate exogenous variation in migration policies and provide causal estimates for

[48] Our estimates of migration costs can be compared with those of Bryan and Morten (2019) and Tombe and Zhu (2019). Two points are worth noting. First, Tombe and Zhu (2019) do not take into account the 0s in the migration matrix when estimating the elasticity of substitution across destinations. This attenuates the estimates of $1/\lambda$, which mechanically leads to higher estimates of migration costs. Second, when reporting average migration costs (as these two papers do), it is also important to think about the role of 0s. The model interprets zero migration flows between an origin and a destination as infinite migration costs (or as costs equal to 100 percent of the wage at destination). Hence, whether the data set has more or fewer 0s, which may be related to data collection rather than true migration costs, has a strong influence on reported average migration costs. This explains why we do not emphasize the level of our estimates as much as their heterogeneity.

Table D.8. Migration costs and migration policies.

Bilateral migration costs	(1)	(2)
Hukou conversion	-4.554	-5.857
	(1.146)	(1.954)
Observations	5,278	2,810
Migration mode	$j = 1$	$j = 2$
F-stat	22.19	14.63

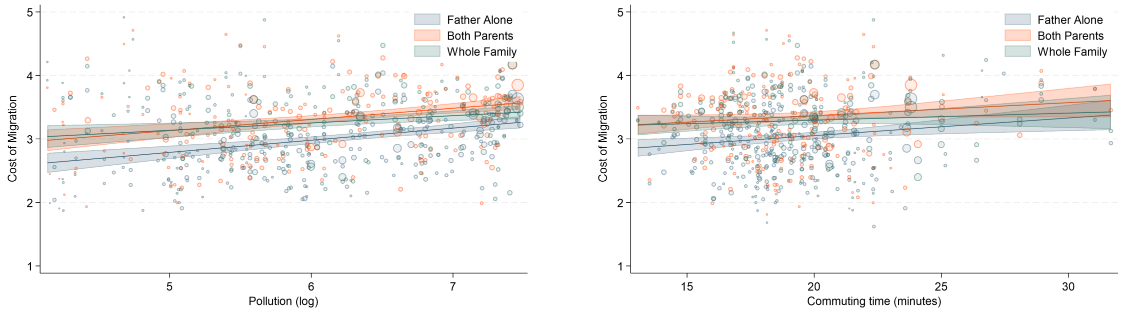
Notes: A unit of observation is a destination/origin pair within the connected set. Standard errors are clustered at the level of destinations and are reported between parentheses. The specification uses population weights in 2000. The dependent variable is the model-computed bilateral cost of migration, $\tau_{ru}^{m_j}$. *Hukou conversion* is the share of migrants who had converted their *hukou* registration place to the local prefecture in 2010, as observed from the 2010 Census. The set of controls consists of: a local price shock between 1995–2000 and 2000–2005 as induced by international crop prices (Imbert et al. 2022), a trade shock computed following Facchini et al. (2019), bilateral (geodesic) distance between origin and destination, and the share of developable land as induced by local geography around city borders before the baseline period (1995-2000). The instrument is the relative level of grain reserves in 1990, g_u, from the *1991 City Statistical Yearbook*.

their impact on the spatial distribution of migration barriers.[49] In Table D.8, we report the effect of a proxy for migration policies—the probability to convert registration at destination—on the inferred migration barriers for migrants with and without family. We find that a marginal increase of 0.01 in the probability to convert registration at destination raises the value of a destination by about 4.55% for migrants without family (column 1) and 5.86% for migrants with family (column 2). To better understand the welfare gap that policy induces across potential destinations, consider the median city in terms of restrictions versus the most restrictive city. This median city (Zhuzhou, Hunan) has a 0.10 higher registration conversion rate, compared to the most restrictive city (Beijing). Our previous estimates would imply that such a policy gap would translate into a very large welfare gap, equivalent to an 80% increase in real wages for family migrants and a 58% increase for migrants without family.[50]

[49]The rationale goes back to constraints on the non-market allocation of resources in a poor country with limited communications and state capability (see, e.g., Riskin 1981). The opening of the Chinese economy in the 1990s and 2000s was expected to generate significant migration flows, and the initial disparity in *hukou* stringency reflected the capacity of a prefecture to sustain its population without external intervention (Cai et al. 2001). The mark left by the Great Famine and its handling by the central government might have made these self-sufficiency constraints palatable to local decision makers, because of the risks of relying on outside supplies of grain (Meng et al. 2015).

[50]These estimates come from the following calculations: A 0.10 higher registration conversion rate reduces the value of migration barriers, $\tau_{ru}^{m_j}$, by 0.455 for migrants without family and 0.586 for migrants with family. Given our modeling assumptions, $\tau_{ru}^{m_j}$ is expressed in (log) units of real wages, and these increases would correspond to a $(\exp(0.455) - 1) \times 100 \approx 58\%$ increase in real wages for migrants without family and a $(\exp(0.586) - 1) \times 100 \approx 80\%$ increase for migrants with family.

Figure D.3. Relative cost of family migration and observable amenities.

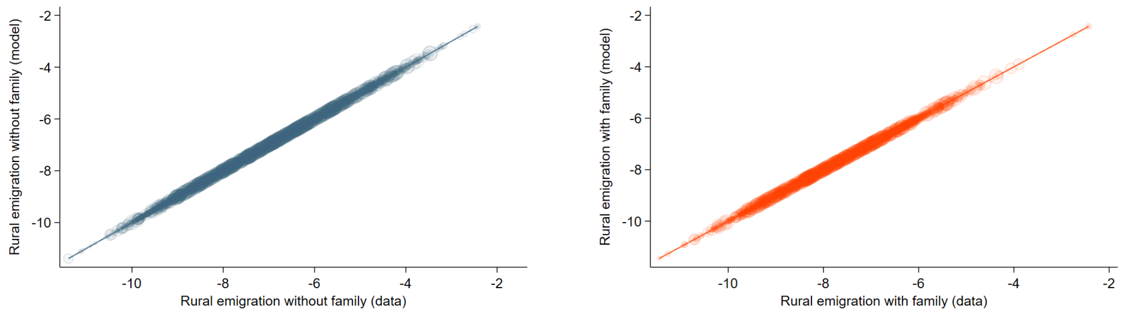


(a) Pollution (b) Commuting time

Notes: This Figure plots the correlation between the average cost, τ_{ju}, for family ($j = 2$) versus non-family migrants ($j = 1$) across destinations against (log) pollution (2001–2005) in panel (a) and commuting time (from the "2015 Mini-Census") in panel (b).

The role of other factors and a sanity check In Figure D.3, we complement the previous evidence by plotting the relationship between the average cost and measures of pollution (panel a) and commuting time (panel b). We find that higher levels of pollution are associated with higher perceived barriers at destination for both migration modes.

Figure D.4. Bilateral migration costs—matching migration flows.



(a) Without family ($\tau^{m_1}_{ru}$) (b) With family ($\tau^{m_2}_{ru}$)

Notes: Panel (a) plots the predicted non-family migration induced by bilateral migration costs ($\tau^{m_1}_{ru}$) against the actual migration rates. Panel (b) plots the predicted family migration induced by bilateral migration costs ($\tau^{m_2}_{ru}$) against the actual migration rates.

Finally, we display in Figure D.4 a validation of our bilateral migration estimates. By construction, these estimates—combined with the other estimates of the nested location model—should allow us to match migration flows between all origins and destinations of the largest connected set (Abowd et al. 1999, Card et al. 2013, Buggle et al. 2023). Figure D.4 shows that our inferred migration barriers indeed allow us to match exactly migration incidences from all origins to all destinations. We perform the same sanity checks for all alternative models described in Section 5.4 and Appendix E.3.

E The role of displaced consumption and frictions in shaping migration

This Appendix provides complements to our counterfactual exercises in Section 5. In a first step, we focus on the main experiments discussed in Sections 5.1, 5.2 and 5.3, and we explore the normative implications of displaced consumption and migration frictions and their redistributive effects. In a second step, we consider simple extensions of our baseline quantitative model to allow for agglomeration and congestion externalities. In a third step, we illustrate the quantitative and qualitative insights induced by our precise modeling of migration and consumption choices. In settings with large differences in living standards across space, the incentives for households to migrate with or without family and split their consumption between origin and destination are instrumental in explaining migration flows. Ignoring them leads to a misspecification of bilateral migration frictions and policy evaluations.

E.1 Displaced consumption, migration frictions, and normative implications

Migration patterns, prices, and remittances In Sections 5.1, 5.2, and 5.3, we present the effects of our counterfactual experiments on migration patterns in China. In Table E.1, we further report their effect on wages and rents at destination and on the amount that is remitted from urban locations to rural origins. One can see that wages and rents respond to immigration flows in similar, yet opposite, fashion. Note, however, that the wage effect is the one explaining most of the welfare response of urban-born households to migration because local prices represent a fraction of expenditures (about 0.65) such that a decrease of 1% of nominal wage has a larger impact on real wage than an increase of 1% in local prices. Table E.1 also sheds light on the compositional effect of migration flows on remittances. For instance, counterfactual experiments (2a), (2b), (3a), or (3b) induce a slight increase in migration flows but a significant, yet small, *decrease* in remittances: The migration increase is indeed disproportionately explained by family migration, which typically generates smaller shares of remittances from each migrant household.

Distributional effects across space We now highlight the distributional effects of our experiments.

We first provide additional evidence on the distributional effects of our counterfactual experiments across more or less expensive cities in Figures E.1 and E.2. More specifically, we display the difference in the concentration of migrants across cities between the counterfactual and baseline scenarios (baseline migrant concentration can be found in Figure 2), the incidence of migration as a function of the actual level of rents in 2005

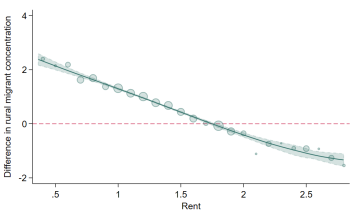
Table E.1. The role of consumption patterns and migration frictions—complements.

	Wage (% rel. base.)	Rent (% rel. base.)	Remit. (% rel. base.)
	1. Consumption imbalances		
No remittances (1)	0.298	-0.393	-100.00
	2. Reducing the cost of education for migrants		
Blanket subsidy (2a)	-0.072	0.085	-1.74
Targeted subsidy (2b)	-0.063	0.080	-3.45
	3. Removing family-specific migration frictions		
No family penalty (3a)	-0.089	0.117	-4.57
No policy-ind. family penalty (3b)	-0.027	0.032	-0.94
	4. Reducing overall migration frictions		
Relaxing *hukou* policy (4)	-0.407	0.452	55.33

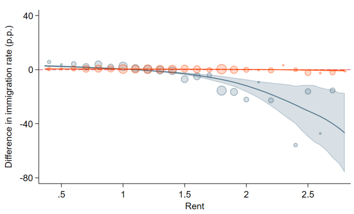
Notes: This Table reports statistics on the extent, nature, and consequences of migration flows in the baseline and in counterfactual experiments (1: taxing remittances), (2a: subsidizing education costs), (2b: subsidizing education costs in non-mega-cities), (3a: equalizing residual migration costs), (3b: family-specific removal of policy-induced frictions), and (4: relaxing *hukou* policy). Across all experiments, we report the differences implied by the experiment—relatively to the baseline, and in percentage points—on: urban wage in column (1), the urban rent in column (2), and the level of remittances by migrants across modes and from all urban destinations to all origins (column 3).

and relative to the baseline, and the differences in the welfare of urban-born households relative to the baseline across cities. The difference in rural migrant concentration, displayed in the left panels, allows us to visualize the change in the spatial distribution of migrants that the counterfactual would generate—a difference that can also be interpreted as the change in the (log) share of total rural migrants that a city hosts. Figure E.1 illustrates that shutting down remittances very significantly reduces migrant concentration in larger, expensive agglomerations (panel a). Removing the possibility for migrants to displace their consumption leads to fewer of them moving to expensive cities without their family and slightly more of them moving with family across all cities (panel b). This experiment leads to moderate welfare losses for urban-born households in the least expensive cities and to larger welfare gains for urban-born households in the most attractive (and expensive) ones—see panel (c). Subsidizing education at destination,

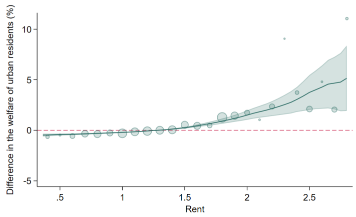
Figure E.1. Distributional effects across cities—consumption imbalances and education policy.



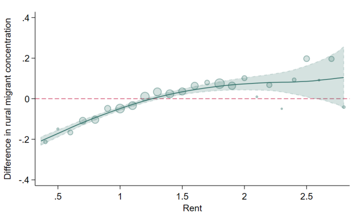
(a) Migrant concentration (1)



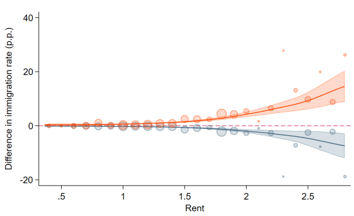
(b) Moving with(out) family (1)



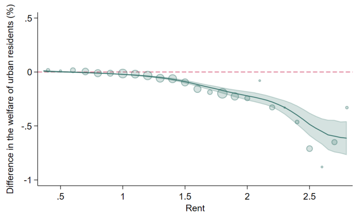
(c) Welfare of natives (1)



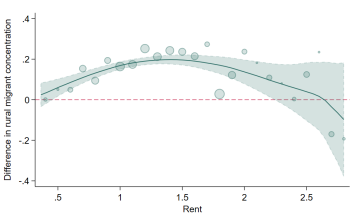
(d) Migrant concentration (2a)



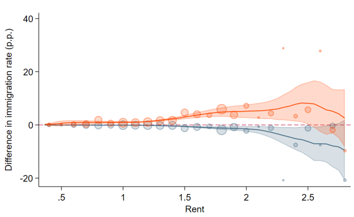
(e) Moving with(out) family (2a)



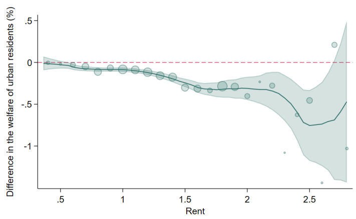
(f) Welfare of natives (2a)



(g) Migrant concentration (2b)



(h) Moving with(out) family (2b)



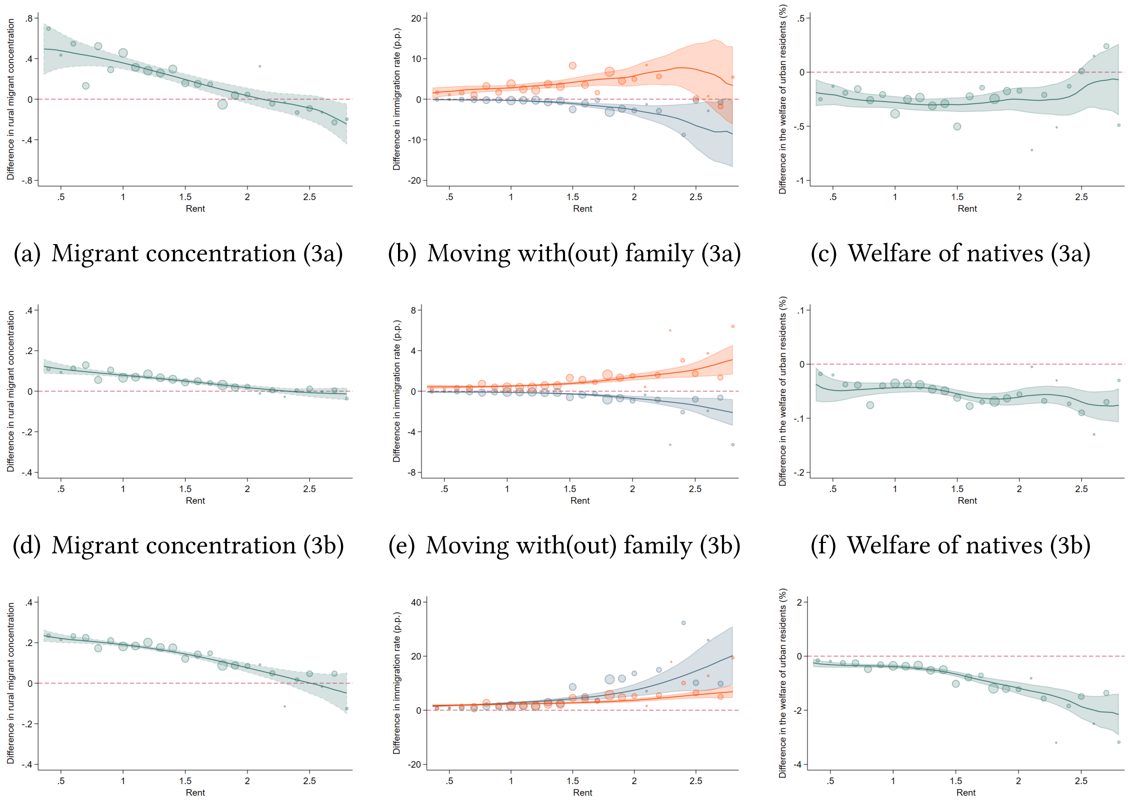
(i) Welfare of natives (2b)

Notes: This Figure reports statistics on the extent, nature, and consequences of migration flows in counterfactual experiments (1: taxing remittances), (2a: subsidizing education costs), and (2b: subsidizing education costs in non-mega-cities). More specifically, we display: the difference in the concentration of migrants across cities between the counterfactual and baseline scenarios in panels (a/d/g); the incidence of migration in percentage points of the baseline city population (with family in orange, without family in blue) in panels (b/e/h); and the differences in the welfare of urban-born households relative to the baseline in panels (c/f/i). We group cities by bins of similar rents to limit the number of points; and their size is weighted by the total population at baseline in those cities.

counterfactual (2a), leads to a massive substitution across migration modes (apparent in panel e) and ambiguous effects on migrant concentration: On the one hand, more expensive cities become more affordable; on the other hand, there are more family migrants, typically more impacted by local prices. We find that the first effect dominates slightly, and migrants concentrate slightly more in more expensive cities, entirely driven by a surge in family immigration. The best way to visualize these effects is to contrast counterfactual (2a) with counterfactual (2b), shutting down the first effect: Migrants then concentrate in mid-size cities, driven by a surge in family migration.

Finally, equalizing the residual component of utilities between the different migration modes, i.e., $\tau_{ru}^{m_2} := \tau_{ru}^{m_1}$ in counterfactual (3a) or the equalization through the effect of policy as in counterfactual (3b), leads to some reduction in migrant concentration, with migrants favoring *medium-sized cities*, and a substitution away from non-family

Figure E.2. Distributional effects across cities—removing migration penalty.



(a) Migrant concentration (3a) (b) Moving with(out) family (3a) (c) Welfare of natives (3a)

(d) Migrant concentration (3b) (e) Moving with(out) family (3b) (f) Welfare of natives (3b)

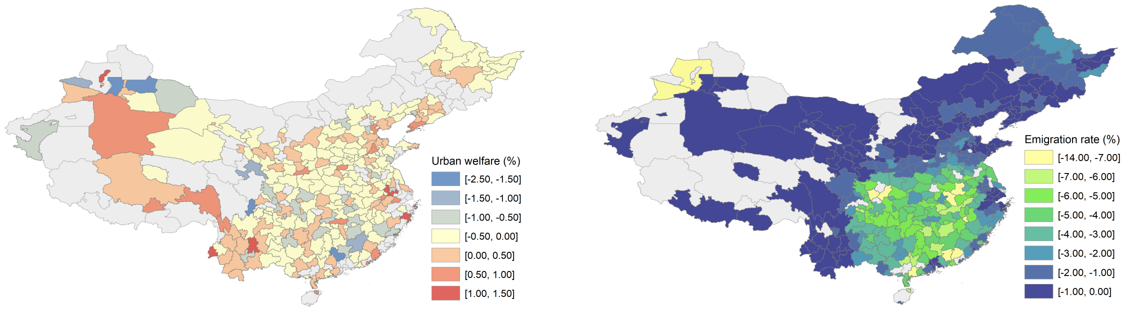
(g) Migrant concentration (4) (h) Moving with(out) family (4) (i) Welfare of natives (4)

Notes: This Figure reports statistics on the extent, nature, and consequences of migration flows in counterfactual experiments (3a: equalizing residual migration costs), (3b: family-specific removal of policy-induced frictions), and (4: relaxing *hukou* policy). More specifically, we display: the difference in the concentration of migrants across cities between the counterfactual and baseline scenarios in panels (a/d/g); the incidence of migration in percentage points of the baseline city population (with family in orange, without family in blue) in panels (b/e/h); and the differences in the welfare of urban-born households relative to the baseline in panels (c/f/i). We group cities by bins of similar rents to limit the number of points; and their size is weighted by the total population at baseline in those cities.

migration. However, these adjustments are one order of magnitude smaller than the ones induced by equalizing the *consumption* component of utilities (counterfactual 1).

We shed further light on the geography of counterfactual experiment (1) in Figure E.3. In panel (a), we nest those effects across destinations and report the change due to the experiment in the welfare of urban-born households. We find that the large, aggregate drop in migration mostly concerns a few urban centers: the large cities (Beijing, Shanghai) and the new exporting regions (Shenzhen/Guangzhou, Fujian, Zhejiang). In panel (b), we nest those effects across origins and report the change in the emigrant share. We find that fewer rural migrants of the "hinterlands" of the highly productive coastal prefectures would leave. In summary, the possibility for migrants to remit explains the very large outflows from the Southern, Central regions of China to productive coastal prefectures with less amenable conditions to family migrants.

Figure E.3. Displaced consumption—implication across destinations and origins.

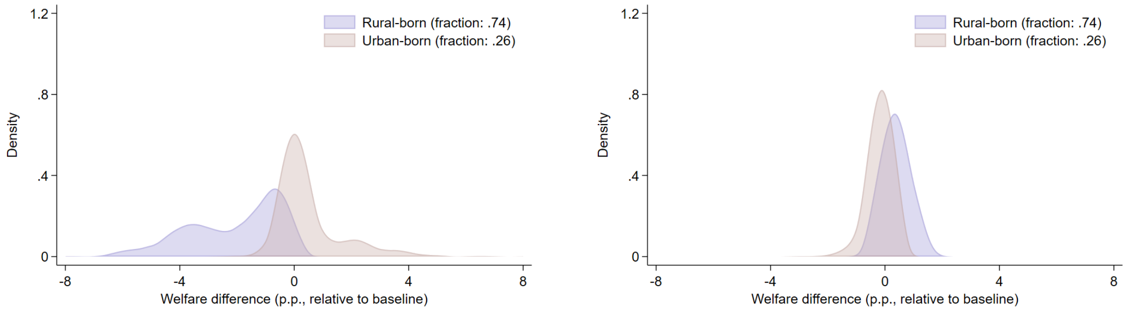


(a) Welfare of urban-born (b) Rural emigration

Notes: Panel (a) displays the change in the welfare of urban-born households (in percentage points) at destination, as induced by the counterfactual (1) that prevents consumption displacement. Panel (b) displays the change in the emigration rate across origins.

Welfare and inequalities The previous section sheds some light on the distributional effects of our counterfactual experiments across space. We now discuss the redistributive effects of such experiments between rural- and urban-born households.

Figure E.4. Consumption patterns and migration frictions—welfare changes.



(a) Welfare changes (1) (b) Welfare changes (3a)

Notes: This Figure displays the welfare effects of our main experiments: counterfactual (1) tilting consumption patterns in panel (a); and counterfactual (3a) equalizing migration restrictions in panel (b). The panels report the differences in the welfare of urban-born and rural-born households in percentage points relative to the baseline. Given our assumptions, those differences can be interpreted as (log) units of equivalent real wage. In other words, a one percentage point difference is equivalent to a change in real wage of 1%.

We provide some evidence about the normative implications of our experiments—counterfactual (1) tilting consumption patterns and counterfactual (3a) equalizing migration restrictions as discussed in Section 5—in Figure E.4. Panel (a) shows that the possibility for potential migrants to remit favors rural-born households. A counterfactual economy with consumption less closely tied to origins would induce welfare gains for urban-born households and would harm most rural-born households. We see that the welfare gains for urban dwellers are dispersed, reflecting the wide heterogeneity in attractiveness across possible destinations. The main winners would be urban-born households in booming, expensive cities. The welfare losses for rural households are also dispersed—reflecting the gravity structure of migration flows and the heterogeneous attractiveness of nearby destinations. More specifically, households living in the proximity of expensive cities are most affected by such an experiment, while households living far from any attractive cities are far less impacted. However, even the most affected households might still be able to mitigate the effect of the policy by switching between migration modes and/or destinations. In summary, counterfactual (1): increases inequality between urban-born and rural-born households; increases the welfare differences within urban-born households; and slightly decreases the welfare differences across rural-born households. Indeed, the lucky urban households born in attractive cities are better off than before, when the relatively lucky rural households born in the hinterlands of such cities are worse off.

Equalizing migration frictions across living arrangements induces much less significant redistributive effects, as illustrated in panel (b) of Figure E.4. The equalization of migration barriers across living arrangements would generate moderate gains for a very large number of rural-born households, the extent of which would depend on the location of rural areas compared to the most attractive destinations. The large mass of rural households in China's interior provinces would gain between 0 and 1% in equivalent real wage from this experiment. In conclusion, this relaxation would be a progressive policy, in the sense that it would reduce the gap between rural- and urban-born households, but with very limited overall impact.

E.2 Introducing externalities

Our quantitative model does not feature any agglomeration externalities or congestion forces other than the ones operating through the adjustment of labor and housing markets across locations. In this section, we show how agglomeration spillovers and congestion externalities at destination would affect (i) the allocation of rural-urban migrants across space and (ii) the normative implications of a relaxation of migration policies.

We consider our baseline model, as estimated in Section 4, and add the following features across four alternative models and three sources of externalities: (i) constant and size-varying production externalities in cities, e.g., the total factor productivity is $\mathcal{A}_u L_u^{0.05}$, where L_u is labor and $\mathcal{A}_u$ is an exogenous productivity shifter in urban location u, as standard in quantitative models of urban economics (see, e.g., Ahlfeldt et al. 2015); (ii) negative congestion externalities arising from urban sprawl or pollution (see, e.g., Khanna et al. 2021), i.e., $Z_u = \mathcal{Z}_u L_u^{-0.025}$, where $\mathcal{Z}_u$ is an exogenous amenity shifter; and (iii) positive externalities from remittances at origin, i.e., the total factor productivity

Table E.2. The role of consumption patterns and migration frictions—externalities.

	Migrant hou. (millions)				Welfare (%)		In mega-cities	
	All	No fam.	Fam.	Fam. sh.	Rural	Urban	All	Fam. sh.
Baseline	28,49	23,01	5.48	0.192	-	-	14,53	0.141
0. Baseline model								
Relaxing *hukou* policy (4)	47,48	35,76	11,72	0.247	2.650	-0.705	23,45	0.186
1. Agglomeration spillovers								
Productive spillovers (cons.)	47,85	36,08	11,77	0.246	2.700	-0.461	23,77	0.185
Productive spillovers (var.)	47,77	36,00	11,77	0.246	2.690	-0.481	23,23	0.187
2. Negative spillovers on amenities								
With negative externalities	47,38	35,67	11,71	0.247	2.640	-0.766	23,35	0.186
3. Spillovers from remittances at origin								
With remittance spillovers	45.48	34,23	11,24	0.247	5.080	-0.638	22,48	0.186

Notes: This Table reports statistics on the extent, nature, and consequences of migration flows in the baseline and in counterfactual experiment (4) across five alternative models: the baseline model, a model with agglomeration spillovers, a model with size-dependent agglomeration spillovers, a model with negative externalities on amenities at destination, and a model with positive productive spillovers at origin as induced by the level of remittances. Across all experiments, we report: the number of migrant households (overall in column 1, without family in column 2, and with family in column 3, all reported in millions of migrant households between 2000 and 2005); the share of migrants living with family in column (4); the welfare of rural-born households in column (5), in % relative to the baseline; the welfare of urban-born households in column (6), in % relative to the baseline; the number of migrant households who are moving toward mega-cities above 5,000,000 residents (Shanghai, Beijing, Chongqing, Tianjin, Guangzhou, Shenzhen, Chengdu, Nanjing, Wuhan, Xi'an, Dongguan, Hangzhou, Foshan, Shenyang, Suzhou, Haerbin, Qingdao, Dalian, Ji'nan) in column (7); and family migration incidence among migrants who are moving toward mega-cities above 5,000,000 residents in column (8).

is $\mathcal{A}_r R_r^{0.05}$, where R_r is the level of remittances received in rural location r (conveying the idea that remittances can be used as productive investment, see Pan and Sun 2024, Khanna et al. 2022).

Table E.2 shows that the addition of productive spillovers (sometimes called agglomeration economies) further boosts the effect of relaxing migration restrictions (policy 4, described in Section 5.3) with a larger number of migrants moving to cities with or without family than in the baseline model. The effect remains, however, limited: The first panel of Table E.2 predicts an additional inflow of about 370,000 rural-born households. Adding positive agglomeration externalities implies that rural-born households are left better off from the relaxation of restrictions than estimated through our externality-free model and urban-born households are less worse off—both effects being driven by a muted response of wages to migration flows. Negative congestion externalities have the exact opposite effect: The migration response to the policy is lower, and its normative implications are less positive. More specifically, urban-born households lose more from the relaxation of restrictions when rural-born households gain slightly less. Finally, assuming that remittances boost production at origin changes our predictions in the most significant manner: While this spillover increases the social returns to migration, these returns are not internalized by migrants such that the increase in local wages mitigates the desire to move to urban destinations. In such a model, migrants would respond *less* positively to a relaxation policy, even though the policy would have much larger welfare effects. Their muted response implies that the level of remittances would be lower than that predicted by the externality-free model. In the presence of such externalities, a social planner would be tempted to subsidize migration rather than penalize it.

E.3 Sensitivity analysis and alternative migration models

Table E.3. The role of migration policies—sensitivity analysis.

	Migrant hou. (millions)				In mega-cities	
	All	No fam.	Fam.	Fam. sh.	All	Fam. sh.
Baseline	47,48	35,76	11,72	0.247	23,45	0.186
Children	46,58	35,36	11,22	0.241	23,49	0.181
Mothers	39,68	27,98	11,70	0.295	19,62	0.222
Controls	45,97	34,38	11,59	0.252	23,48	0.191

Notes: This Table reports statistics on the extent, nature, and consequences of migration flows in counterfactual experiment (4: relaxing *hukou* policy). We do so for the baseline model and for three alternative parameterizations for the location choice model, based on two alternative definitions of living arrangements (*Children*: migrants without versus with children at their destination, *Mothers*: female migrants leaving children behind versus those with their children at their destination) and a procedure with additional control variables (*Controls*, adding the population at origin for the estimation of all nests, and the land supply shifter at origin for the middle and upper nests). See Table D.6 in Appendix D.2. We report: the number of migrant households (overall in column 1, without family in column 2, and with family in column 3, all reported in millions of migrant households between 2000 and 2005); the share of migrants living with family in column (4); the number of migrant households who are moving toward mega-cities above 5,000,000 residents (Shanghai, Beijing, Chongqing, Tianjin, Guangzhou, Shenzhen, Chengdu, Nanjing, Wuhan, Xi'an, Dongguan, Hangzhou, Foshan, Shenyang, Suzhou, Haerbin, Qingdao, Dalian, Ji'nan) in column (5); and family migration incidence among migrants who are moving toward mega-cities above 5,000,000 residents in column (6). Note that rural-born households constitute about 75% of our sample.

Sensitivity analysis In Table D.6 of Appendix D.2, we consider alternative parameterizations of our location choice model with alternative definitions of living arrangements or a procedure with additional control variables. We show the differences implied by these choices for our counterfactual experiment (4: relaxing *hukou* policy)—an experiment that can be run for various, alternative models of location choice, as will be clear in the next sub-section. We find that these variations around the baseline do not affect our insights too markedly. Only the *Mothers* parameterization, based on female migrants leaving children behind versus those with their children at their destination, *slightly* differs from the baseline: The former features more substitutability between living arrangements (and thus more migration with children in experiment 4) and less responsiveness to local conditions versus those in urban areas (and thus fewer migrants in the aggregate).

Alternative migration models Our quantitative model of location choice is designed to best capture the choice of rural residents in transforming economies with large productivity and price differentials across urban areas and an even wider rural-urban gap. In those settings, rural migrants often consume at origin to mitigate the living costs at destination, and an important adjustment margin is whether to leave relatives behind or not (as we document in Section 2). For these reasons, we add the following ingredients to the standard migration models (see, for instance, Bryan and Morten 2019, Tombe and Zhu 2019, Monras 2020): (i) a three-nest structure for the location choice model allowing potential migrants to trade off whether to migrate or not, how to do so (with or without family), and where to go; and (ii) a technology to displace part of the consumption of non-tradable goods across household members and across space, depending on the migration mode (with or without family).

In this section, we illustrate the quantitative and qualitative insights gained through the adoption of those two novel features. To do so, we estimate three alternative models: (1) a simple model of location choice among numerous alternatives, and where the birth location is one of those alternatives (Bryan and Morten 2019, Tombe and Zhu 2019); (2) a two-nest structure with the upper nest capturing the decision to migrate or not, and the lower nest modeling the choice of destinations (Monras 2020); and (3) a two-nest structure adding the possibility for migrants to displace part of their consumption (Albert and Monras 2022). In all these models, we treat family and non-family migrants as two separate populations, thus estimating separate elasticities. We estimate these models using a similar approach as in Section 4. We thus estimate Model 1 by assuming a standard formulation for real wages, i.e., $\ln(w_u/p_u^{\alpha})$, and estimating the parameters λ_j in a similar manner as in Table 2 (but with a slightly different explanatory variable).

We estimate Model 2 by assuming the same standard formulation for real wages, i.e., $\ln(w_u/p_u^{\alpha})$, estimating the parameters λ_j and γ_j in a similar manner as in Tables 2 and 4. Model 3 follows the same estimation as Model 2, except for the computation of price indices, which are calculated—across living arrangements—as in the baseline.

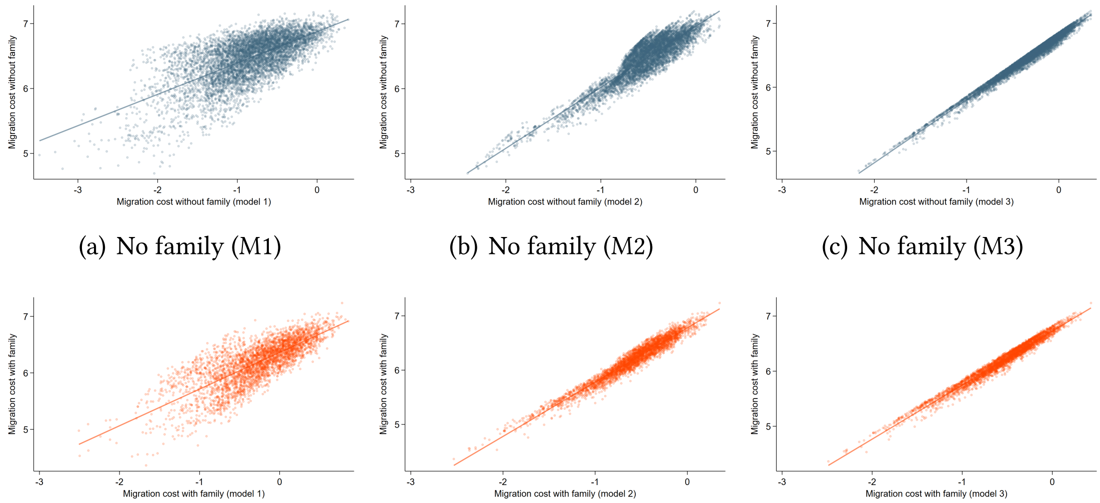
Table E.4. The role of migration policies—alternative migration models.

	Migrant hou. (millions)				In mega-cities	
	All	No fam.	Fam.	Fam. sh.	All	Fam. sh.
Our model	47,48	35,76	11,72	0.247	23,45	0.186
rel. baseline (%)	*+66.7*	*+55.4*	*+113.9*	*+28.6*	*+61.4*	*+31.9*
Model 1 (λ_i)	532,00	443,70	88,33	0.166	239,80	0.128
rel. baseline (%)	*+1767.3*	*+1828.3*	*+1511.9*	*-13.5*	*+1550.4*	*-9.2*
Model 2 (λ_i, γ_i)	46,51	39,07	7,44	0.160	23,52	0.118
rel. baseline (%)	*+63.2*	*+69.8*	*+35.8*	*-16.7*	*+61.9*	*-16.3*
Model 3 ($\lambda_i, \gamma_i, \mathcal{P}_i$)	47,62	40,13	7,49	0.157	24,96	0.116
rel. baseline (%)	*+67.1*	*+74.4*	*+36.7*	*-18.2*	*+71.8*	*-17.7*

Notes: This Table reports statistics on the extent, nature, and consequences of migration flows in counterfactual experiment (4: relaxing *hukou* policy). We do so for the baseline model and for three alternative models: model 1, model 2, and model 3. We report: the number of migrant households (overall in column 1, without family in column 2, and with family in column 3, all reported in millions of migrant households between 2000 and 2005); the share of migrants living with family in column (4); the number of migrant households who are moving toward mega-cities above 5,000,000 residents (Shanghai, Beijing, Chongqing, Tianjin, Guangzhou, Shenzhen, Chengdu, Nanjing, Wuhan, Xi'an, Dongguan, Hangzhou, Foshan, Shenyang, Suzhou, Haerbin, Qingdao, Dalian, Ji'nan) in column (5); and family migration incidence among migrants who are moving toward mega-cities above 5,000,000 residents in column (6). For each variable and each model, the percentage difference between the counterfactual prediction and its initial level is reported in *italics*.

To show the quantitative differences implied by the different models, we evaluate counterfactual experiment (4: relaxing *hukou* policy). Model 1 provides nonsensical predictions, because it only features *one* elasticity across all locations (including the birth location) for each migrant mode, and this elasticity is very high. A significant improvement in conditions across possible destinations—as in counterfactual experiment (4)—would generate massive outflows. Model 2, by introducing an upper nest and lower estimates for the elasticity of outmigration, corrects for this issue. Overall migration incidence is quite close to our baseline estimates, as are additional migration inflows to large cities. It however misses the substitutability across living arrangements and significantly under-estimates the incidence of family migration: migration without family is predicted to increase relatively more than family migration, leading to a decrease in the incidence of family migration in the aggregate and in large cities. This prediction starkly contrasts with our model insight. Adding realistic measures of local prices across living arrangements—as in Model 3—does not help in that respect: the overall number of additional migrant households remains closely aligned with our model prediction(s), but not their composition; altering the sensitivity to local prices has different implications in a model where households *can* switch from one migration mode to the other. In summary, our quantitative model of location choice does not only provide qualitative insights about the nature of migration in transforming economies; it also has quantitative implications for the effect of migration frictions/policies on the spatial allocation of migrant households and their composition across space.

Figure E.5. Correlation between migration frictions across models.



(a) No family (M1) (b) No family (M2) (c) No family (M3)

(d) Family (M1) (e) Family (M2) (f) Family (M3)

Notes: Model 1 assumes a standard formulation for real wages, i.e., $\ln(w_u/p_u^{\alpha})$, and a one-nest migration model for each migrant mode j (we estimate λ_j in a similar manner as in Table 2). Model 2 assumes the same standard formulation for real wages, i.e., $\ln(w_u/p_u^{\alpha})$, but considers a two-nest migration model for each migrant mode j (λ_j and γ_j are estimated in a similar manner as in Tables 2 and 4). Model 3 follows the same estimation as Model 2, except for the computation of price indices which are calculated as in the baseline.

One crucial element of such migration models—including our baseline model—is to nest all residual, unexplained variation in migration flows in bilateral migration costs. This set of inferred parameters, labeled $\left\{\tau_{ru}^{m_j}\right\}_{j,r,u}$ in our framework, are capturing actual pull or push factors, and gravity or network effects, but also residual errors and biases when the model is misspecified. In Figure E.5, we show the correlation between our baseline bilateral costs and the estimated costs in alternative models. Overall, we find that our estimated bilateral costs for family migration become more closely matched when we introduce the various elements of our theory: a multi-nest location choice model, and realistic price indices. However, we argue that the variation underlying these residual terms remains better behaved in our baseline model than in these simpler alternatives.

Table E.5 regresses (a transformation of) the bilateral migration costs obtained across

Table E.5. Explaining bilateral costs $\left\{\tau_{ru}^{m_j}\right\}_{j,r,u}$.

Bilateral migration costs $\left(\exp(-\tau_{ru}^{m_j})\right)$	Model 1	Model 2	Model 3	Baseline
Wage × $\mathbb{1}_{j=2}$	-0.166	-0.142	-0.171	-0.032
	(0.081)	(0.080)	(0.079)	(0.086)
Local price × $\mathbb{1}_{j=2}$	-0.085	-0.089	0.043	0.009
	(0.064)	(0.063)	(0.063)	(0.065)
Bilateral distance × $\mathbb{1}_{j=2}$	-0.202	-0.249	-0.232	-0.177
	(0.029)	(0.029)	(0.029)	(0.031)
Observations	175,154	175,154	175,154	174,576

Notes: A unit of observation is a triplet of mode/origin/destination (j, r, u). The estimation is a Poisson regression, and standard errors are reported between parentheses. The dependent variable is a transformation of the bilateral migration costs, $\exp(-\tau_{ru}^{m_j})$, and the explaining variables are the wage, local prices at destination, and bilateral distance interacted with the mode, $\mathbb{1}_{j=2}$. The reported estimates are relative differences in bilateral migration costs across living arrangements, as induced by observable living standards at destination (and distance). All specifications control for the wage, local prices at destination, a mode fixed effect, origin-fixed effects and the (log) distance between the origin and the destination. Model 1 assumes a standard formulation for real wages, i.e., $\ln(w_u/p_u^{\alpha})$, and a one-nest migration model for each migrant mode j (we estimate λ_j in a similar manner as in Table 2). Model 2 assumes the same standard formulation for real wages, i.e., $\ln(w_u/p_u^{\alpha})$, but considers a two-nest migration model for each migrant mode j (λ_j and γ_j are estimated in a similar manner as in Tables 2 and 4). Model 3 follows the same estimation as Model 2, except for the computation of price indices which are calculated as in the baseline.

the different models, $\exp(-\tau_{ru}^{m_j})$, on a set of observable predictors for these migration frictions (interacted with the migration mode, $j = 2$): (i) the wage of migrants at destination and (ii) the local price at destination, as placebo variables that should not be predictive outside of its indirect effect through real wages, and (iii) distance between origins and destinations to capture the iceberg costs of migration. Models 1 and 2 fail to restrict the effect of wages/local prices to their impact through real wages (see columns 1 and 2)—a feature that we attribute to their failure to account for displaced consumption and the fact that migrants allocate different shares of their income to local consumption when they migrate with or without family. Model 3 better accounts for the latter effect, as apparent from the predictive power of the price of the non-tradable good, but does not fully neutralize the correlation between bilateral migration costs and living standards at destination. Because it ignores substitutability across migration modes, any factor favoring one migration mode will appear in both bilateral costs, positively in one and negatively in the other. The impact of such misspecification is made salient through the observed gaps across migration modes in the estimates for wages—a gap that we do not observe in our baseline model (column 4). We interpret these findings as supportive evidence for our baseline model.